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Alou Adessé Dama

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**ÉCOLE DOCTORALE SCIENCES ÉCONOMIQUES,
JURIDIQUES, POLITIQUES ET DE GESTION**
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Ecole Doctorale des Sciences Economiques, Juridiques, Politiques et de gestion
Centre d'Etudes et de Recherche sur le Développement International (CERDI)

Université Clermont Auvergne, CNRS, IRD, CERDI, F-63000 Clermont-Ferrand, France

DOMESTIC REVENUE MOBILIZATION IN DEVELOPING COUNTRIES: COLLECT MORE SPEND BETTER

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pour l'obtention du titre de Docteur en Sciences Economiques

par

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sous la direction de

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DEDICACE

Je dédie ce travail à :

L'éternel Dieu le plus haut,

Pour sa protection et sa grâce. J'espère devenir un meilleur croyant et un pratiquant irréprochable.

A ma mère Mariam Konaté,

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RESUME

Cette thèse aborde la thématique du *Collect more spend better* dans les pays en développement avec un focus sur les pays d'Afrique sub-saharienne. Une meilleure mobilisation des recettes fiscales combinée à une utilisation efficiente des ressources publiques représente une réponse crédible au besoin de financement des pays pauvres. La thèse contient six chapitres et un chapitre supplémentaire en annexe.

Le chapitre 1 porte sur la politique fiscale dans les pays en développement. Dans ce chapitre, nous démontrons l'existence d'une concurrence fiscale pour taxer la même base lorsque le pouvoir d'imposition est fragmenté. Le chapitre 2 explore la relation entre la libéralisation des échanges et les recettes fiscales. Les résultats montrent que la libéralisation a été accompagnée d'une réduction des recettes fiscales. Le chapitre 3 étudie les manifestations. Il démontre l'importance des réseaux sociaux dans le processus de propagation des manifestations. Le chapitre 4 estime l'effet des conflits internes sur les recettes fiscales. Nos estimations montrent un impact négatif des conflits sur les recettes fiscales. Le chapitre 5 développe une mesure de la qualité des dépenses publiques. On y montre le besoin d'amélioration de la qualité des dépenses publiques dans les pays en développement. Dans le chapitre 6, nous identifions les déterminants de cette qualité des dépenses publiques. Le chapitre complémentaire en annexe mesure l'effort fiscal en Afrique sub-saharienne.

Les différents chapitres illustrent l'importance d'améliorer la mobilisation des recettes fiscales et d'utiliser efficacement ces ressources collectées dans le pays en développement. Afin que cette pratique *collect more spend better* contribue à un développement harmonieux de ces pays, elle doit être accompagnée d'un accroissement de la capacité de l'Etat et d'un renforcement de la sécurité.

Mots clés : Afrique subsaharienne, analyse comparée des pays, conflit interne, connaissance et information, contagion, croissance économique, dépense publique, efficience, fiscalité, impôt, jeux non-coopératifs, libéralisation des échanges, macroéconomie, manifestation, modèle et données en coupe transversale, modèle et données en panel, origine coloniale, ouverture commerciale, pays en développement, performance du gouvernement, politique budgétaire, politique fiscale, réseaux sociaux, ressources du gouvernement, ressources naturelles, revenus fiscaux, structure des impôts, système juridique, variable instrumentale.

JEL Codes: C21, C23, C26, C31, C33, C36, C72, D74, D8, E62, F13, F5, H11, H2, H25, H5, H56, H77, H87, O1, O11, O23, O43, O57, Y4

SUMMARY

This thesis addresses the issue of “collect more spend better” in developing countries with a focus on Sub-Saharan countries. Better mobilization of tax revenue combined with an efficient use of public resources is a reliable solution to the financing needs of poor countries. The thesis contains six chapters and an additional chapter in the appendix.

Chapter 1 focuses on tax policy in developing countries. In this chapter, we demonstrate the existence of interministerial tax competition when the power to tax is fragmented. Chapter 2 explores the relationship between trade liberalization and tax revenue. The results show that liberalization has led to a reduction in tax revenues. Chapter 3 studies the manifestations. It demonstrates the key importance of social media in protest spillover. Chapter 4 estimates the effect of internal conflicts on tax revenue. Our estimates show a negative impact of conflicts on tax revenues. Chapter 5 develops a measure of the quality of public expenditure. It shows the need to improve the quality of public spending in developing countries. In Chapter 6, we identify the determinants of this quality of public expenditure. The additional chapter in the appendix measures the tax effort in Sub-Saharan Africa.

The various chapters illustrate the importance of improving the mobilization of tax revenues and of effectively using these collected resources in the developing country. For this “collect more spend better practice to contribute to the harmonious development of these countries, it must be accompanied by an improvement in State capacity and a strengthening of security.

Keywords: comparative studies of countries, Colonial origin, contagion, cross-sectional models, developing countries, economic development, economic growth, efficiency, expenditure, fiscal policies, government revenue, information and knowledge, instrumental variables, internal conflict, legal origin, macroeconomics, natural resources, noncooperative games, openness, social media, panel data models, performance of government, public spending, street protest, Sub-Saharan Africa taxation, tax policy, tax revenue, tax structure, trade liberalization.

JEL Codes: C21, C23, C26, C31, C33, C36, C72, D74, D8, E62, F13, F5, H11, H2, H25, H5, H56, H77, H87, O1, O11, O23, O43, O57, Y4

Table of contents

<i>DECLARATION</i>	<i>i</i>
<i>DEDICACE</i>	<i>ii</i>
<i>REMERCIEMENTS</i>	<i>iii</i>
<i>RESUME</i>	<i>iv</i>
<i>SUMMARY</i>	<i>v</i>
0. General introduction	18
0.1. <i>Le contexte de la mobilisation des recettes fiscales dans les pays en développement – focus sur l’Afrique sub-saharienne.</i>	20
0.1.1. Une faible mobilisation des recettes fiscales.....	20
0.1.2. ... et un faible effort fiscal	24
0.2. <i>Quelques éléments théoriques de cette faible mobilisation des ressources fiscales</i>	25
0.2.1. Le niveau de revenu et l’importation	26
0.2.2. Les recettes non fiscales.....	26
0.2.3. La structure de l’économie.....	27
0.2.4. Les institutions et la capacité administrative.....	28
0.2.5. Le civisme (fiscal).....	28
0.2.6. L’attraction des capitaux.....	29
0.2.7. L’évasion fiscale.....	29
0.3. <i>La contribution de la thèse</i>	29
0.4. <i>La croissance économique et le concept de « collect more spend better »</i>	33
References.....	38
1. Chapter I: Interministerial Tax competition: The Case of Resource Rich Developing Countries	43
1.1. <i>Introduction</i>	45
1.2. <i>The theoretical model</i>	49
1.2.1. The economy	49
1.2.2. The policy.....	51
1.2.3. The centralized tax regime as a benchmark.....	53
1.2.4. Tax policy regime 1.....	54
1.2.5. Alternative tax policy regimes.....	56
1.3. <i>Analytical and numerical illustrations</i>	57
1.4. <i>Empirical analysis</i>	64
1.4.1. Econometric framework.....	64
1.4.2. Empirical results.....	68
1.5. <i>Conclusion</i>	74
1.6. <i>References</i>	76
A. <i>Appendix to chapter I</i>	79
A.1. Proof of Lemma 1.1	79

A.2.	Proof of Proposition 1.1: strategic substitutability of tax rates	80
A.3.	Proof of Proposition 1.2.....	81
A.4.	First stage of instrumental regressions.....	82
A.5.	The Second Order Conditions of the Centralized Solution	83
A.6.	Second Order Conditions in the Tax Policy Regime 1.....	84
A.7.	List of countries and their respective share of resources' rent.....	85
A.8.	Correlations	86
A.9.	Robustness.....	86
2.	Chapter II: Revisiting the Relationship between Trade Liberalization and Taxation	89
2.1.	<i>Introduction</i>	91
2.2.	<i>Data and Empirical Analysis</i>	93
2.2.1.	Data.....	93
2.2.2.	Empirical Framework.....	95
2.3.	<i>Main Results</i>	96
2.3.1.	Tax Revenues and Trade Liberalization.....	96
2.3.2.	Exploring the Dynamics	101
2.3.3.	Addressing Endogeneity	103
2.4.	<i>Extensions</i>	105
2.4.1.	Trade Liberalization and Tax Structure	105
2.4.2.	Trade Liberalization and VAT.....	109
2.5.	<i>Conclusion</i>	111
2.6.	<i>References</i>	113
B.	<i>Appendix to chapter II</i>	116
B.1.	Appendix: Data	116
B.2.	Appendix: Robustness Checks—Outcome-Based Measure of Liberalization.....	119
B.3.	Appendix: First Stage of the Two Stage Least Square Estimation.....	123
B.4.	Appendix: Tax Revenues and Trade Liberalization—Before and After VAT Implementation.....	125
3.	Chapter III: Contagious protests.....	129
3.1.	<i>Introduction</i>	131
3.2.	<i>Data and Empirical Strategy</i>	132
3.3.	<i>Results</i>	138
3.4.	<i>Robustness Checks</i>	143
3.5.	<i>Conclusions</i>	144
3.6.	<i>References</i>	145
C.	<i>Appendix to chapter III</i>	147
C.1.	Appendix: Country list and summary statistics.....	147
C.2.	Appendix: Contagion and distance using reduced sample.....	149
C.3.	Appendix: Contagion, distance and social media—2010 Facebook penetration.....	150
C.4.	Appendix: Contagion, Distance, and Social Media	151

C.5.	Appendix: Distribution of Protests.....	152
C.6.	Appendix: Market Shares of Facebook.....	153
C.7.	Appendix: Facebook Penetrations and Protests.....	154
4.	Chapter IV: Exploring Tilly’s Theory: Violent Conflicts and Tax Revenue in Sub-Saharan Africa	156
4.1.	<i>Introduction</i>	<i>159</i>
4.2.	<i>Taxation and conflicts: a brief literature review.....</i>	<i>160</i>
4.3.	<i>Conflicts in Sub-Saharan Africa.....</i>	<i>163</i>
4.3.1.	The Central African Republic (2001).....	165
4.3.2.	Cote d’Ivoire (2002).....	166
4.3.3.	The Republic of Congo (1993).....	167
4.3.4.	Guinea (2000).....	168
4.3.5.	Guinea-Bissau (1998).....	168
4.4.	<i>Methodology and data</i>	<i>169</i>
4.4.1.	Data.....	169
4.4.2.	Empirical strategy	172
4.5.	<i>Empirical results.....</i>	<i>175</i>
4.5.1.	Average effects of conflicts on tax revenue.....	175
4.5.2.	Exploring the specificities.....	178
4.5.3.	Effects of conflicts on tax revenue in specific countries	183
4.6.	<i>Conclusion</i>	<i>188</i>
4.7.	<i>References.....</i>	<i>189</i>
D.	<i>Appendix to chapter IV.....</i>	<i>195</i>
D.1.	Appendix:	195
D.2.	Appendix: Trends in non-resource tax revenue.....	199
D.3.	Appendix: Impact of conflict on tax revenue over 10 years (OLS).....	199
D.4.	Appendix: Results from the synthetic control estimation.	200
D.5.	Appendix: Additional robustness for Cote d’Ivoire.....	205
5.	Chapter V: The quality of public expenditure in developing countries	209
5.1.	<i>Introduction</i>	<i>211</i>
5.2.	<i>The quality of public expenditure: an overview of the existing literature.....</i>	<i>213</i>
5.2.1.	The size of the government: classical approach of the role of the state.	214
5.2.1.	The composition of public expenditure: productive versus unproductive spending	215
5.2.2.	The Analysis of the effectiveness or efficiency of public expenditure.....	216
5.2.3.	Some recent initiatives aiming to improve budget management and the quality of public expenditure	216
5.3.	<i>The outcomes indicator of public expenditure</i>	<i>218</i>
5.3.1.	Methodology of construction of the sectoral indices and the outcomes indicator of public expenditure	218
5.3.2.	Measure of the outcomes of public expenditures	220
5.3.3.	Results of the outcomes indicator of public expenditure.....	225
5.4.	<i>Estimation of public expenditure efficiency.....</i>	<i>229</i>

5.4.1.	Estimation strategy	229
5.4.2.	Results of public expenditure efficiency	233
5.4.3.	Analysis of the efficiency scores for a few countries	239
5.5.	<i>Conclusion</i>	240
5.6.	<i>References</i>	242
<i>E.</i>	<i>Appendix to chapter V</i>	248
E.1.	Appendix: Methodological notes.....	248
	Brief presentation the Shiny application.....	249
E.2.	Appendix: Sectoral indices: Country average over 1990-2015	250
E.3.	Appendix: Summary of public expenditure efficiency	251
E.4.	Appendix: Additional sensitivity analysis	251
E.5.	Appendix: Summary table of data, definition, sources, number of observations, temporal depth	254
6.	Chapter VI: La qualité de la dépense publique : Principaux déterminants et quelques effets.....	257
6.1.	<i>Introduction</i>	259
6.2.	<i>Méthodologie et données</i>	261
6.2.1.	Procédure de réplcation et d'extension.....	261
6.2.2.	Stratégie d'estimation des déterminants de la qualité des dépenses publiques	262
6.2.1.	Stratégie d'estimation de l'effet de l'amélioration de la qualité des dépenses publiques sur la croissance et les inégalités.....	265
6.3.	<i>Résultats</i>	267
6.3.1.	Réplcation de La Porta et al. (1999).....	267
6.3.2.	Déterminants de la qualité des dépenses publiques.....	269
6.3.3.	Effets de la qualité des dépenses publiques sur la croissance et les inégalités de revenus	275
6.4.	<i>Conclusion</i>	278
6.5.	<i>Références</i>	280
<i>F.</i>	<i>Appendix to chapter VI</i>	284
F.1.	Annexe : Modifications apportées à la base d'origine.....	284
F.2.	Annexe : Relations entre les variables.....	284
F.3.	Annexe : Résultats de réplcation et d'extension de La Porta et al. (1999).....	286
7.	General Conclusion	296
	General Appendix.....	300
i.	Tax effort in Sub-Saharan African countries: Replication and evidence from a new dataset.....	302
i.1.	<i>Introduction</i>	304
i.2.	<i>Tax revenue dataset for Sub-Saharan Africa over 1980-2015</i>	305
i.3.	<i>Brief literature review on tax effort</i>	310
i.4.	<i>Empirical methodology: The Stochastic Frontier Analysis</i>	312

<i>i.5.</i>	<i>Results</i>	317
<i>i.6.</i>	<i>Replication</i>	324
i.6.1.	Replication of Gupta (2007)	325
i.6.2.	Replication of Fenochietto and Pessino (2013)	326
<i>i.7.</i>	<i>Conclusion</i>	327
<i>i.8.</i>	<i>References</i>	329
<i>i.9.</i>	<i>Appendix</i>	335
i.9.1.	Appendix: Data, descriptive statistics, and robustness	335
i.9.2.	Appendix: Replications of Gupta (2007)	342
i.9.3.	Appendix: Replications of Fenochietto and Pessino (2013)	346

List of Figures

Figures in Text

Figure 0.1:	Recettes fiscales hors ressources naturelles – Moyenne sur la période 1980-2018	23
Figure 0.2:	Evolution des recettes fiscales hors ressources naturelles	24
Figure 0.3:	Relation entre l’effort fiscal/recettes fiscales hors ressources naturelles et la qualité des dépenses publiques	35
Figure 0.4:	Relation entre la croissance économique et l’effort fiscal/qualité des dépenses publiques sans contrôle	36
Figure 1.1:	Equilibrium values in the centralized tax regime	59
Figure 1.2:	Equilibrium values in the tax policy regime 1	61
Figure 1.3:	Equilibrium values – centralized tax regime and tax policy regime 1	63
Figure 2.1:	Dynamic Effects of Trade Liberalization on Aggregate Tax Revenues	102
Figure 2.2:	Dynamic Effects of Trade Liberalization on Non-Resource Tax Revenues	103
Figure 3.1:	Evolution of the Total Number of Protests	133
Figure 3.2:	News-Based Measure of Street Protests	135
Figure 3.3:	Protests during the Arab Spring	136
Figure 4.1:	Conflict-ridden countries in Africa, 1980-2015	164
Figure 4.2:	Non-resource tax revenue in safe and conflict-ridden countries (average 1980-2015)	171
Figure 4.3:	Predictors according to exposure to conflict (average 1980-2015)	171
Figure 4.4:	Gap between tax revenue and the synthetic tax revenue	184

Figure 4.5: Gap Distribution of individual effects of conflicts for the five treated countries.....	188
Figure 5.1: Total and productive public expenditure.....	215
Figure 5.2: Correlation of our indices with the HDI and components	220
Figure 5.3: Outcome variables of education sector.....	222
Figure 5.4: Outcome variables of health sector	223
Figure 5.5: Outcome variables of infrastructure sector	224
Figure 5.6: GDP per capita (PPP, 2011 international USD).....	224
Figure 5.7: Outcomes indicator of public expenditure by region and income level – Average over 1990-2015	228
Figure 5.8: Theoretical frontiers – SFA versus DEA	230
Figure 5.9: Public expenditure efficiency by region and income level – Average over 1990-2015.....	236
Figure 5.10: Evolution of efficiency scores – countries with 30 percent or more inefficiency.....	237
Figure 5.11: Inputs and output in Algeria, Lebanon and Luxembourg	240
Figure 6.1 : Réponse cumulative de la variation du PIB réel par tête à la variation de la qualité des dépenses publiques sur 6 ans (par rapport à l'année 0, en pourcentage)	277
Figure 6.2 : Réponse cumulative de la variation de l'inégalité de revenu à la variation de la qualité des dépenses publiques sur 6 ans (par rapport à l'année 0, en pourcentage)	278

Figures in Appendix

Figure C.5.1: Distribution of Number of Protests per Country per Month.....	152
Figure C.5.2: Distribution of Protests News Intensity	152
Figure C.6.1: Facebook versus other Social Media Platforms.....	153
Figure C.6.2: Facebook's Market Share in Different Regions	153
Figure C.7.1: Average Number of Protests per Million Persons Per Month.....	154
Figure C.7.2: Facebook Penetration (% of Population, December 2018).....	154
Figure D.1.1: Number of years in active conflicts over the period 1980-2015.....	195
Figure D.1.2: Average intensity level of active conflicts in the 1980s and 2000s.....	196
Figure D.2.1: Evolution of non-resource tax revenue.....	199

Figure D.3.1: Impact of conflict on tax revenue over 10 years (OLS).....	199
Figure D.4.1: Non-resource tax revenue treated and synthetic control.....	200
Figure D.4.2: Non-resource tax revenue gaps in the treated countries and Placebo gaps in all their respective control countries.....	202
Figure D.5.1: Non-resource tax revenue gaps in Cote d'Ivoire and Placebo gaps in control countries with a post/pre MSPE ratio higher.....	205
Figure D.5.2: Non-resource tax revenue treated and synthetic control in Cote d'Ivoire excluding Swaziland and Zimbabwe.....	205
Figure D.5.3: Gap between tax revenue and the synthetic tax revenue in Cote d'Ivoire excluding Swaziland and Zimbabwe.....	206
Figure E.1.1: Explanatory diagram on how to calculate the outcomes indicator	248
Figure F.2.1 : Relation entre le PIB par tête et l'indice d'efficience des dépenses publiques	284
Figure F.2.2 : Relation entre l'indice d'inégalité de Gini et l'indice d'efficience des dépenses publiques	285

List of Tables

Tables in Text

Table 0.1: Ressources publiques : niveau et structure par région et niveau de revenu – Moyenne sur la période 1980-2018.....	22
Table 0.2: Croissance, effort fiscal et efficience des dépenses publiques – Moindres Carrés Ordinaires	37
Table 1.1: Sources and descriptive statistics.....	66
Table 1.2: Inter-ministerial competition in the determination of the ETR of natural resources and corporate taxes in resource-rich countries – OLS.....	69
Table 1.3: Inter-ministerial competition in the determination of the ETR of natural resources and corporate taxes in resource-rich countries – OLS.....	70
Table 1.4: Inter-ministerial tax competition and the abundance of natural resources.....	71
Table 1.5: Inter-ministerial competition in the determination of the ETR of natural resources and corporate taxes in resource-rich countries - dynamic model	72
Table 1.6: Inter-ministerial competition in the determination of the ETR of natural resources and corporate taxes in resource-rich countries – G2SLS Ethnic affiliation (second stage).....	73

Table 1.7: Inter-ministerial competition in the determination of the ETR of natural resources and corporate taxes in resource-rich countries – G2SLS Ethnic affiliation and IMF program (second stage)	74
Table 2.1: Trade Liberalization and Aggregate Tax Revenues—Ordinary Least Square.....	97
Table 2.2: Trade Liberalization and Non-Resource Tax Revenues—Ordinary Least Square.....	98
Table 2.3: Trade Liberalization and Aggregate Tax Revenues—Outcome based Measure of Liberalization.....	99
Table 2.4: Trade Liberalization and Non-Resource Tax Revenue—Outcome based Measure of Liberalization.....	100
Table 2.5: Trade Liberalization and Aggregate Tax Revenues—Two Stage Least Square Estimation	104
Table 2.6: Trade Liberalization and Non-Resource Tax Revenues—Two Stage Least Square Estimation	105
Table 2.7: Trade Liberalization and Tax Structure--Non-Resource Tax Composition.....	107
Table 2.8: Trade Liberalization and Structure of Taxation—Direct Tax Composition.....	108
Table 2.9: Trade Liberalization and Aggregate Tax Revenues—VAT Adoption.....	110
Table 2.10: Trade Liberalization and Non-Resource Tax Revenues—VAT Adoption.....	111
Table 3.1: Contagion, Distance and Social Media—Actual Protests	139
Table 3.2: Contagion, Distance and Social Media—News based Protests	141
Table 3.3: Contagion, Polity, Corruption, and Language.....	142
Table 3.4: Contagion, Distance, and Social Media—Quarterly Frequency.....	143
Table 3.5: Contagion, Distance, and Social Media—Poisson Estimator	144
Table 4.1: Descriptive statistics	170
Table 4.2: Impact of conflict on tax revenue (OLS)	176
Table 4.3: Impact of conflict on tax revenue (entropy balancing).....	177
Table 4.4: Impact of conflict on tax revenue (GMM-system).....	178
Table 4.5: Impact of conflict on tax revenue (entropy balancing) – Controlling for specificities	180
Table 4.6: Impact of conflict on tax revenue (GMM-system) – Controlling for specificities	181
Table 4.7: Impact of conflict on tax revenue (entropy balancing) – Controlling for alternative sources of funding	182

Table 4.8: Impact of conflict on tax revenue (GMM-system) – Controlling for alternative sources of funding	183
Table 4.9: Impact of conflict on tax revenue using Pessaran (2006).....	187
Table 5.1: Outcomes indicator of public expenditure – country average over 1990-2015.....	227
Table 5.2: Step-one results of the approach of Kumbhakar <i>et al</i> (2014)	233
Table 5.3: Summary of public expenditure efficiency – Baseline results.....	234
Table 5.4: Public expenditure efficiency – country average over 1990-2015.....	235
Tableau 6.1: Efficience des dépenses publiques, système légal (S.L.), colonisateur et religion	270
Tableau 6.2: Efficience des dépenses publiques, système légal (S.L.), colonisateur et religion	272
Tableau 6.3 : Efficience des dépenses publiques, système légal (S.L.), colonisateur et religion.....	274
Tableau 6.4 : Réponse cumulative de la variation du PIB réel par tête à la variation de la qualité des dépenses publiques sur 6 ans (par rapport à l'année 0, en pourcentage)	276
Tableau 6.5 : Réponse cumulative de la variation de l'inégalité de revenu à la variation de la qualité des dépenses publiques sur 6 ans (par rapport à l'année 0, en pourcentage).....	277

Tables in Appendix

Table A.4.1: Inter-ministerial competition in the determination of the ETR of natural resources and corporate taxes in resource-rich countries – G2SLS Ethnic affiliation (first stage).....	82
Table A.4.2: Inter-ministerial competition in the determination of the ETR of natural resources and corporate taxes in resource-rich countries – G2SLS Ethnic affiliation and IMF program (first stage) 83	
Table A.8.1: Correlation of the key variables (whole sample)	86
Table A.8.2: Correlation of the key variables (resource-rich countries).....	86
Table A.9.1: Inter-ministerial tax competition and abundance of natural resources – robustness	87
Table B.1.1: Summary Statistics.....	116
Table B.1.2: VAT Introduction Year and (First) Liberalization Episode.....	117
Table B.2.1: Trade Liberalization and Aggregate Tax Revenues—Sample Adjustment	119
Table B.2.2: Trade Liberalization and Non-Resource Tax Revenues—Sample Adjustment	120
Table B.2.3: Trade Liberalization and Aggregate Tax Revenues—Non-Resource Trade.....	121
Table B.2.4: Trade Liberalization and Non-Resource Tax Revenue—Non-Resource Trade.....	122

Table B.3.1: Trade Liberalization and Aggregate Tax Revenues—First Stage Regression	123
Table B.3.2: Trade Liberalization and Non-Resource Tax Revenues—First Stage Regression	124
Table B.4.1: Trade Liberalization and Aggregate Tax Revenue—VAT Adoption	125
Table B.4.2: Trade Liberalization and Non-Resource Tax Revenue—VAT Adoption	126
Table C.1.1: Countries included in the ACLED dataset with at least 1 protest	147
Table C.1.2: Countries included in the news-based protest dataset	148
Table C.1.3: Summary Statistics.....	148
Table C.2.1: Actual Protests using Reduced Sample.....	149
Table C.2.2: News Coverage using Reduced Sample.....	149
Table C.3.1: Contagion, Distance, and Social Media—Actual Protests.....	150
Table C.3.2: Contagion, Distance and Social Media—News based Protests.....	150
Table C.4.1: Actual Protests---including Countries with Social Media Penetration below Thresholds	151
Table C.4.2: News based Protests – Including Countries with Social Media Penetration below Thresholds	151
Table D.1.1: Detailed chronology of conflicts.....	197
Table D.1.2: Correlation between variables	198
Table D.4.1: Estimated synthetic control weights	200
Table D.4.2: P values of the treated unit post/pre MSPE ratio.....	204
Table E.2.1: Sectoral indices – country average over 1990-2015.....	250
Table E.3.1: Summary of public expenditure efficiency – Sensitivity analysis	251
Table E.4.1: Step-one results of the approach of Kumbhakar <i>et al.</i> (2014) – additional sensitivity analysis	251
Table E.4.2: Summary of public expenditure efficiency – additional sensitivity analysis.....	252
Table E.4.3: Public expenditure efficiency – country average over 1990-2015 (additional sensitivity analysis).....	253
Tableau F.1.1: Listes des noms de pays supprimés des données originales de La Porta et al. (1999)	284
Tableau F.3.1 : réplique de La Porta et al. (1999) – Performance du gouvernement et système judiciaire sans variables de contrôle.....	286

Tableau F.3.2 : réplification de La Porta et al. (1999) – Performance du gouvernement et système judiciaire avec variables de contrôle.....	287
Tableau F.3.3 : réplification de La Porta et al. (1999) – Performance du gouvernement et religion sans variables de contrôle.....	288
Tableau F.3.4 : Réplification de La Porta et al. (1999) – Performance du gouvernement et religion avec variables de contrôle.....	289
Tableau F.3.5 : Réplification de La Porta et al. (1999) – Performance du gouvernement, système judiciaire et religion sans variables de contrôle.....	290
Tableau F.3.6 : réplification de La Porta et al. (1999) – Performance du gouvernement, système judiciaire et religion avec variables de contrôle	291
Tableau F.3.7 : Extension de La Porta et al. (1999) – Performance du gouvernement et colonisateur sans variables de contrôle.....	292
Tableau F.3.8 : Extension de La Porta et al. (1999) – Performance du gouvernement et colonisateur avec variables de contrôle.....	293
F.3.9: Efficience des dépenses publiques, système judiciaire, colonisateur et religion – Spécification de La Porta et al. (1999).....	294

“La connaissance n'est pas réservée aux seuls vieillards : un enfant qui sait interroger peut l'acquérir.” ~ Proverbe malien.

0. General introduction

La question de la mobilisation des recettes publiques intérieures a longtemps occupé une place marginale dans les discussions de croissance économique et de développement de longs termes des pays. Les problèmes liés à l'action gouvernementale dans les pays en développement (corruption, inefficience, intérêts personnels des dirigeants) ont poussé nombres de chercheurs à recommander un Etat aussi minimal que possible (voir Burgess et Stern, 1993). Easterly (2001) relate parfaitement l'historique des stratégies de développement préconisées aux pays pauvres ainsi que les échecs cuisants de ces stratégies. Il explique comment les pays en développement se sont vu proposer l'aide publique, la formation du capital humain, la réduction de la population, les prêts pour les réformes des politiques publiques, les programmes d'ajustements structurels et l'annulation de la dette. Toutes ces stratégies ont en commun le fait qu'elles renvoient aux finances publiques et à l'intervention de l'Etat, en particulier à la collecte des impôts et l'utilisation qui en est faite. Les stratégies portant sur l'aide publique, les prêts et l'annulation de la dette étaient liées au besoin de financement de l'économie et à l'élargissement de l'espace budgétaire. Tandis que l'investissement dans l'éducation, la formation du capital humain et les programmes d'ajustements structurels renvoyaient aux dépenses publiques.

La mobilisation des recettes intérieures est aujourd'hui nécessaire dans les pays en développement afin que ces pays financent leur développement et réduisent la pauvreté, en particulier dans un contexte où l'aide publique au développement stagne et que les capacités d'endettement sont limitées. En conséquence, ces pays doivent améliorer la conception de leur politique fiscale. L'importance de la mobilisation des ressources intérieures pour le développement est également soulignée par plusieurs initiatives internationales dont les principales sont la conférence des nations unies sur le financement du développement, l'agenda 2030 des objectifs de développement durables et l'initiative « *collect more spend better* » de la Commission de l'Union Européenne. La mobilisation des ressources publiques intérieures contribue à l'élargissement de l'espace budgétaire. Elle représente la meilleure source de financement des gouvernements dans les pays en développement compte tenu des problèmes¹ auxquels font face ces pays. La fiscalité, qui constitue la principale source de ressources intérieures dans les pays en développement, est partie intégrante du contrat social, elle participe à l'amélioration de la gouvernance par une incitation au civisme fiscal, à la transparence et surtout à la redevabilité des gouvernements vis-à-vis des gouvernés. Une meilleure mobilisation des ressources publiques intérieure peut

¹ Marchés de capitaux déformés, systèmes financiers réprimés ou sous-développés (voir Burgess et Stern, 1993) ; Gouvernements irresponsables ou prêts hypothéquant les revenus des générations futures (voir Easterly, 2001) ; dilemme du samaritain (voir Buchanan, 1975).

également être une réponse à la spirale d'endettement des pays en développement, particulièrement les pays pauvres très endettés (PPTE). Par ailleurs, les ressources intérieures présentent l'avantage d'être peu volatiles, ne sont pas soumises à des taux d'intérêt et ne nécessitent pas de collatéral².

La mobilisation des ressources intérieures apparaît indispensable à l'émancipation financière des pays pauvres. Toutefois, il est important de la combiner à une utilisation efficace et efficiente des dépenses publiques. Comme le disent Burgess et Stern (1993), le problème de la fiscalité ne doit pas être vu simplement comme l'utilisation des impôts pour financer une dépense fixe, donnée de manière exogène. Un pays en développement aura beau collecter des recettes publiques, si elles ne sont pas utilisées à des fins de provision de biens et services publics (de façon efficace), sa situation demeurera la même. Les dépenses publiques efficaces peuvent passer par un partage équitable du produit de la fiscalité³ car dans nombres de pays en développement la redistribution peut être sélective. Par exemple, les dépenses consacrées à l'enseignement supérieur ont tendance à favoriser les élites et leurs familles, tandis que les services de santé de base sont plus susceptibles d'aider les pauvres (Besley et Persson, 2014). Une utilisation efficace et efficiente des dépenses publiques permet de dégager un espace budgétaire supplémentaire et constitue le complément idéal à l'effort de collecte de la fiscalité interne.

Une mobilisation des recettes fiscales capable d'accompagner de façon soutenue le développement économique nécessite une conception efficace du système fiscal (voir par exemple Bachas and Soto, 2018 ; Best et al., 2015) associée à des investissements dans la capacité fiscale (voir Besley and Persson, 2013, 2010 ; Slemrod and Gillitzer, 2014). Elle nécessite également une prise en considération de certaines spécificités des pays en développement comme la richesse en ressources naturelles, les fortes instabilités politiques, les guerres intestines, l'informalité etc. Enfin, cette mobilisation des recettes fiscales doit être accompagnée d'un accroissement de la capacité redistributive du système fiscal et d'une utilisation efficace et efficiente des dépenses publiques. Ces trois aspects constituent différentes dimensions d'une même problématique que cette thèse tentera d'aborder.

² Les instruments utilisés, en particulier, la fiscalité doivent être optimaux. Ils doivent permettre de mobiliser des ressources sans nuire à la machine productive de l'économie voir (Mankiw et al. 2009).

³ Voir le modèle Meltzer et Richards (1981) qui suppose un partage équitable du produit de la fiscalité.

0.1. Le contexte de la mobilisation des recettes fiscales dans les pays en développement – focus sur l’Afrique sub-saharienne.

0.1.1. Une faible mobilisation des recettes fiscales...

Dans cette section, nous présentons les tendances des recettes fiscales dans le monde avec un focus sur les pays en développement et l’Afrique au sud du Sahara.

Malgré son augmentation au cours des trente dernières années, le ratio impôts / PIB dans de nombreux pays à revenu faible et intermédiaire reste faible (inférieur à 20% dans la plupart des pays)⁴. L’Afrique sub-saharienne est particulièrement concernée par la faible mobilisation des recettes fiscales.

Le Table 0.1 présente les chiffres sur la tendance réelle des recettes fiscales et de leurs structures dans le monde avec un focus sur les pays en développement. Le niveau des recettes publiques hors cotisations sociales et aides publiques s’établit à 22.8% du PIB en moyenne sur la période 1980-2018 (colonne 1 du Table 0.1). Ces recettes émanent en moyenne à 74% des recettes fiscales (colonne 3 Table 0.1). La colonne 11 du Table 0.1 démontre l’importance des impôts indirects dans la structure des recettes fiscales. La moyenne mondiale montre que les recettes directes sont composées principalement des impôts sur les revenus des particuliers (colonne 7 du Table 0.1).

La désagrégation des données des recettes fiscales montre de grandes disparités entre les régions. Cela illustre bien le fait que la mobilisation des recettes fiscales est une question profonde qui mérite d’être analysée avec prudence et surtout en considérant les spécificités des régions et des groupes de pays. Les différences régionales sont particulièrement marquées pour les recettes non fiscales. Pour la majorité des pays, les recettes fiscales constituent la principale source des recettes publiques. Les pays d’Asie de l’Est et d’Amérique Latine et Caraïbes ont les niveaux de recettes fiscales les plus élevés avec un peu plus de 16% du PIB. A l’opposé, les pays d’Afrique sub-saharienne, du Moyen-Orient et d’Afrique du Nord (MENA dans le Table 0.1) ainsi que ceux d’Asie du Sud ont des niveaux de recettes fiscales assez faibles, moins de 14% du PIB. Les pays de la région Moyen-Orient et Afrique du Nord collectent peu en recettes fiscales car ils reposent leurs recettes publiques sur les recettes non fiscales composées essentiellement des revenus issus de l’exploitation des ressources naturelles (contrats de partages...). En Afrique sub-saharienne, malgré le niveau faible, les recettes fiscales représentent une part importante des recettes publiques (un peu moins de 80%). Le défi de mobilisation des ressources fiscales apparaît donc immense et urgent pour ces

⁴ Seuil retenu par les Nations Unies pour atteindre les ODD (Voir Long et Miller, 2017)

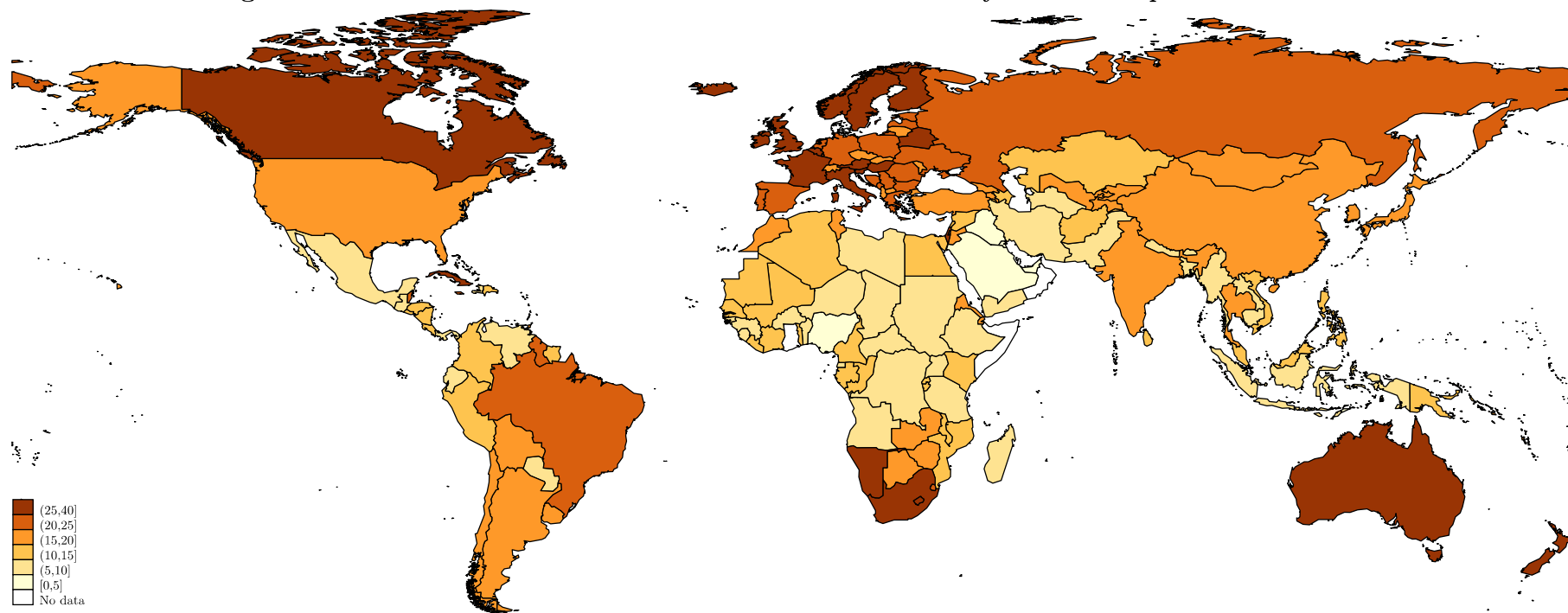
pays dans la mesure où elle représente la principale source de recettes publiques et que son niveau demeure faible.

Table 0.1: Ressources publiques : niveau et structure par région et niveau de revenu – Moyenne sur la période 1980-2018

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]
Variable	Rec. pub. hors contrib. soc. et aides	Rec. non fisc.	Rec. fisc. hors contrib. soc. et aides	Rec. fisc. hors ress. nat.	Rec. fisc. issues des ress. nat.	Rec. fisc. directes hors contrib. soc. et ress. nat.	Impôts sur les rev. des particuliers	Impôts sur les sociétés hors ress. nat.	Impôts sur la masse salariale	Impôts sur la propriété	Rec. fisc. indirectes hors ress. nat.	Taxe sur les ventes	TVA	Droits d'accises	Taxe sur le cce internat.	Autres impôts et taxes
Tous les pays	22.80	5.87	16.90	16.06	0.71	6.50	4.02	2.33	0.19	0.57	10.05	5.22	4.86	1.99	2.58	0.40
Pays en dév.	19.53	4.64	14.56	13.69	0.86	4.43	2.04	2.10	0.10	0.23	9.69	4.69	4.43	1.75	3.23	0.47
Amérique Lat. Car.	19.37	3.01	16.36	15.96	0.51	5.03	1.86	2.01	0.15	0.40	11.04	5.25	3.98	1.39	3.43	0.43
MENA	30.00	17.21	12.00	11.26	0.45	3.88	2.45	2.01	0.33	0.46	7.10	4.61	3.58	1.62	1.90	0.58
Asie de l'Est	24.18	7.18	16.85	15.67	1.07	7.38	3.96	3.09	0.13	0.60	9.33	3.94	3.44	1.79	2.54	0.48
Asie du Sud	15.05	4.75	10.50	10.71	0.00	2.52	0.81	1.73	0.02	0.10	8.29	2.25	1.61	1.86	2.98	0.30
Afrique Sub-Sah.	17.36	3.52	13.55	12.23	1.25	4.01	2.08	1.83	0.09	0.16	8.57	3.41	3.53	1.34	4.10	0.32
ASS - rev. faibles	11.18	1.52	9.28	8.95	0.35	2.69	1.11	1.18	0.07	0.09	6.40	2.88	3.38	1.13	2.44	0.28
ASS - rev. Interm. Inf.	19.55	4.47	15.49	13.33	1.97	4.50	2.51	1.80	0.07	0.12	9.91	3.41	3.37	1.44	5.21	0.30
ASS - rev. Interm. Sup.	28.84	7.40	20.74	16.88	3.48	6.22	3.76	2.76	0.08	0.38	11.07	4.38	3.80	2.08	5.91	0.53
UEMOA	12.27	1.81	10.37	10.20	0.32	2.63	1.00	1.01	0.19	0.10	7.51	3.99	4.32	0.84	2.81	0.41
Mali	13.05	2.39	10.65	11.85	1.58	3.70	0.74		0.20	0.23	8.36	3.65	4.24	1.07	1.97	1.09

Sources : UNU-WIDER Government Revenue Dataset', 2020 et les calculs propres des auteurs. La base couvre 196 pays. Les ventilations par région portent sur l'ensemble des pays de la région sans distinction du niveau de revenu. UEMOA inclut les 8 pays de l'union. Les données sur le Mali sont disponibles uniquement sur les 4 à 6 dernières années pour les variables recettes fiscales hors ressources naturelles, recettes fiscales issues des ressources naturelles, les impôts directs et indirects.

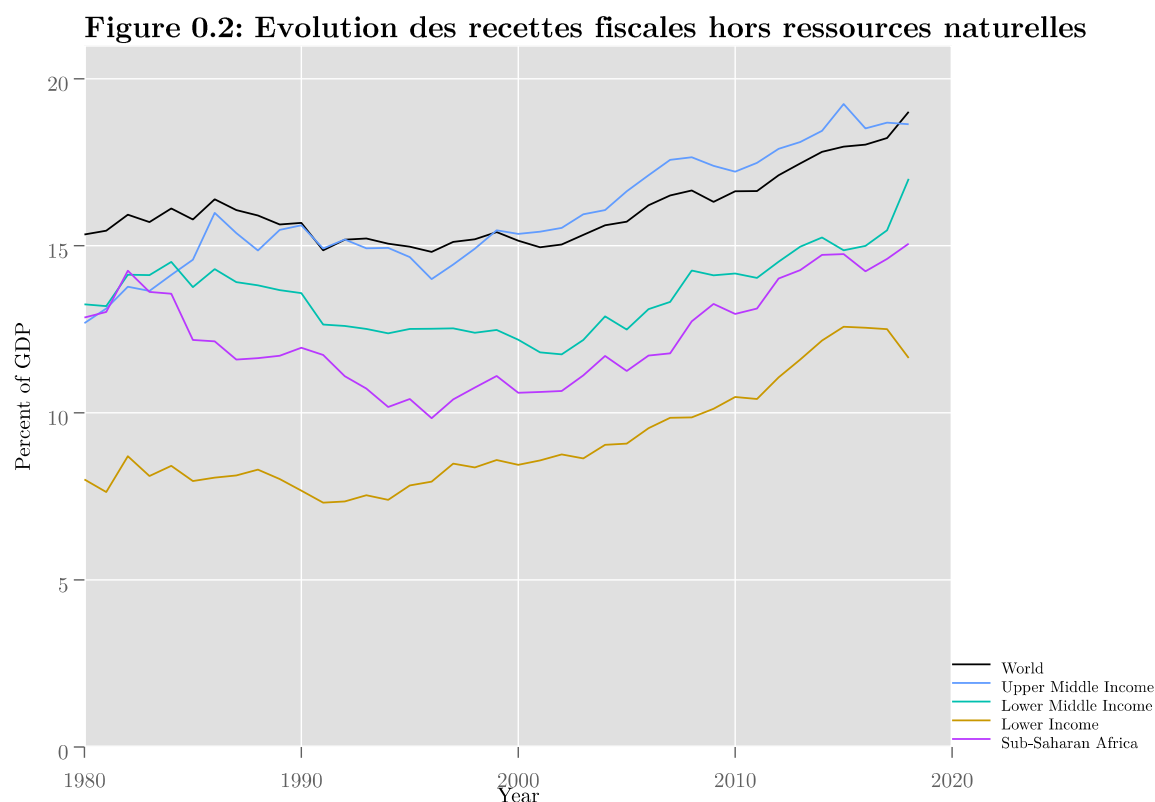
Figure 0.1: Recettes fiscales hors ressources naturelles – Moyenne sur la période 1980-2018



Sources : UNU-WIDER Government Revenue Dataset⁷, 2020 et les calculs propres des auteurs.

Les recettes fiscales en Afrique au sud au Sahara cachent également d'énormes différences. Les pays à revenus intermédiaires supérieurs tirent leur épingle du jeu avec un niveau moyen de 20.7% du PIB. Au même moment, le niveau moyen de recettes fiscales des pays à revenus faibles est inférieur à 10% du PIB. L'UEMOA (Union Economique et Monétaire Ouest Africaine) composée majoritairement de pays à revenus faibles dont mon très cher Mali, abritent les pays avec les plus bas niveaux de prélèvements publics et de recettes fiscales du monde, 10% en moyenne sur la période.

La Figure 0.2 montre une tendance à la hausse des recettes fiscales hors ressources naturelles pour tous les niveaux de revenus. Le niveau de recettes fiscales hors ressources naturelles demeure en dessous de la barre des 15% du PIB en moyenne en Afrique sub-saharienne et dans les pays à revenus faibles. Le graphique montre une augmentation des niveaux de recettes fiscales à mesure que le niveau de revenu augmente.



0.1.2. ... et un faible effort fiscal

Les problèmes de mobilisation des ressources domestiques en Afrique sub-saharienne ne se limitent pas qu'au faible niveau de prélèvement public. Dans le papier 0 de *General Appendix*, nous montrons que les pays d'Afrique sub-saharienne disposent de marges pour augmenter leurs recettes fiscales.

Le papier i General Appendix intitulé *Tax effort in Sub-Saharan African countries: Replication and evidence from a new dataset* constitue une base de cette thèse⁵. Elle a contribué à déblayer le terrain en estimant l'effort de collecte réalisé par les pays compte tenu de certaines caractéristiques économiques. Il représente donc une évaluation de la situation des pays permettant ainsi d'étudier plus en profondeur l'effet de certains facteurs déterminants de la faible mobilisation des recettes fiscales dans les pays en développement. L'approche adoptée a été purement économique car elle repose uniquement sur les caractéristiques économiques. Néanmoins, elle permet une comparaison entre pays ayant des caractéristiques économiques similaires.

Nous calculons l'effort fiscal pour 42 pays d'Afrique sub-saharienne. Nos résultats confirment les effets des variables précédemment étudiées sur les recettes fiscales hors ressources naturelles. L'effort fiscal estimé s'établit à 0,57, ce qui signifie que les pays d'Afrique sub-saharienne peuvent augmenter les recettes fiscales hors ressources naturelles jusqu'à 23.2% du PIB s'ils utilisaient pleinement leur potentiel. L'effort fiscal estimé a légèrement augmenté dans le temps avec beaucoup de pays améliorant leur effort de prélèvement. Les pays d'Afrique de l'Est sont les plus performants alors que les pays de la CEMAC (Communauté Economique et Monétaire d'Afrique Centrale) sont les moins performants. Les résultats montrent aussi que les facteurs variables du prélèvement fiscal – qui sont à la fois spécifiques aux pays et à la période, comme la politique fiscale, la performance de l'administration fiscale, les découvertes des ressources naturelles et les cycles de prix des produits de base – comptent beaucoup pour l'effort fiscal. Par exemple, les pays pourraient améliorer leur performance de l'administration fiscale en serrant l'étau sur l'évasion fiscale, par la formation des agents fiscaux ou en utilisant des outils fiscaux plus sophistiqués. En outre, l'effort fiscal des pays pourrait changer à la suite de la découverte des ressources naturelles ou d'un boom des prix des produits de base. Enfin, nous trouvons que la richesse en ressources naturelles réduit l'effort de collecte des recettes fiscales hors ressources naturelles. Ces résultats sont liés à l'effets de d'éviction de ces recettes par les recettes issues des ressources naturelles (voir Bornhorst *et al.*, 2009, Crivelli and Gupta, 2014, James, 2015).

0.2. Quelques éléments théoriques de cette faible mobilisation des ressources fiscales

La littérature théorique et empirique a identifié plusieurs facteurs qui influencent la capacité de prélèvement des pays en développement. Ces facteurs expliquent les différences de niveau de recettes et la faible mobilisation de recettes fiscales par les

⁵ Malgré notre contribution importante dans le papier, nous avons choisi de ne pas l'inclure en tant que chapitre car c'est une coécriture et il fait déjà l'objet d'un chapitre dans la thèse d'un des co-auteurs.

pays en développement. L'objectif ici n'est pas de produire une revue de la littérature complète mais plutôt d'introduire les principaux facteurs identifiés et les canaux spécifiques par lesquels ils peuvent influencer les recettes fiscales dans les pays en développement. Pour une revue de littérature sur les principaux déterminants des recettes fiscales dans les pays en développement, voir Burgess et Stern (1993) ; Besley and Persson (2013) ; (2014).

0.2.1. Le niveau de revenu et l'importation

Le niveau de revenu et l'importation sont deux facteurs très importants de la mobilisation des recettes fiscales dans les pays en développement. L'importance du niveau de revenu réside d'une part dans sa relation directe avec les impôts : les instruments fiscaux se diversifient avec le développement économique, ce qui peut se traduire par un élargissement de l'assiette fiscale (voir Musgrave, 1969). D'autre part, cette variable est fortement corrélée à la plupart des déterminants (structurels ou institutionnels) de la capacité de prélèvement public : accroissement de la capacité administrative avec le développement économique par exemple. De façon similaire, l'importation constitue l'assiette fiscale de plusieurs impôts. Dans le cas, particulier des pays en développement, les recettes sur le commerce international représentent toujours une part importante des recettes fiscales. De plus, Ebrill et al. (2001) rapportent sur un échantillon de 22 pays en développement, que plus de 50% des recettes de TVA proviennent au stade de l'importation. Par ailleurs, la collecte des recettes fiscale au stade de l'importation est relativement plus aisée et nécessite moins de capacité administrative.

0.2.2. Les recettes non fiscales

Les recettes non fiscales sont des revenus hétérogènes et varient énormément selon les régions. Ils incluent en plus des revenus provenant du patrimoine de l'Etat, les contrats de partages et l'aide publique. Ces revenus fluctuent beaucoup et sont caractérisés par d'énormes instabilités. Cette caractéristique rend la planification des politiques publiques difficiles dans les pays où elles sont importantes. Par ailleurs, ces revenus peuvent avoir un effet d'éviction sur les recettes fiscales.

Par exemple, les flux d'aide peuvent être considérables dans certains pays en développement et être associés à un niveau faible de revenu fiscal. Ils peuvent développer une dépendance à l'aide voire contribuer au dilemme du Samaritain. L'effet d'éviction de l'aide publique sur les recettes fiscales peut simplement refléter la forte crédibilité accordée aux promesses d'aides internationales par les décideurs. Il faut également noter que comparée aux recettes fiscales, l'aide publique s'accompagne de moins de redevabilité vis-à-vis des gouvernés. La littérature empirique n'aboutit pas à un consensus quant aux effets de l'aides publiques sur les recettes fiscales. Les résultats

varient selon le type d'aide (prêt ou subvention), ou des termes de concessionnalité (voir Morrissey, 2015 pour une revue de la littérature empirique).

Les revenus provenant du secteur des ressources naturelles peuvent également avoir un effet d'éviction sur les recettes fiscales. Une large littérature empirique établit une relation négative entre les recettes fiscales et les revenus provenant de l'extraction des ressources naturelles (voir Bornhorst et al., 2009 ; Crivelli and Gupta, 2014 ; James, 2015 ; Jensen, 2011). Jensen (2011) en particulier établit qu'une augmentation de 1% de la part des rentes issues des ressources naturelles dans le revenu total du gouvernement est associé à une baisse de 1,4% de la part des recettes fiscales en % du PIB. Pour James (2015), cet effet d'éviction résulte de la réaction d'un gouvernement bienveillant : une augmentation des revenus issus des ressources implique une diminution de l'impôt sur le revenu puisque le taux d'imposition est égal à l'utilité marginale de la consommation privée et publique. Collier (2006) soutient que les gouvernements des pays riches en ressources naturelles imposent moins et ne sont pas soumis à un examen minutieux. Les décideurs sont moins redevables vis-à-vis de la population sur l'utilisation des revenus tirés des ressources naturelles. Cette moindre redevabilité peut se manifester via une utilisation inefficace des dépenses publiques, une distribution à des fins de patronages ou l'attribution de bénéfices à un groupe spécifique (voir Robinson et al. 2006 ; Robinson et Torvik, 2005).

0.2.3. La structure de l'économie

La structure de l'économie dans les pays en développement impacte à la fois la conception du système fiscal et la collecte des recettes. Les grands secteurs informels des pays à revenu faible sont par nature difficile à taxer. Cela s'explique par l'importance de ces secteurs mais aussi par l'organisation des activités traditionnelles. Le secteur primaire constitue l'illustration par excellence. Dans bon nombre de pays en développement, une part importante de la production émane toujours de ce secteur. En plus d'être difficile à taxer, beaucoup d'entreprises de ce secteur sont souvent exemptées. Cela peut avoir pour conséquence une diminution l'assiette fiscale des impôts indirects.

Il existe une relation ambivalente entre la fiscalité et l'informalité. D'une part, la fiscalité peut entraîner de l'informalité : le désir d'éviter les impôts est un motif important de l'informalité (Laporta et Shleifer, 2014). D'autres parts, L'informalité empêche la mise en place des mécanismes de vérification et peut conduire à une réduction des recettes fiscales. Par exemple, l'informalité empêche la mise en place des mécanismes de retenue à la source, qui facilité la vérification croisée des déclarations fiscales entre les individus et les entreprises (Kelven et al., 2009). Une taille importante du secteur informel peut indiquer que l'élasticité du revenu imposable par rapport au niveau des impôts est très élevée (Besley et Persson, 2014). Les auteurs expliquent que

dans une telle configuration, si le gouvernement tente d'augmenter les impôts, le revenu imposable déclaré au gouvernement peut chuter considérablement.

Le développement financier, qui est aussi identifié comme un déterminant des prélèvements fiscaux, peut adoucir les effets négatifs de l'informalité sur la collecte des impôts. Le développement financier associé à un accès au crédit permet aux agents économiques de financer des projets profitables et d'augmenter le système d'information sur les activités économiques (voir Gordon and Li, 2009). Par ailleurs, le développement financier associé à une réduction de l'informalité réduit le coût d'investissement des réformes d'amélioration du système fiscal.

0.2.4. Les institutions et la capacité administrative

La qualité des institutions en particulier de l'administration fiscale détermine l'effectivité et l'efficacité de la collecte des impôts. Le processus d'imposition peut être divisé en 4 phases distinctes : Conception et promulgation des codes fiscaux (design et validation des codes fiscaux) ; identification des contribuables et la collecte d'information sur eux ; L'évaluation des passifs, des litiges fiscaux et de l'exécution ; et la collecte. Une faible capacité de l'administration fiscale peut exister à chaque étape et aura pour conséquence d'amputer le processus.

0.2.5. Le civisme (fiscal)

La création d'une culture de conformité peut être essentielle pour augmenter les revenus. Cette culture de conformité est analysée dans la littérature par la notion de « *tax moral* », morale fiscale qui représente le respect volontaire des règles fiscales et la création de norme sociale de conformité. Bien évidemment, l'application de la loi est le principal moteur de la conformité fiscale, cependant la morale fiscale améliore considérablement la conformité fiscale. Luttmer et Singhal (2014) passe en revue cinq principaux canaux par lesquels la morale fiscale agit : la motivation intrinsèque, la réciprocité, les effets des pairs et influences sociales, les facteurs culturels de long terme, les limites à la rationalité. L'importance de la morale fiscale dépend de l'environnement d'application de la loi, car les deux interagissent. De son analyse il ressort que la morale fiscale joue un rôle important dans la conformité fiscale dans les pays développés. Concernant les pays en développement, il y'a peu de consensus sur les effets et l'importance empirique de la morale fiscale (Besley et Persson, 2014). Une autre limite de l'analyse de ce facteur est que les estimations varient d'un pays à l'autre et les résultats très peu généralisables. Par ailleurs, les initiatives récentes conçues afin d'améliorer la morale fiscale ont eu des résultats mitigés. Pour autant, il n'est pas raisonnable d'ignorer l'importance de la morale fiscale lorsqu'on veut comprendre les différences de niveau de recettes fiscales.

0.2.6. L'attraction des capitaux

Afin d'attirer, les capitaux, certains pays peuvent s'engager dans une concurrence fiscale horizontale, entraînant une réduction des recettes fiscales (voir Crivelli et al. 2015, pour plus de discussion). Le désir d'attirer les capitaux pourraient aussi expliquer certaines incohérences des régimes fiscaux dans les pays en développement, en particulier certaines formes d'incitations fiscales. Beaucoup de pays d'Afrique subsaharienne pratiquent des taux réduits ou octroient des exonérations fiscales. Ces pratiques conduisent à une régressivité dans le système fiscal car elles bénéficient de manière disproportionnée aux entreprises plus rentables et plus grandes. Arezki et al. (2021) suggèrent que les crédits d'impôts devraient être systématiquement privilégiés.

0.2.7. L'évasion fiscale

Les paradis fiscaux facilitent l'évitement d'impôts qui auraient dû être payés en permettant aux contribuables de réaffecter des revenus imposables dans les juridictions à faible niveau d'imposition. Ces pratiques peuvent se faire via des transferts de prix ou via des investissements effectués à partir des prêts contractés dans des juridictions à faible niveau d'imposition (voir Dharmapala et Hines, 2006 ; Dharmapala, 2014). Crivelli et al. (2015) ont estimé une perte de revenus subie par les gouvernements de l'ordre de 200 milliards pour les pays non-membres de l'OCDE.

0.3. La contribution de la thèse⁶

Les développements précédents nous renseignent sur 3 points essentiels : i) il existe un immense besoin d'accroissement des recettes fiscales dans les pays en développement, en particulier en Afrique subsaharienne ; ii) le défi est énorme dans la mesure où les pays ont plusieurs particularités qui empêchent une amélioration de la mobilisation des recettes fiscales ; iii) il est indispensable que ces pays mettent en place une bonne planification et une meilleure utilisation des dépenses publiques.

Cette thèse aborde la question de la mobilisation des recettes fiscales et l'utilisation efficiente des dépenses publiques dans les pays en développement avec un focus particulier sur l'Afrique subsaharienne. Elle se place dans la logique du concept *collect more, spend better*. La première partie porte sur l'analyse de la politique fiscale dans les pays riches en ressources naturelles (chapitre 1) et l'analyse des effets de la libéralisation des échanges (chapitre 2). Dans la seconde partie, nous étudions la propagation des instabilités politiques (chapitre 3) et leurs effets sur les recettes fiscales

⁶ Nous fournissons un document détaillant la contribution apportée dans chaque chapitre.

(chapitre 4). La troisième partie mesure la qualité des dépenses publiques (chapitre 5) et de ses déterminants (chapitre 6)⁷.

Tout au long de cette thèse l'accent est mis sur la réplication ainsi que la répliquabilité des analyses. La réplication est essentielle afin d'assurer la crédibilité de la recherche scientifique. Ces dernières années, l'accent est particulièrement mis sur le caractère répliquable des travaux : toutes les cinq principales revues en économie exigent que les auteurs mettent des données et du code à la disposition de tous les chercheurs à des fins de réplication (Sukhtankar, 2017). Par ailleurs, *l'American Economic Review* a consacré en 2017 un volume entier à la question de réplication. La réplication nécessite beaucoup de minutie et de rigueur, des vertus importantes dans le domaine de la recherche. Enfin la réplication ne contient pas de jugement substantiel⁸. Dans le chapitre Tax effort in Sub-Saharan African countries: Replication and evidence from a new dataset et Chapter VI: La qualité de la dépense publique : Principaux déterminants et quelques effets, nous proposons des illustrations des méthodes de réplication.

Au-delà des principaux résultats, analyses et recommandations de politiques économiques présentés dans les différents chapitres, j'ai développé deux applications web sous R-Shiny permettant la répliquabilité de ses travaux et leurs extensions.

Les chapitres de cette thèse forment une analyse cohérente du contrat social dans les pays en développement en étudiant aussi bien les questions de mobilisation des recettes fiscales que celles relatives à l'efficacité des dépenses publiques.

Dans le chapitre 1 nous complétons l'analyse d'estimation de l'effort fiscal par un diagnostic de la politique fiscale dans les pays riches en ressources naturelles d'Afrique subsaharienne. Dans les pays avec une taille importante du secteur des ressources naturelles, nous démontrons l'existence d'une concurrence fiscale interministérielle se traduisant par une substitution des instruments fiscaux. Cette compétition a pour conséquence de réduire les recettes collectées et conduit à une concentration de l'activité économique. Cette concurrence interministérielle affaiblit la qualité des institutions, en particulier, celles en charge de la politique fiscale et constitue une explication plausible des différences d'effort de collecte entre les pays d'Afrique subsaharienne riches en ressources naturelles et les autres. La fragmentation du pouvoir de taxation résultant de cette concurrence pourrait expliquer a priori certaines incohérences dans les régimes fiscaux du secteur extractif de certains pays africains

⁷ Nous présentons ici les apports de chaque chapitre sans préciser les co-auteurs. Les co-auteurs ainsi que l'état de publication de chaque papier sont précisés juste avant le chapitre.

⁸ Anderson et Kichkha (2017), après une discussion sur les trois principales méthodes de synthèse de la recherche (enquêtes bibliographiques traditionnelles, méta-analyse et réplication), soutiennent que seule la « réplication pure » ne contient pas de jugement substantiel.

telles que l'exonération partielle ou complète de l'impôt sur les sociétés, associée à une taxe sur le chiffre d'affaires ou la redevance.

Le chapitre 2 explore les effets dynamiques de la libéralisation des échanges sur les recettes fiscales. L'analyse porte sur tous les pays du monde (pour lesquels les données sont disponibles). La libéralisation a été longtemps présentée aux pays en développement comme une « voie salutaire » vers la croissance et le développement. La littérature sur la question a longtemps identifié une relation positive entre les échanges commerciaux et les recettes fiscales. En utilisant une mesure politique, nos résultats montrent qu'à court terme la libéralisation des échanges a eu un effet négatif sur les recettes fiscales tandis qu'elle n'a eu aucun effet à moyen terme. L'effet négatif à court terme de la libéralisation sur les recettes fiscales s'explique par une perte de revenus fiscaux – liée à la suppression des tarifs – non compensée par l'augmentation de la base fiscale. À moyen terme, les effets de la libéralisation sur les recettes fiscales deviennent positifs à mesure que la base s'élargit. Toutefois, les sources importantes de fuites domestiques et internationales mitigent cet effet en particulier dans un contexte où les pays en développement disposent de peu de moyen pour lutter contre l'optimisation agressive et l'évasion fiscale. En effet, nos résultats montrent que la libéralisation est associée à une baisse de la part de l'impôt sur les sociétés dans les recettes fiscales totales. Une explication plausible est que la libéralisation permet aux multinationales d'élaborer une planification fiscale plus agressive. La libéralisation induit aussi une modification de la structure des recettes fiscales orientant celles-ci vers les impôts indirects. Cela réduit la capacité redistributive des systèmes fiscaux. Un résultat particulièrement important est que les économies ayant adopté la TVA avant la libéralisation ont atténué ses effets négatifs sur les recettes fiscales. Cela illustre le rôle complémentaire de la capacité de l'Etat (State capacity) afin de tirer parti des avantages de la libéralisation.

La fiscalité peut être source de manifestations ou peut tout simplement les alimenter. La manifestation des « gilets jaunes » en est une illustration. Bien que le mouvement ait plusieurs causes, le déclencheur immédiat fut sans doute la nouvelle taxe sur les carburants instaurée par le gouvernement. De façon plus générale, parmi les manifestations enregistrées par ACLED (Armed Conflict Location & Event Data) entre janvier 1997 et janvier 2020, 91 étaient liées à des enjeux fiscaux ou de dépenses du gouvernement. Le chapitre 3 analyse des manifestations non violentes. En particulier, nous nous intéressons au processus de propagation des manifestations. Les résultats pointent vers une propagation des manifestations à travers les pays, que nous qualifions de manifestations contagieuses. Les réseaux sociaux jouent un rôle de catalyseur, en particulier, le degré de pénétration entre le pays source et le pays destinataire détermine la propagation des manifestations. Dans certains cas extrêmes, les manifestations peuvent conduire à des instabilités politiques sévères comme au

Mali. Le coup d'état de 2012 au Mali, qui a entraîné la chute du Président Amadou Toumani Touré et de son gouvernement avait plusieurs causes mais son déclencheur a été la série de manifestations contre la gestion de la rébellion Touareg par le gouvernement. Ces instabilités ont permis aux djihadistes de s'emparer des trois régions du Nord (Tombouctou, Gao et Kidal). Ces événements furent le début du conflit armé qui sévit toujours au Mali. Entre janvier 1997 et janvier 2020, ACLED a recensé 30 manifestations associées à des violences armées. L'impact de ces conflits armés sur les recettes fiscales est étudié dans le chapitre 4.

Dans le chapitre 4, nous explorons la théorie de Charles Tilly, en étudiant la relation entre les conflits et la fiscalité. Partant du constat que la majorité des pays africains ont connu un conflit armé depuis leur indépendance et que ces pays ont des niveaux faibles de recettes fiscales, nous estimons l'impact de ces conflits sur les recettes fiscales dans 42 pays d'Afrique sub-saharienne. Nous affinons ensuite nos résultats avec 5 études de cas. Les résultats montrent que les conflits internes violents ont eu un impact négatif sur les recettes fiscales contrairement aux expériences européennes ou étatsuniennes. Les résultats montrent l'importance de certaines spécificités des pays d'Afrique sub-saharienne telles que la fragmentation ethnique et la richesse en ressource naturelle.

Le Chapitre 5 est consacré à la mesure de la qualité des dépenses publiques. Nous conciliions les trois branches de l'analyse des dépenses publiques (la taille de l'Etat, la composition des dépenses publiques et l'effectivité des dépenses publiques) pour construire une mesure unique et nouvelle de mesure de la qualité des dépenses publiques. La mesure construite permet d'intégrer tous les secteurs affectés par les dépenses publiques. Elle permet aussi de capter simultanément les effets des résultats sectoriels ainsi que les potentiels effets de complémentarité. Sa construction s'est faite en trois étapes principales. Dans une première étape, des indices sectoriels de mesure des résultats dans les secteurs éducation, santé et infrastructure publique sont élaborés. La seconde étape a consisté à agréger ces indices sectoriels pour obtenir un indicateur unidimensionnel de résultat de la dépense publique. Dans la dernière étape, un modèle à frontière stochastique est utilisé pour estimer l'indicateur d'efficience en ayant pour output l'indicateur unidimensionnel de résultats et pour inputs les dépenses publiques totales (en pourcentage du PIB ou par tête) et la part des dépenses des secteurs éducation, santé et infrastructure publique dans les dépenses publiques totales. Dans notre analyse, nous avons remarqué que les pays en développement en particulier ceux d'Afrique sub-saharienne consacrent le moins de ressources aux secteurs de l'éducation et de la santé. Par conséquent, ils obtiennent de mauvais résultats en termes de formation de capital humain et de santé de la population ce qui affecte directement la production et la croissance économique. L'Afrique au Sud du Sahara est largement à la traîne en termes de résultats des dépenses publiques et l'efficience des dépenses

publiques en pâtit. Il faut néanmoins remarquer que ces pays connaissent une amélioration de leur efficacité dans le temps.

Dans le chapitre 6, nous identifions les déterminants de cette qualité des dépenses publiques. Nous analysons les différences de qualité des dépenses publiques par les caractéristiques politiques, historiques et culturelles, en s'inspirant de La Porta et al. (1999). Contrairement à La Porta et al. (1999), nous obtenons que les différences entre systèmes juridiques ne sont pas très déterminantes pour expliquer les différences de qualité des dépenses publiques. Comparé au protestantisme, le catholicisme serait également associé à une meilleure qualité des dépenses publiques alors que l'islam aurait un effet non significatif. Nos résultats montrent que les pays colonisés par la Belgique, la Chine et la France présenteraient une moindre qualité de leurs dépenses publiques que ceux colonisés par la Grande-Bretagne. En revanche, les pays colonisés par le Danemark et les Pays Bas afficheraient une meilleure qualité. Les analyses de l'effet de la qualité des dépenses publiques montrent que cette dernière favoriserait la croissance économique. Enfin, nous montrons qu'une amélioration des dépenses publiques réduit les inégalités.

0.4. La croissance économique et le concept de « *collect more spend better* »

Dans cette section, nous nous intéressons aux relations qui existent entre la mobilisation des recettes, l'utilisation efficace des dépenses publiques et la croissance économique. Les chapitres de la thèse s'intéressent à la mobilisation des recettes fiscales et l'amélioration de l'efficacité des dépenses publiques. Nous présentons ici une illustration des bienfaits que peuvent apporter le fait de collecter plus et dépenser mieux en utilisant le taux de croissance.

Dans la Figure 0.3, nous présentons la relation entre la qualité de la dépense publique et la mobilisation des recettes fiscales. Le Panel A de la Figure 0.3 montre la relation entre la mesure de qualité des dépenses publiques développée au chapitre 5 et la mesure d'effort fiscal, développé dans le papier i en annexe. De façon similaire le Panel B de la Figure 0.3 présente la relation entre la qualité de la dépense publique et le taux de prélèvement fiscal.⁹ Il existe une très forte relation entre la mobilisation des recettes fiscales et la qualité des dépenses publiques. Le Panel A de Figure 0.3 montre qu'une meilleure utilisation des dépenses publiques est associée à un effort fiscal plus important. La relation entre la qualité des dépenses publiques et le taux de prélèvement fiscal est plus forte, la pente du Panel B est plus raide que celle du Panel A.

⁹ Les données couvrent les pays d'Afrique Sub-Saharienne sur la période 1990-2015 car l'effort fiscal a été estimé pour 42 pays d'Afrique Sub-Saharienne sur la période 1980-2015 alors que l'efficacité des dépenses publiques a été estimée pour 146 pays du monde pour la période 1990-2015.

L'amélioration de l'efficacité est associée à un niveau plus élevé de mobilisation tandis que l'effort de collecte est mesuré compte tenu des facteurs structurels du pays.

Le Panel A de la Figure 0.4 présente les relations entre collecter plus et la croissance économique tandis que dans le Panel B nous montrons le lien entre dépenser mieux et la croissance économique. Le Panel A porte uniquement sur les pays d'Afrique subsaharienne alors que le Panel B inclut des pays de toutes les régions du monde.

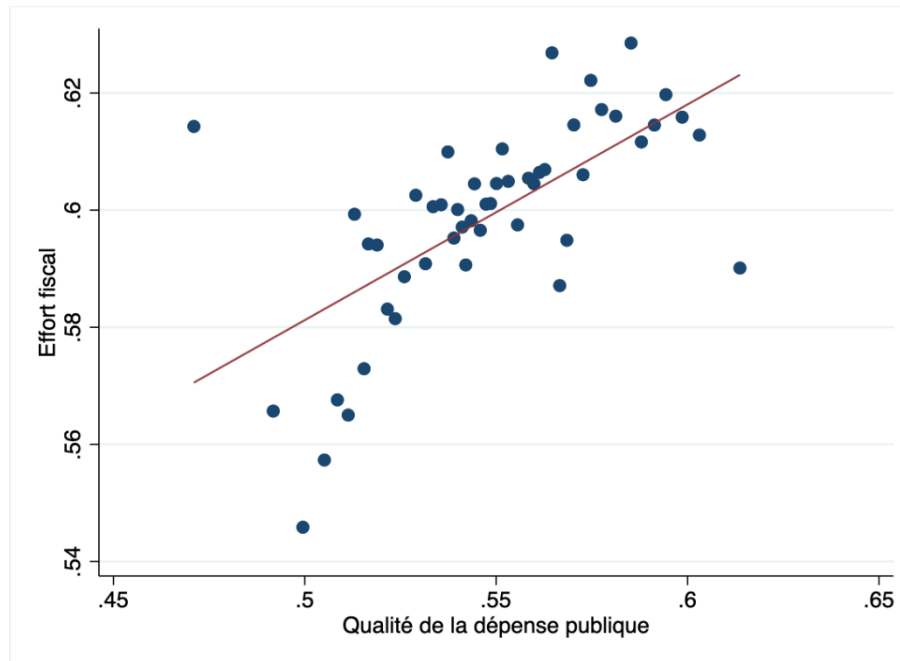
Nous affinons ces résultats dans la Table 0.2 avec des régressions à l'aide des moindres carrés ordinaires. Les colonnes (1) à (3) de la Table 0.2 montrent que l'effort fiscal est associé à un taux de croissance plus élevé. Dans la colonne (2) nous contrôlons pour l'investissement qui est l'un des déterminants de la croissance les plus utilisés. La colonne inclut le taux de croissance retardé comme variable de contrôle. Le but est de voir comment réagit la variable lorsqu'on introduit la croissance de l'année précédente dans la régression. L'introduction des variables de contrôles induit une diminution de la magnitude du coefficient qui reste tout de même significatif. Le coefficient 10.17 signifie qu'une augmentation d'un écart-type de l'effort fiscal est associé à une augmentation de 0.3 écart-type du taux de croissance. Ce résultat confirme l'existence d'une forte corrélation entre l'effort de mobilisation et la croissance.

De la même manière que l'effort fiscal, une meilleure utilisation des dépenses publiques est positivement et significativement associée à la croissance (colonnes 4 à 6). Le résultat est robuste à l'introduction de l'investissement mais pas à celui du taux de croissance retardé. Le coefficient 12.1 signifie qu'une augmentation d'un écart type de l'efficacité des dépenses publiques conduit à une augmentation de 0.3 du taux de croissance.

Les colonnes 7 à 9 de la Table 0.2 revêtent plus une valeur indicative. Les variables d'effort fiscal et d'efficacité des dépenses publiques varient dans le temps (même si les variations annuelles sont faibles). De ce fait, la multiplicative devrait s'accompagner des variables elles-mêmes. Cependant, comme le montre le Panel A de la Figure 0.3 les deux mesures sont fortement corrélées. Cela explique pourquoi nous ne les intégrons pas dans la même régression simultanément. Le point important des colonnes 7 à 9 de la Table 0.2 est que lorsqu'on multiplie les scores d'efficacité et d'effort fiscal le coefficient associé est plus élevé. Ceci illustre bien l'idée qu'associer une meilleure utilisation des dépenses publiques à une bonne mobilisation des recettes fiscales conduirait à une meilleure situation économique pour les pays d'Afrique subsaharienne.

Figure 0.3: Relation entre l'effort fiscal/recettes fiscales hors ressources naturelles et la qualité des dépenses publiques

Panel A. Effort fiscal



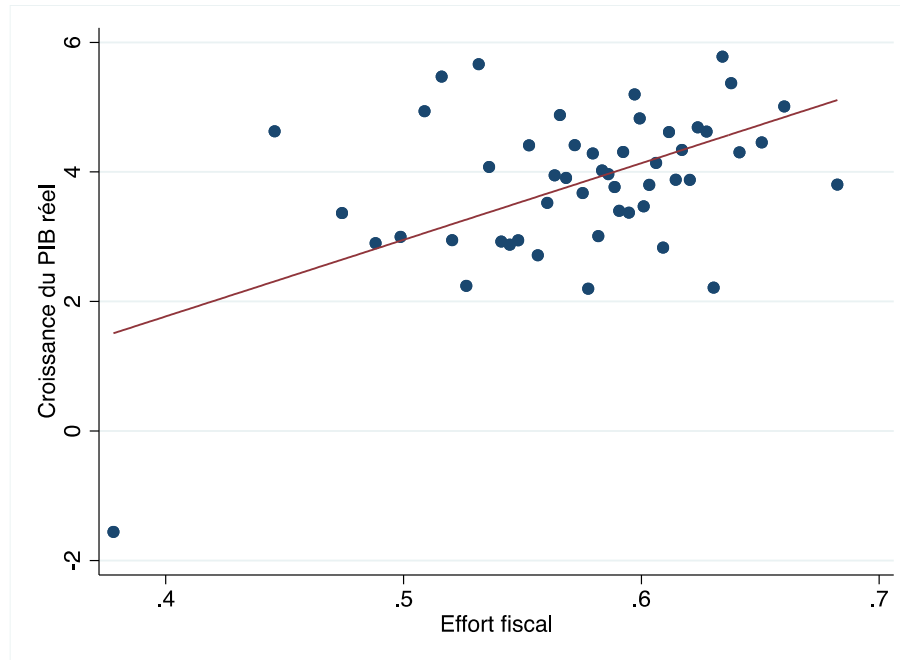
Panel B. Recettes fiscales hors ressources naturelles



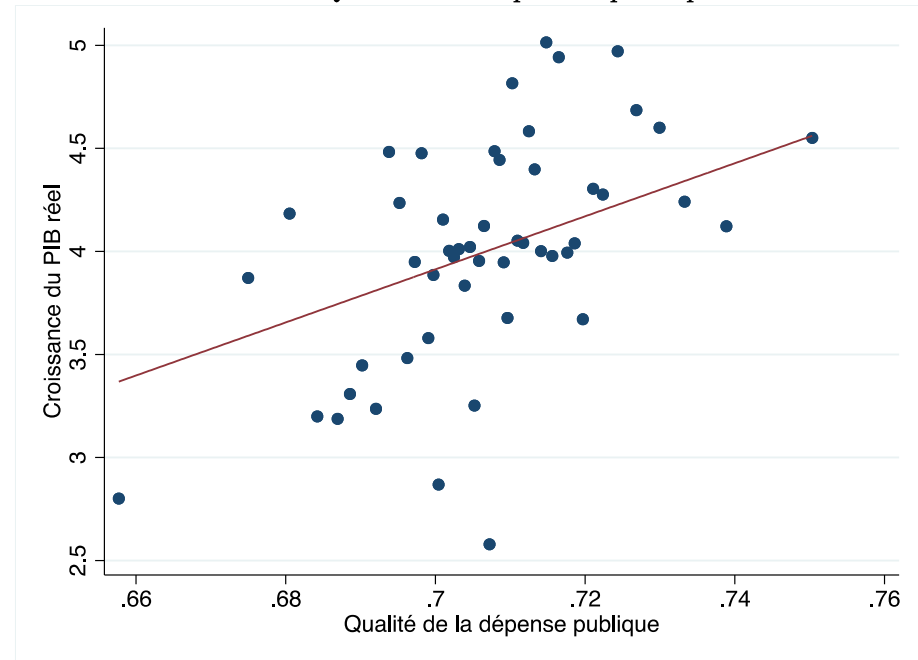
Binned scatterplots with 50 quantiles. In the binned scatterplots, the x-axis is divided into 50 equal bins, represented by one dot. In each bin, the average tax effort/non-resource tax revenue as % of GDP is plotted against the average quality of public expenditure. Country fixed effects are controlled for.

Figure 0.4: Relation entre la croissance économique et l'effort fiscal/qualité des dépenses publiques sans contrôle

Panel A. Effort fiscal



Panel B. Qualité des dépenses publiques



Binned scatterplots with 50 quantiles. In the binned scatterplots, the x-axis is divided into 50 equal bins, represented by one dot. In each bin, the average Real GDP growth is plotted against the average tax effort/quality of public expenditure. Year and country fixed effects are controlled for.

Table 0.2: Croissance, effort fiscal et efficience des dépenses publiques – Moindres Carrés Ordinaires

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Taux de croissance du PIB réel									
Effort fiscal	11.829*** (2.548)	10.959*** (2.692)	10.170*** (2.537)						
Qualité des dépenses publiques				12.875** (5.300)	12.103** (5.592)	6.583 (5.128)			
Effort fiscal x Qualité des dépenses publiques							20.992** (8.571)	19.129** (9.041)	20.299** (8.547)
Formation brute du capital fixe (% du PIB)		0.052** (0.024)			0.178*** (0.021)			0.117*** (0.039)	
Taux de croissance du PIB réel ₍₋₁₎			0.164*** (0.030)			0.229*** (0.020)			0.098** (0.047)
Constant	-3.281* (1.751)	-3.276* (1.919)	-2.578 (1.739)	-4.262 (3.550)	-7.902** (3.764)	-1.320 (3.427)	-1.273 (3.100)	-3.058 (3.167)	-1.608 (3.093)
Observations	1,146	1,079	1,143	2,459	2,275	2,452	543	514	543
Nombre de pays	39	39	39	146	137	146	35	34	35
R-carré	0.094	0.097	0.119	0.090	0.120	0.138	0.075	0.100	0.084

Notes : Le tableau présente les résultats de régression du taux de croissance réel sur l'effort fiscal, la qualité des dépenses publiques, le produit entre effort fiscal et qualité des dépenses publiques ainsi que les variables de contrôle. *** p<0,01, ** p<0,05, * p<0,1. Ecart-types entre parenthèses.

References

- Anderson, R. G., & Kichkha, A. (2017). Replication, meta-analysis, and research synthesis in economics. *American Economic Review*, 107(5), 56-59.
- Arezki, R., A. A. Dama, G. Rota-Graziosi and F Sawadogo (2021), "The worst form of tax incentives: Tax holydays," Working Paper.
- Bachas, P. J., & Soto, M. (2018). Not (ch) your average tax system: corporate taxation under weak enforcement. *World Bank Policy Research Working Paper*, (8524).
- Besley, T., and Persson, T. (2014). Why do developing countries tax so little?. *Journal of Economic Perspectives*, 28(4), 99-120.
- Besley, T., Persson, T., 2010. State Capacity, Conflict, and Development. *Econometrica* 78, 1–34.
- Besley, T., Persson, T., 2013. Taxation and Development, in: Handbook of Public Economics. Elsevier, pp. 51–110.
- Best, M.C., Brockmeyer, A., Kleven, H.J., Spinnewijn, J., Waseem, M., 2015. Production versus Revenue Efficiency with Limited Tax Capacity: Theory and Evidence from Pakistan. *J. Polit. Econ.*
- Bornhorst, F., Gupta, S., & Thornton, J. (2009). Natural resource endowments and the domestic revenue effort. *European Journal of Political Economy*, 25(4), 439-446.
- Buchanan, J. M. (1975): The Samaritan's dilemma. In: *Altruism, morality and economic theory*. In: E.S. Phelps (ed.), New York: Russel Sage foundation.
- Burgess, R., & Stern, N. (1993). Taxation and development. *Journal of economic literature*, 31(2), 762-830.
- Collier, P. (2006). Is aid oil? An analysis of whether Africa can absorb more aid. *World development*, 34(9), 1482-1497.
- Crivelli, E., & Gupta, S. (2014). Resource blessing, revenue curse? Domestic revenue effort in resource-rich countries. *European Journal of Political Economy*, 35, 88-101.
- Crivelli, E., De Mooij, R. A., & Keen, M. M. (2015). *Base erosion, profit shifting and developing countries*. International Monetary Fund.
- Dharmapala, D. and Hines Jr, J.R., 2006. *Which countries become tax havens?* (No. w12802). National Bureau of Economic Research.

Dharmapala, D., 2014. What do we know about base erosion and profit shifting? A review of the empirical literature. *Fiscal Studies*, 35(4), pp.421-448.

Easterly, W. (2001). *The elusive quest for growth: economists' adventures and misadventures in the tropics*. MIT press.

Ebrill, M., Keen, M., and Perry, V. (2001). *The modern VAT*. International Monetary Fund.

Gordon, Roger and Wei Li. (2009). "Tax Structures in Developing Countries: Many Puzzles and a Possible Explanation." *Journal of public economics* 93 (7–8): 855–866.

James, A. (2015). US state fiscal policy and natural resources. *American Economic Journal: Economic Policy*, 7(3), 238-57.

Jensen, A. D. (2011). State-building in resource-rich economies. *Atlantic Economic Journal*, 39(2), 171-193.

Kleven, H. J., Kreiner, C. T., & Saez, E. (2016). Why can modern governments tax so much? An agency model of firms as fiscal intermediaries. *Economica*, 83(330), 219-246.

La Porta, R., & Shleifer, A. (2014). Informality and development. *Journal of Economic Perspectives*, 28(3), 109-26.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. (1999). The quality of government. *The Journal of Law, Economics, and Organization*, 15(1), 222-279.

Long, C., & Miller, M. (2017). Taxation and the Sustainable Development Goals. *Do good things come to those who tax more*. ODI Briefing Note.

Luttmer, E. F., & Singhal, M. (2014). Tax morale. *Journal of economic perspectives*, 28(4), 149-68.

Mankiw, N. G., Weinzierl, M., & Yagan, D. (2009). Optimal taxation in theory and practice. *Journal of Economic Perspectives*, 23(4), 147-74.

McGuirk, E. F. (2013). The illusory leader: natural resources, taxation and accountability. *Public choice*, 154(3), 285-313.

Meltzer, A. H., & Richard, S. F. (1981). A rational theory of the size of government. *Journal of political Economy*, 89(5), 914-927.

Musgrave, R. A. (1969). *Fiscal systems* Yale University Press.

Robinson, J. A., & Torvik, R. (2005). White elephants. *Journal of public economics*, 89(2-3), 197-210.

Robinson, J. A., Torvik, R., & Verdier, T. (2006). Political foundations of the resource curse. *Journal of development Economics*, 79(2), 447-468.

Slemrod, J. (2019). Tax compliance and enforcement. *Journal of Economic Literature*, 57(4), 904-54.

Slemrod, J., & Gillitzer, C. (2014). Insights from a Tax-systems Perspective. *CESifo Economic Studies*, 60(1), 1-31.

Sukhtankar, S. (2017). Replications in development economics. *American Economic Review*, 107(5), 32-36.

PART I: COLLECT MORE

“You must decide where you are going in the evening, if you intend to leave early in the morning.” ~ A Malian proverb.

1. Chapter I: Interministerial Tax competition: The Case of Resource Rich Developing Countries

This chapter is a joint work with Emilie Caldeira (CERDI-CNRS), Ali Compaoré (CERDI-CNRS), and Grégoire Rota-Graziosi (CERDI-CNRS).

Our contribution has been on the empirical part, the theoretical framework has been designed and developed by one of the co-authors. We include the full article in the thesis as a chapter for readability purposes.

Abstract

We formalize tax policy as the result of inter-ministerial tax competition. Focusing our analysis on resource-rich developing countries, we consider two Ministers: the Minister of Finance (MoF) and the Minister of Mines and Petroleum (MoM) and two tax instruments: a tax on capital and a mining royalty (or equivalently a Production Sharing Contract). Depending on the taxing power assignment between Ministers, some intragovernmental tax competition may take place, which determines tax policy for the whole economy. This competition is characterized by the strategic substitutability of the two tax instruments. We propose a numerical illustration to appreciate the effect of a resource boom. We observe that the inter-ministerial tax competition reduces total tax revenue and favors the concentration of the economy in the extractive industry curbing the economic development of the country (captured through the total stock of capital in the country). We test the tax reaction functions of each Minister for 41 Sub-Saharan countries from 1980 to 2010. We confirm empirically the strategic substitutability of tax instruments.

Keywords: Tax policy; natural resources; developing countries; government.

JEL Codes: H25; H77; H87; C72.

1.1. Introduction

In economic science, the design of tax policy corresponds usually to the decision of a unitary ruler. This ruler may be driven in her choice by some electoral considerations (Meltzer and Richard, 1981, Persson and Tabellini, 2003), lobbies interests (Marceau and Smart, 2003), rent-seeking behavior (Brennan and Buchanan, 1980) or taxpayers reactions (Slemrod, 2007). This ruler may also interact with other ones in the context of horizontal or vertical tax competition (see Keen and Konrad, 2013). In political science, the analysis of the budget process proposed by Wildavsky (1974) addresses the issue of fiscal power's fragmentation by distinguishing the taxing power from the spending one: the Guardian, the Ministry of Finance (MoF), fixes the tax policy, while the other Ministries, the Spenders, advocate for program spending. The purpose of this paper is to go beyond the commonly shared assumption of a unitary tax policymaker by considering that the effective tax policy results from intragovernmental tax competition. This competition arises between the Ministers of the same government.

The fragmentation of the taxing power has been mainly studied in the context of federal countries. It results from countries' Constitution itself or from some policy failures in the definition and the implementation of tax laws. Constitution determines the taxing power assignment among levels of governments. It also fixes the form of government (parliamentary or presidential regime) and the allocation of decision-making rights among offices (see Persson and Tabellini, 2003). But Constitution may be an incomplete contract. In this case, some vertical tax competition occurs: local and central governments tax the same base as formalized in Keen and Kotsogiannis (2002). Beyond Constitution, weaknesses in tax law's enforcement or even in its definition may involve some taxing power fragmentation. For instance, Berkowitz and Li (2000) develop the notion of tax rights, which is the property rights that a government has on a particular tax base. They applied this notion to the case of Russia and China and conclude that the poorer allocation of tax rights in the former country may explain its lower economic performance. The over-exploitation of the same tax base by multiple tax agencies induces an excessive high aggregate tax rate, low investments, inefficient public expenditures, and finally a poor economic performance overall. The analysis of Berkowitz and Li (2000) remains mainly focused on the behavior of local governments. However, a taxing power fragmentation can also emerge in well-developed and unitary countries such as Japan. Jinno and DeWit (1998) describe the tax conflict between the MoF and the Ministry of Home Affairs (MoHA), which resulted from the property tax reform in Japan during the 1990s. While the MoHA was in charge of local and land taxation, the reform offered a window of opportunity for the MoF to "invade MoHA's turf" (p. 238) by levying a tax on land, building, and housing assets. This reform ended into a tax revolt fuelled by the intragovernmental competition and the bursting of the real estate bubble.

Our analysis formalizes the taxing power fragmentation as a tax competition between two Ministries of the same cabinet. We focus on resource-rich developing countries, where several factors contribute to the fragmentation of the taxing power between two Ministers: the MoF and the Ministry in charge of the mining and/or petroleum sector (the MoM). First, the weaknesses of Public Finance Management (PFM) in developing countries such as delays or even arrears in the payment of civil servants' wages have pushed Ministries to look for their own financial resources and damaged the implementation of the Treasury Single Account.¹⁰ For instance, the MoM may raise some quasi-taxes, which are collected by their own civil servants or take directly a share of mining royalties or petroleum revenue through some special mining or petroleum funds.¹¹ These failures in PFM explain why we will assume a distinct objective function for each Minister.¹² Second, resource-rich developing countries are often subject to a resource curse (Sachs and Warner, 1995 and van der Ploeg, 2011), which is mainly attributed to policy failure (Mehlum *et al.* 2006 and Robinson *et al.* 2006, Andersen and Aslaksen, 2008). Even if national Parliaments vote (tax) laws, the design of the latter and their drafting remain mainly on the hands of the executive branch in developing countries (see Francois *et al.* 2015). Third, the tax policy of the extractive sector is rarely an exclusive competence of the MoF. Indeed, given the necessary specialization to deal with sector, officials of the MoM participate actively in the definition of specific mining or petroleum tax regime. For instance, they may fix the rates and the bases of mining royalties or design the details of Production (or Profit) Sharing Contracts (PSC).¹³ Moreover, the effective implementation of the Mining or Petroleum Code (or Act) requires Ministerial Decrees (or Order) from the MoM, which may modify significantly the effective tax burden. Finally, invested capital in the extractive industry is mainly irreversible. Firms operating in this sector have then more incentives to lobby for a special tax treatment (see Marceau and Smart, 2003). This lobbying may erode the taxing power of the MoF in favor of the MoM to obtain an advantageous tax regime under the supervision of the latter.

We assume a two-sector economy with extractive industry and a non-extractive one. We consider a potential fragmentation of the taxing power between the MoF and the MoM. While the former decides the tax rate of capital invested in both sectors, the MoM raises a mining royalty or decides the share of the PSC commonly used in the

¹⁰ The Treasury Single Account (TSA) is an important tool for effective and efficient budget execution. By aggregating the cash resources of the government, TSA is a crucial factor of budget's transparency and accountability.

¹¹ A purpose of these funds -sometimes explicit in the Law or Act- is to finance additional revenue for officials of the MoM. We present briefly the cases of Cote d'Ivoire, Ghana, and Mali later in the text.

¹² An alternative explanation, which is not explored here is the personal agenda of each Minister, which may be inclined to become Prime Minister or President.

¹³ See Daniel *et al.* (2010) for a survey of the taxation of extractive industries.

upstream oil sector, which is equivalent to a tax on the extractive sector's turnover. Both Ministries look for maximizing their own tax revenue. The taxing power assignment induces an intragovernmental tax competition, which is characterized by the strategic substitutability of tax rates as in the vertical tax competition case. We consider the centralized solution as a benchmark. We conclude that the interministerial competition does not involve a race to the bottom: at least, one tax instrument rate at the Nash equilibrium is higher at the equilibrium than at the centralized solution. We discuss other tax power assignments: the exclusive taxing power of the MoM over the extractive sector means a complete capital tax exemption of this sector,¹⁴ while the exclusive taxing power of the MoF involves a null royalty rate.

We develop an analytical and numerical illustration of our theoretical model. We appreciate the effect of a resource boom, i.e. an increase in commodity price, on equilibrium tax and royalty rates, invested capital in each sector, and tax revenue. Tax policy centralization allows internalizing the negative spillover of each tax instrument over the tax base of the other Minister. We observe that the interministerial tax competition reduces total tax revenue. Moreover, it favors the concentration of the economy in the extractive industry. Indeed, the increase in commodity price reduces the capital tax rate under the centralized solution, while the MoF increases this rate in the case of intragovernmental tax competition. Given these contrasting variations, invested capital in the non-extractive industry would increase (respectively decrease) under the centralized tax policy regime (resp. with the interministerial tax competition). Finally, we observe that the centralized tax regime allows attracting more capital in the whole economy.

We test empirically the existence of intragovernmental tax competition, as previously defined, which is characterized by the strategic substitutability of tax rates. Following the literature on tax competition, we consider the tax reaction function of each Minister to the tax policy decision of the other. More specifically, we study if and how the effective tax rate (ETR) of the natural resource sector reacts to the ETR of the non-resource sector. We also appreciate the reverse relationship. Our database covers 41 Sub-Saharan countries from 1980 to 2010 and distinguishes tax revenue from both sectors. To correct for potential biases, we consider two instruments, which capture the relative power of the MoF: Her/his ethnic alignment with the President in office

¹⁴ Keen and Mansour (2010) emphasize that 80 per cent of African countries, including resource-rich countries, offered tax holidays in 2005.

and the country participation to an International Monetary Fund (IMF) program at time $t - 1$.¹⁵

Depending on the specifications of the empirical model, we establish that a one percent increase in the ETR of the non-resource sector involves a 0.21 to 0.61 percent decreases in the ETR of the resource sector in resource-rich developing countries. This relationship vanishes for countries with a resource rent lower to 10 percent of GDP. Inversely, a one percent increase in the ETR of the resource sector involves a 0.46 percent decrease in the ETR of the non-resource sector. Our analysis provides an alternative view to Bornhorst, Gupta, and Thornton (2009), Crivelli and Gupta (2014) or James (2015), who consider the negative relationship between resource and non-resource revenues as the expression of a crowding out effect between these sources of revenue. For James (2015), this crowding-out effect results from the reaction of a benevolent government: an increase in resource revenue involves a decrease in income taxation since the tax rate equalizes the marginal utility of private and public consumption. For McGuirk (2013), this crowding-out effect expresses the strategy of the government, which remains in power by reducing its accountability contingent to taxation in general.¹⁶ We stress here that the reduction of the government's accountability through a lower tax pressure may result from the inter-ministerial tax competition.

By going beyond the assumption of a unitary tax policymaker we explain some a priori inconsistencies in actual extractive tax regimes, such as partial or complete Corporate Income Tax (CIT) exemption combined with a turnover tax. In line with Besley and Persson (2013), our analysis provides a potential new explanation of institutional failure in resource-rich developing countries. Besides tax revenue and invested capital, inter-ministerial tax competition may deteriorate the transparency of the tax system and consequently the accountability of government.

It can explain partly the poor institutional quality of resource-rich countries completing the analyses of (Mehlum *et al.*, 2006 and Boschini *et al.*, 2007).

Our approach can be extended beyond the case of resource-rich developing countries. First, it may concern other countries of which economic activity is highly concentrated in a particular sector, the latter enjoying a specific tax regime. For instance, the MoM could be replaced by the Minister in charge of tourism: hotels and resorts are exempted

¹⁵ We assume that an IMF program reinforces the MoF's power. Indeed, the IMF program promotes some fiscal adjustment strategies, which usually require fiscal consolidation (included the reinforcement of the Treasury Single Account) and the reduction of fiscal deficit. We do not have any a priori belief on the effect of the ethnic (mis-)alignment of the MoF with the President on the taxing power of the former.

¹⁶ The author validates the negative relationship between resource rents and the demand for accountability through empirical analyses on households' surveys in 15 African countries.

from CIT, but they still have to pay a tax on their turnover, which takes the form of the room occupancy tax (see the case of Costa Rica for instance). Second, we can consider some tax incentives to specific economic sectors as the expression of a taxing power, or at least a tax exempting power, of the relevant sectoral Ministry. This would complete the view of the Guardian-Spender model from Wildavsky (1974) by considering tax expenditure as an alternative tool of the Spender Ministries.

The paper is structured as follows: Section 1.2 develops a theoretical model of competition between Ministers; Section 1.3 proposes an analytical and numerical illustration of the previous model; Section 1.4 estimates a tax reaction function for 41 Sub-Saharan countries from 1980 to 2010 to test the existence of inter-ministerial interactions; Section 1.5 concludes.

1.2. The theoretical model

We propose a stylized theoretical framework of the competition between Ministers, who tax partly the same base. This interaction modifies significantly the tax policy regime, tax revenue, and the equilibrium level of capital invested in the economy. We establish the strategic substitutability of the tax instruments controlled by each Minister.

1.2.1. The economy

We consider two sectors in the economy: sector M is the extractive (mining or petroleum) sector; sector E encompasses all the other economic activities. We denote by k the capital-labor ratio invested in each sector. We consider two tax instruments: the first, denoted by $t_{i=E;M}$, is a tax on capital revenue; the second one is a mining royalty at rate τ , which is only raised on the extractive industries' turnover. The tax on capital may be viewed as a combination of capital income tax and profit tax, while the mining royalty is also equivalent to the State's take in Production Sharing Contracts (PSC) in the petroleum industry.

We assume a representative firm in each sector. The profit of the mining firm is given by

$$\pi_M(k) = (1 - \tau)pf_M(k) - (r + t_M)k,$$

where r is the net return of capital, p is the price of the commodity, and $f_M(\cdot)$ is the production function of the firm. In a similar way, the profit of the representative firm of the non-extractive sectors is given by

$$\pi_E(k) = f_E(k) - (r + t_E)k,$$

where $f_E(\cdot)$ is the production function of the non-extractive representative firm. Without loss of generality, we normalize to one the price of the composite good produced by this sector. The net return of capital (r) and the commodity price (p) are exogenously given.¹⁷

We make the following assumptions regarding production functions:

Assumption 1.1

The production functions are increasing and concave.

$$\forall i \in \{E, M\}, f_i'(k) > 0 > f_i''(k) \text{ and } f_i'''(k) \geq 0. \quad (\text{eq. 1.1})$$

Assumption 1.2

The marginal production function of each sector is log-concave:

$$f_i'(k) f_i'''(k) - (f_i''(k))^2 \leq 0. \quad (\text{eq. 1.2})$$

The non-negativity of the third derivative and the log-concavity of the marginal production functions rely on the curvature of the production function, which will be determinant for the slope of the best reply functions of the Ministers and the existence of a Nash Equilibrium.¹⁸

Each firm maximizes its profit with respect to its investment in capital ($k_{i=E;M}$). We deduce the demand for capital in each sector:

$$\begin{cases} k_M \equiv \operatorname{argmax}_{k \geq 0} \{\pi_M(k)\} \\ k_E \equiv \operatorname{argmax}_{k \geq 0} \{\pi_E(k)\} \end{cases}. \quad (\text{eq. 1.3})$$

The First Order Conditions (FOCs) of the previous maximization programs yield the following expressions:

$$f_M'(k_M) = \frac{r+t_M}{(1-\tau)p} \text{ and } f_E'(k_E) = r + t_E. \quad (\text{eq. 1.4})$$

We obtain:

¹⁷ We consider that the country is too small to have an impact on any of these variables.

¹⁸ Such assumptions are usual in Industrial Organization (see Bagnoli and Bergstrom, 2005 for a review of log concavity applications in economic science and Rota-Graziosi, 2019 in the case of tax competition).

$$k_M(t_M, \tau) = f_M'^{-1} \left(\frac{r+t_M}{(1-\tau)p} \right), \quad (\text{eq. 1.5})$$

$$k_E(t_E) = f_E'^{-1}(r + t_E). \quad (\text{eq. 1.6})$$

The assumption of perfect mobility of capital across sectors yields the following capital market clearing condition:

$$(1 - \tau)pf_M'(k_M(t_M, \tau)) - t_M = f_E'(k_E(t_E)) - t_E = r. \quad (\text{eq. 1.7})$$

Our setup differs from the standard vertical or even horizontal tax competition in the following assumptions: (1) The net return of capital (r) is exogenous; (2) The stock of capital in the whole economy ($k_M + k_E$) is endogenous.

Given the concavity of the production functions, we obtain the following Lemma:

Lemma 1.1. *we have:*

$$\begin{aligned} \frac{\partial k_E(t_E)}{\partial t_E} &< 0, \quad \frac{\partial k_M(t_M, \tau)}{\partial t_M} < 0, \quad \frac{\partial k_M(t_M, \tau)}{\partial \tau} < 0, \\ \frac{\partial k_E(t_E)}{\partial \tau} &= \frac{\partial k_M(t_M, \tau)}{\partial t_E} = 0, \\ \frac{\partial^2 k_E(t_E)}{\partial t_E \partial \tau} &= 0, \quad \frac{\partial^2 k_M(t_M, \tau)}{\partial t_M \partial \tau} < 0, \\ \frac{\partial^2 k_E(t_E)}{\partial (t_E)^2} &> 0, \quad \frac{\partial^2 k_M(t_M, \tau)}{\partial (t_M)^2} > 0, \quad \frac{\partial^2 k_M(t_M, \tau)}{\partial \tau^2} < 0. \end{aligned}$$

Proof. See Appendix A.1.

Taxes decrease the demand for capital in both sectors. There is no direct effect of the royalty rate (τ) on the demand for capital in the non-extractive sector (k_E). The sign of $\frac{\partial^2 k_M(t_M, \tau)}{\partial t_M \partial \tau}$ induces a common pool issue, when tax instruments t_M and τ are decided by the two distinct authorities: the MoF and the MoM. Demands for capital in both sectors are convex with respect to capital tax rates t_E and t_M , while the royalty rate (τ) decreases the marginal demand for capital in the extractive industry.

1.2.2. The policy

The main originality of our analysis is to go beyond the assumption of a unitary tax policymaker. Several stylized facts justify our approach. First, the MoM is usually directly or indirectly interested in the activity of the sector, which is here captured through the turnover of the extractive industry. For instance, the mining code or law

in several countries introduces some special mining funds or mineral development funds, which are financed through a share of collected royalties and aim at financing the development of this sector. The mining code may even specify explicitly that the special mining fund provides complementary revenue (premiums or bonuses) to officials working in the MoM. As an illustration, Article 15 of the mining code of Côte d'Ivoire (1996) states that the product of duties, taxes, and fees from the mining sector are shared as follows: 85 percent for the general budget, 10 percent for the Special Fund for Mining Promotion (financing among other things the training of technical staff of the MoM), and 5 percent for officials of the MoM. Similarly, the 2015 mining code of Burkina Faso introduced a fund for the financing of the geological and mining research and support to the training of earth sciences, which is financed through 15 percent of mining royalty revenue. A third example is the recent Ghanaian Minerals Development Fund Act voted on March 29, 2016, which is funded through a 20 percent take on mining royalties and has among other objects to “support the policy planning, evaluation and monitoring functions of the Ministry [of Lands and Natural Resources] in respect of mining related activities.”

Second, in resource-rich countries, the MoF does not have always complete control over mining royalty revenue. Mining royalty, its bases, and its rates are usually neither defined in the Tax Code, nor in the Mining Code, but in the MoM's implementation Decree or Order of the latter. In some cases, (e.g. Mali), the tax administration or authority is not even in charge of collecting mining royalty.¹⁹ Finally, royalty is not a tax per se,²⁰ but a payment for the right to extract natural resources, which is owned by the State (except in the United States) on behalf of the people.

Two tax regimes apply mainly to the oil extraction industry: the concession regime and the Production or Profit-Sharing Contract. The former is very close to the mining royalty regime combined with a profit tax (e.g. CIT). The latter consists of sharing production or profit after some oil costs have been deduced to cover investors costs (see Daniel *et al.*, 2010). The Ministry in charge of the oil sector participates actively to the design of these contracts with private investors. The share going to the State is equivalent to a tax on oil companies' turnover.

We describe the payoff function of the two Ministries, who interact in the definition of tax policy. The objective function of the Minister of Finance (MoF) consists in tax revenue, denoted by $R^{MoF}(t_M, t_E, \tau)$, raised through the capital tax, while the payoff

¹⁹ The Land and Property Rights Directorate is in charge of collecting mining royalties. However, this Directorate depends on the Minister of housing and urban planning in Mali.

²⁰ Daniel *et al.* (2010) notice that royalties are usually recorded as non-tax revenue in national fiscal accounts.

function of the Minister of Mining (MoM), denoted by $R^{MoM}(t_M, \tau)$, corresponds to mining royalty revenue raised on the turnover of this sector.²¹ We have then:

For the MoF,

$$R^{MoF}(t_M, t_E, \tau) = t_E k_E(t_E) + t_M k_M(t_M, \tau). \quad (\text{eq. 1.8})$$

For the MoM,

$$R^{MoM}(t_M, \tau) = \tau p f_M(k_M(t_M, \tau)). \quad (\text{eq. 1.9})$$

With this set-up, we formalize the interactions of both Ministers, which tax partly the same base: the capital invested in the extractive sector.

1.2.3. The centralized tax regime as a benchmark

As a benchmark, we consider the centralized tax regime, in which the government decides the unique capital tax rate and the mining royalty.²² We have: $t_E = t_M = t$. We simplify the notation of the MoF's payoff function as $R^{MoF}(t, \tau) = R^{MoF}(t, t, \tau)$. In this case, total tax revenue is denoted by $R^T(t, \tau) = R^{MoF}(t, \tau) + R^{MoM}(t, \tau)$. The maximization of total tax revenue ($R^T(t, \tau)$) is then:

$$(t^C, \tau^C) \equiv \underset{t \in [0, \bar{t}], \tau \in [0, \bar{\tau}]}{\text{argmax}} \{R^T(t, \tau)\}. \quad (\text{eq. 1.10})$$

The mobility of capital across sectors and the assumption of a unique capital tax rate involve the following equality

$$f'_E(k_E(t^C)) = (1 - \tau^C) p f'_M(k_M(t^C, \tau^C)) \quad (\text{eq. 1.11})$$

The First Order Conditions (FOCs) are given by²³

$$k_M(t^C, \tau^C) + k_E(t^C) + t^C \left. \frac{\partial k_E(t)}{\partial t} \right|_{t^C} + [t^C + \tau^C p f'_M(k_M(t^C, \tau^C))] \left. \frac{\partial k_M(t, \tau)}{\partial t} \right|_{t^C} = 0. \quad (\text{eq. 1.12})$$

$$p f'_M(k_M(t^C, \tau^C)) + [t^C + \tau^C p f'_M(k_M(t^C, \tau^C))] \left. \frac{\partial k_M(t, \tau)}{\partial \tau} \right|_{\tau^C} = 0 \quad (\text{eq. 1.13})$$

These expressions define implicitly the level of capital tax and royalty rates under a unitary tax policy regime.

²¹ In order to stress the inter-ministerial competition, we do not develop a welfare approach and consider tax revenue maximisers.

²² We will discuss the issue of tax rates discrimination latter in the text, since the taxing power assignment may induce some preferential tax treatments of the extractive sector.

²³ We assume that the Hessian matrix is semi-negative definite. See Appendix A.5 for the SOCs.

1.2.4. Tax policy regime 1

In the tax policy regime 1, we consider that the taxing power is shared as follows: The MoF decides over the unique capital tax rate, while the MoM chooses the royalty rate. This scenario seems relatively common in developing countries (and beyond), where royalty remains a very specific tax instrument (see Otto *et al.*, 2013). We have the following maximization program under the constraint (1.11) in (t^1, τ^1) :

$$\begin{cases} t^1 \equiv \operatorname{argmax}_{t \geq 0} \{R^{MoF}(t, \tau)\} \\ \tau^1 \equiv \operatorname{argmax}_{\tau \geq 0} \{R^{MoF}(t, \tau)\} \end{cases} \quad (\text{eq. 1.14})$$

The FOCs of (1.14) are²⁴

$$k_M(t^1, \tau^1) + k_E(t^1) + t^1 \left(\frac{\partial k_M(t, \tau)}{\partial t} \Big|_{t^1} + \frac{\partial k_E(t)}{\partial t} \Big|_{t^1} \right) = 0. \quad (\text{eq. 1.15})$$

$$f_M(k_M(t^1, \tau^1)) + \tau^1 f'_M(k_M(t^1, \tau^1)) \frac{\partial k_M(t, \tau)}{\partial \tau} \Big|_{\tau^1} = 0. \quad (\text{eq. 1.16})$$

We obtain the following proposition:

Proposition 1.1. *When the MoF decides over the unique capital tax rate and the MoM chooses the royalty rate (tax policy regime 1), the game played by the two Ministers displays negative spillovers and tax instruments are strategic substitutes.*

Proof. See Appendix A.2

The strategic substitutability of tax instruments characterizes the nature of the interactions between both Ministers. If the MoF increases its capital tax rate, the MoM reacts by reducing its royalty rate (and reciprocally). Indeed, any increase in one of the two tax instruments reduces the total amount of available capital in the economy and consequently affects the tax revenues of both Ministers. Thus, the negative relationship between resources and non-resource tax revenues emphasized by Bornhorst *et al.* (2009), Crivelli and Gupta (2014) or James (2015) expresses here the strategic substitutability of tax rates and captures the taxing power assignment assumed in the tax policy regime 1.

Given the strategic substitutability of tax rates, the game played by both Ministers in the tax policy regime 1 is submodular. The Nash Equilibrium exists since there are only two players at stake and considering the opposite strategy of one player allows

²⁴ The SOC's are established in Appendix A.6.

us transforming this submodular game into a submodular game (see Vives, 1999). Moreover, the Nash Equilibrium of this game is commitment robust, i.e. each Minister would prefer to play the simultaneous game rather than one of the two Stackelberg games, in which one is the leader, the other the follower.²⁵

From the properties of strategic substitutability and negative tax spillovers we deduce the following Corollary.

Corollary 1.1. *In the tax policy regime 1, at least one of the tax rates (capital tax rate and royalty rate) is above the level maximizing total tax revenue (centralized solution): $t^1 > t^C$ or $\tau^1 > \tau^C$.*

Proof. Let denote $R_1^i(t, \tau) \equiv \partial R^i(t, \tau) / \partial t$, $R_2^i(t, \tau) \equiv \partial R^i(t, \tau) / \partial \tau$, and

$R_{12}^i(t, \tau) \equiv \partial^2 R_i(t, \tau) / \partial t \partial \tau$ for $i \in \{MoF, MoM\}$. Let assume that $t^1 < t^C$ and $\tau^1 < \tau^C$, we have

$$\begin{aligned} R_1^{MoF}(t^1, \tau^1) &= 0 \\ &> R_1^{MoF}(t^C, \tau^1) \\ &> R_1^{MoF}(t^C, \tau^C) \\ &> -R_1^{MoM}(t^C, \tau^C) > 0, \end{aligned}$$

which yields to a contradiction. The first equality is the FOC (1.15). The first inequality: $R_1^{MoF}(t^1, \tau^1) > R_1^{MoF}(t^C, \tau^1)$ results the concavity of $R^{MoF}(.,.)$ and the assumption that $t^1 < t^C$. The second inequality $R_1^{MoF}(t^1, \tau^1) > R_1^{MoF}(t^C, \tau^C)$ is due to the sign of $R_{12}^{MoF}(.,.)$ and the assumption $\tau^1 < \tau^C$. The equality $R_1^{MoF}(t^1, \tau^1) = -R_1^{MoM}(t^C, \tau^C)$ results from the FOC (1.12). Finally, the last inequality expresses the negative spillovers of t on $R^{MoM}(.,.)$: $R^{MoM}(.,.) < 0$. We would obtain a similar contradiction with the assumption $t^1 > t^C$ and $\tau^1 > \tau^C$.

Tax interactions among ministries do not induce a race to the bottom (nor to the top) if we consider the centralized solution as the benchmark. Given the strategic

²⁵ Developing an endogenous timing version of the studied game, that is introducing a preliminary stage in which each minister would commit to playing early or late, does not modify the equilibrium. Each Minister has a first mover incentive (choosing early instead of playing simultaneously), which involves that the Perfect Subgame Nash Equilibrium of the endogenous timing game corresponds to the Nash Equilibrium of the static game (see Kempf and Rota-Graziosi, 2010).

substitutability property of the tax competition game, an increase in one tax instrument induces the other Minister to reduce its tax level.

1.2.5. Alternative tax policy regimes

We discuss some assumptions of our theoretical framework allowing various extensions of our analysis. We consider a third tax power assignment (tax policy regime 2), which confers to the MoM all the taxing power over the extractive sector. Such a tax regime introduces some capital tax rate discrimination between economic sectors. The OECD (2008, 2010) and the EU Commission condemned capital tax rate discrimination and more broadly preferential tax regimes. However, several authors (e.g. Keen, 2001; Janeba and Smart, 2003; Bucovetsky and Haufler, 2007; Gagné and Wooton, 2011) discussed the relevance of such tax regimes highlighting potential gains in tax rate discrimination. The main intuition is that a uniform capital tax rate may induce a more intensive tax competition since this rate concerns the whole tax base, while preferential tax regimes may soften tax competition by isolating footloose economic sectors. These sectors benefit from a reduced rate or even tax exemptions while countries still tax at a higher rate economic sectors in which capital is less mobile. In other words, capital tax rate discrimination would reduce the impact of tax competition on the bases, where capital is more mobile.

The Nash equilibrium of the tax policy regime 2 is the solution of the following maximization program:

$$\begin{cases} t_2^E \equiv \underset{t^E \geq 0}{\operatorname{argmax}} \{R^{MoF}(t^E, t^M, \tau)\} \\ (t_2^M, \tau_2) \equiv \underset{t^M, \tau \geq 0}{\operatorname{argmax}} \{R^{MoM}(t^M, \tau)\} \end{cases} \quad (\text{eq. 1.17})$$

We obtain the following Proposition.

Proposition 1.2. *When the MoM has complete taxing power over the extractive sector, the equilibrium tax and royalty rates are:*

$$t_2^E > 0, t_2^M = 0, \text{ and } \tau_2 > 0$$

Proof. See Appendix A.3

The considered taxing power assignment involves a capital tax rates discrimination between economic sectors: the mining sector is completely exempted from capital tax, while the other sector is taxed at a non-zero rate ($t_2^E > 0$). Indeed, we obtain a corner solution for the capital tax rate of the mining sector. Given its payoff function, the

MoM is not interested in taxing capital invested in the mining sector and exempts the mining sector from CIT. Such exemptions of capital tax rate correspond to tax incentives provided by the MoM to firms investing in the extractive sector. Tax policy regime 2 induces a break-up between the two economic sectors in terms of taxation: commodity price does not impact the non-extractive sector. The economy is then completely dual.

Finally, another potential tax policy regime would consist to assign the total taxing power to the MoF. The maximization program is given by:

$$(t_3, \tau_3) \equiv \underset{t, \tau \geq 0}{\operatorname{argmax}} \{R^{MoF}(t, \tau)\}$$

Under this tax regime, the MoF does not raise any royalty on the extractive industry: $\tau_3 = 0$. The capital tax rate (t_3) is the highest given the strategic substitutability of tax instruments.

1.3. Analytical and numerical illustrations

This section provides an analytical illustration of a resource boom in presence of interministerial tax competition. We assume quadratic production functions, given by:

$$\forall i \in \{M, E\}, f_i(k) = (a_i - b_i k/2)k, \text{ with } a_i, b_i > 0.$$

The demand for capital in each sector (expressions 2.5 and 2.6) corresponds to:

$$k_M(t, \tau) = \frac{a_M p(1-\tau) - r - t}{(1-\tau)pb_M} = \frac{a_M}{b_M} - \frac{r+t}{(1-\tau)pb_M}, \quad k_E(t) = \frac{a_E - r - t}{b_E}$$

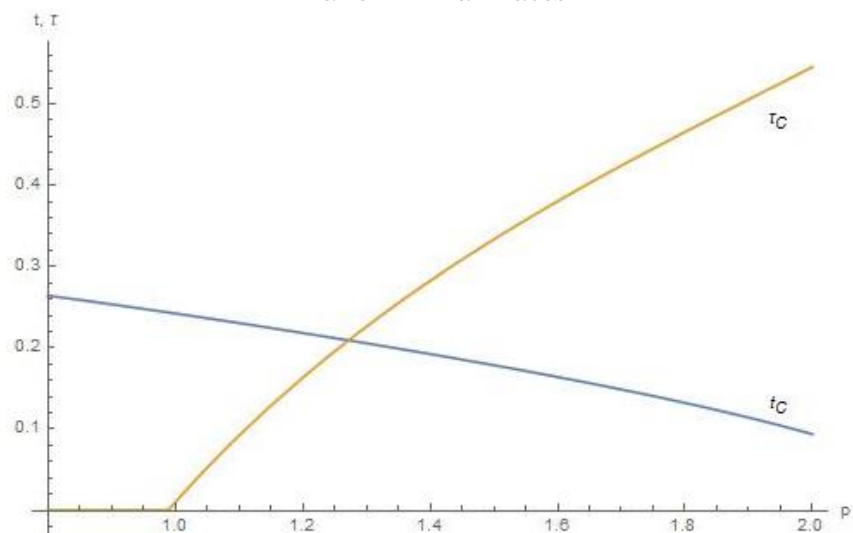
Given the previous expressions and the form of the payoff functions, we proceed to numerical simulations with the following values of the parameters: $r = 0.2$, $a_M = 0.65$, $b_M = 0.2$, $a_E = 0.8$, $b_E = 0.5$. We consider a variation in the commodity's price.

Panel A of Figure 1.1 displays the equilibrium tax rates when the commodity price (p) increases from 0.65 to 2. The royalty rate is increasing in the commodity price, while the capital tax rate decreases. Higher commodity price increases the capital net return of the extractive sector, which involves *ceteris paribus* a flow of capital from the non-extractive industry to the extractive sector. The centralized tax authority reacts by decreasing the capital tax rate, which improves the attractiveness of both economic sectors and increases invested capital in both sectors. In Panel B of Figure 1.1, we represent the equilibrium level of capital in both sectors, which are increasing in p . Given the values of the parameter, we observe that the attractiveness of the extractive sector is increasing in p despite the rise of the royalty rate τ^C . The non-extractive sector benefits from the decrease in capital tax rate t^C and the equilibrium level of capital in this sector increases in p . Panel C of Figure 1.1 presents the Ministries'

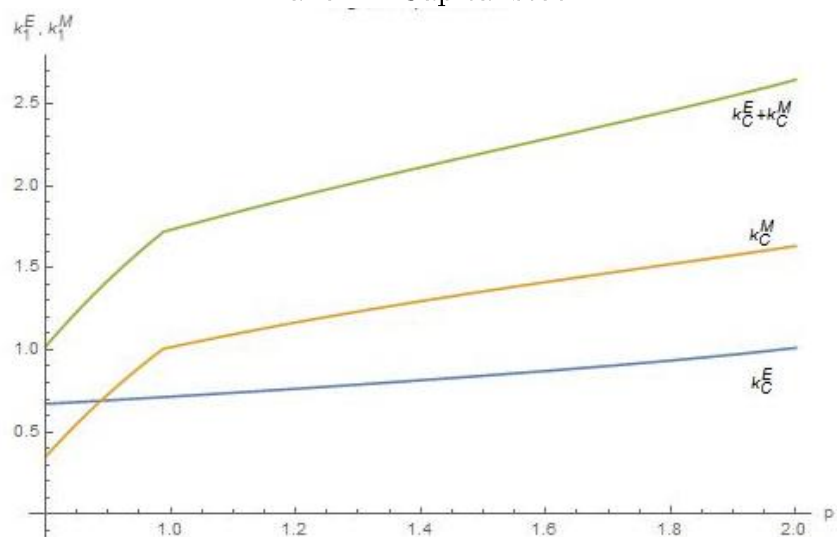
revenues. The MoF's revenue is decreasing in p : the increase in invested capital levels does not offset the decrease in capital tax rate (t^C). In contrast, the MoM's revenue is increasing in p since the royalty rate and the invested capital in the extractive sector are both increasing. Finally, the total tax revenue is increasing in p .

Figure 1.1: Equilibrium values in the centralized tax regime

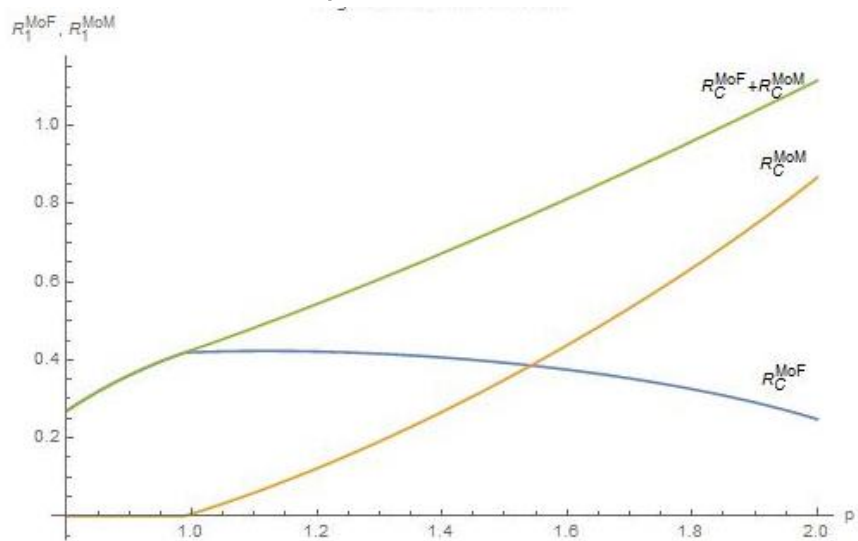
Panel A. Tax rates



Panel B. Capital stock



Panel C. Ministries' revenues



With the same previous quadratic specifications, we display the equilibrium tax rates (τ^1 and t^1), the level of invested capital in each sector, and tax revenues of each Minister at the Nash equilibrium describing the tax policy regime 1. Panel A of Figure 1.2 presents the best reply functions, which are both decreasing illustrating the strategic substitutability of tax rates. Panels B, C, and D of Figure 1.2 show respectively tax rates, the amount of capital in each sector and its total level, and Ministries' revenues at the equilibrium when the commodity price (p) increases from 0.65 to 2. We notice that both tax rates (τ^1 and t^1) are increasing in p . Panel C of Figure 1.2 displays a contrasting variation in the stock of capital invested in both sectors. Finally, we notice that tax revenue increases for both Ministers (see Panel D of Figure 1.2).

Figure 1.2: Equilibrium values in the tax policy regime 1

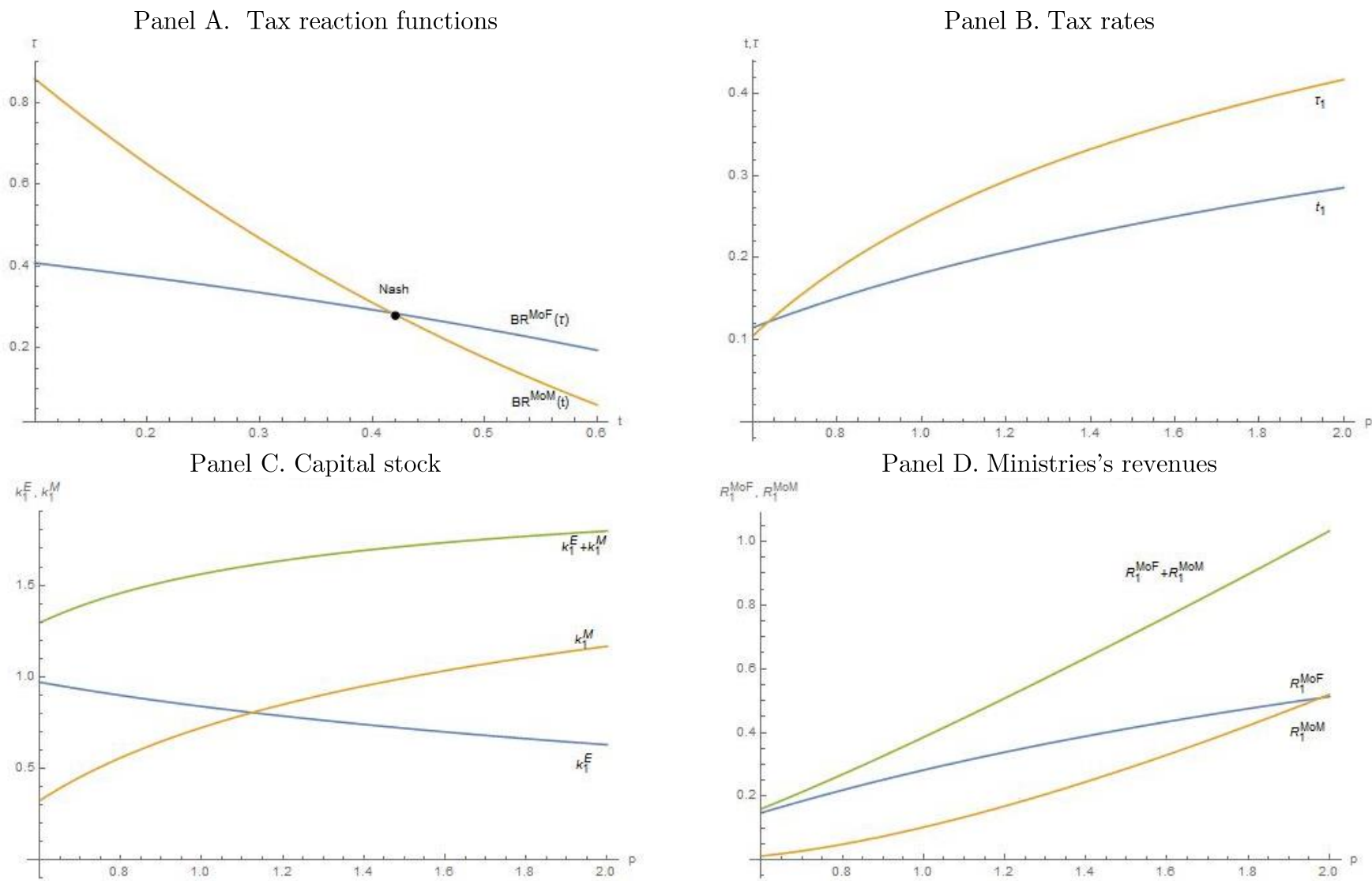
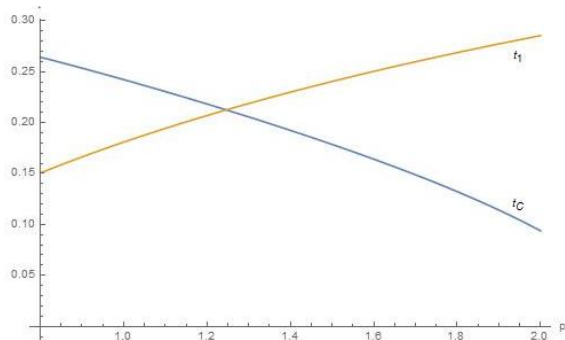


Figure 1.3 compares the equilibrium values (tax rates, stocks of capital, and tax revenues) between the centralized tax regime and the tax policy regime 1. We observe some contrasting variations between both regimes. In particular, the capital tax rate decreases in p under the centralized tax regime, while it increases under tax policy regime 1. Such a difference involves a significant divergence in the case of a resource boom. Indeed, we observe that the tax policy regime 1 induces a concentration of the economic activity, captured through the stock of capital, in the extractive industry, while the centralized tax regime involves a more balanced development of both economic sectors. The reduction of the capital tax rate under the centralized tax regime allows spreading the gain of any increase in the commodity price over the whole economy. In contrast, intragovernmental tax competition under the tax policy regime 1 involves a concentration of capital in the extractive industry, which may reinforce the taxing power of the MoM.

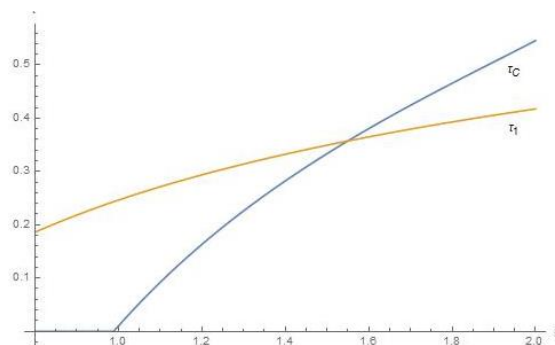
With the chosen parameters' specifications, we notice that the total stock of capital and the total tax revenues are respectively higher under the centralized solution than under tax policy 1 for a sufficient commodity price. Our analytical illustration stresses the inefficiency of the inter-ministerial tax competition in terms of revenue mobilization and even in terms of economic development captured through the total stock of invested capital in the economy. Indeed, the centralized solution allows internalizing the negative spillovers of capital taxation between economic sectors, which emerge when the taxing power is shared.

Figure 1.3: Equilibrium values – centralized tax regime and tax policy regime 1

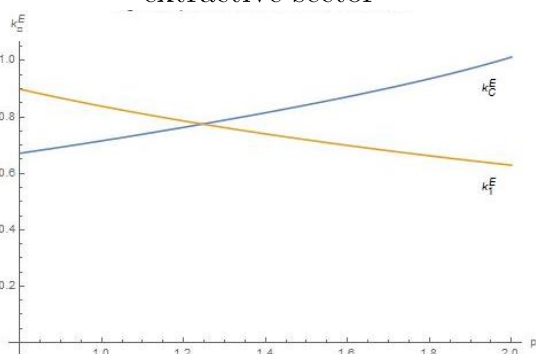
Panel A. Tax rates of the non-extractive sector



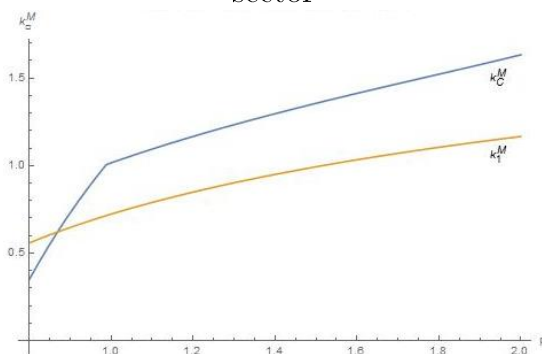
Panel B. Royalty rates



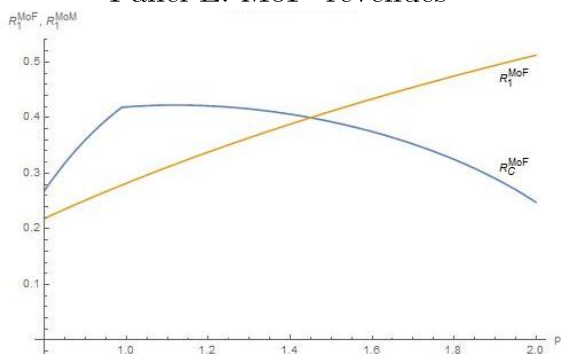
Panel C. Capital stock in the non-extractive sector



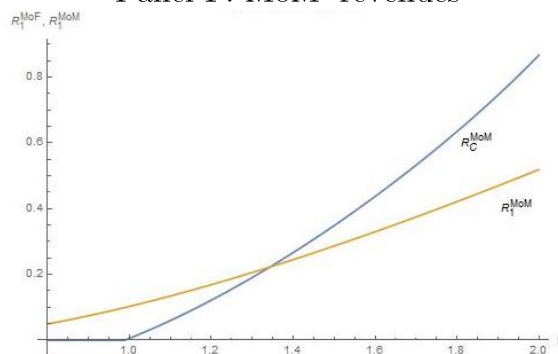
Panel D. Capital stock in the extractive sector



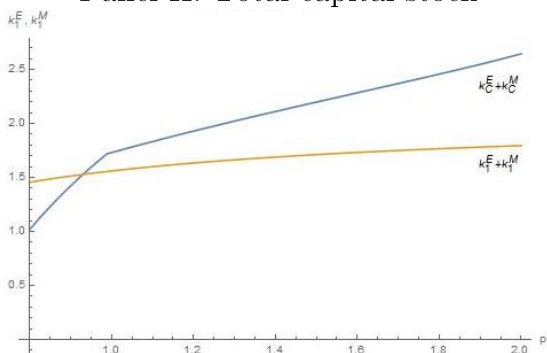
Panel E. MoF' revenues



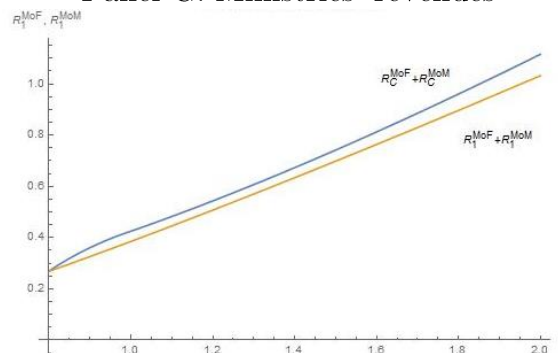
Panel F. MoM' revenues



Panel H. Total capital stock



Panel G. Ministries' revenues



1.4. Empirical analysis

This section establishes empirically the existence of inter-ministerial tax competition and identifies its nature: strategic complementarity or substitutability. More precisely, we intend to tackle the following issues: (1) Does inter-ministerial tax competition exist? (2) If yes, what is the nature of this competition (strategic complements or substitutes)? Does an increase in the capital tax rate induce a similar or inverse variation in the royalty tax rate? (3) Does the abundance of natural resources boost this competition? What happens in resource-poor developing countries? Considering the context of weak institutions, our empirical analysis focuses on 41 Sub-Saharan countries, including 26 resource-rich countries in which natural resource rent exceeds 15 percent of GDP.

1.4.1. Econometric framework

We test the existence of tax reaction functions among Ministers. First, we consider how the MoM's strategic variable, denoted by τ_{it} , depends on the decisions of the MoF, denoted by T_{it} . Second, we study the inverse relationship, that is how the MoF reacts to tax policy decision of the MoM. We have then two expressions:

$$\tau_{it} = \beta T_{it} + \rho X_{it} + \alpha_i + \theta_t + \varepsilon_{it} \quad (\text{eq. 1.18})$$

$$T_{it} = \tilde{\beta} \tau_{it} + \tilde{\rho} X_{it} + \tilde{\alpha}_i + \tilde{\theta}_t + \varepsilon_{it} \quad (\text{eq. 1.19})$$

where $i = 1, \dots, N$ denotes country, $t = 1, \dots, T$ the time period, β , ρ , α and θ (respectively $\tilde{\beta}$, $\tilde{\rho}$, $\tilde{\alpha}$ and $\tilde{\theta}$) are unknown parameters, and ε_{it} is a random error. Our empirical analysis focuses on Effective Tax Rate (ETR), which captures the effective tax burden for each economic sector. The variable τ_{it} is the ETR of the natural resource sector in country i at year t .²⁶ It corresponds to the ratio of resource tax revenue to natural resource rent. The variable T_{it} corresponds to the ETR of the non-resource sector. It corresponds to the non-resource component of CIT revenue to non-resource GDP. We consider that this variable is the tax policy instrument under the control of the MoF.

We use resource and corporate tax revenues from Mansour (2014), who provides detailed tax revenue for 41 Sub-Saharan countries - including the 26 resource-rich

²⁶ We use a log-log model so that the coefficient β represents the elasticity of the variable τ_{it} with respect to the variable T_{it} .

countries - from 1980 to 2010.²⁷ In addition, natural resource rent (in value)²⁸ comes from the World Bank Development Indicators (WDI) database and non-resource GDP²⁹ as proxies for the tax base for the natural resource and non-resource sectors, respectively (see the Appendix A.7 for the list of countries).

A first challenge of the empirical work is to ascertain that the potential observed interaction ($\beta \neq 0$) results from strategic interactions between the MoF and the MoM and not from exogenous correlations in omitted country characteristics or common shocks to both tax policymakers. To deal with this issue we include a country-specific effect α_i , which captures time-invariant observed and unobserved country characteristics. We introduce also time dummies to capture shocks in each period, which are common to both Ministers.

Following the literature on tax effort (see Bornhorst *et al.*, 2009, Crivelli and Gupta, 2014, and Feger and Asafu-Adjaye, 2014), we consider a vector of specific controls, X_{it} , which encompass the following variables: the level of development, trade openness, the structure of the economy, the quality of institutions, the financial development, and commodities' prices. The omission of one of these variables could lead to observe the strategic complementarity of resource and non-resource tax revenue since it may affect them in the same positive way. The level of development (measured by the logarithm of GDP per capita) stands as the most common explanatory variable in the domestic revenue mobilization literature. Through its effects on the supply and demand sides,³⁰ a high level of income per capita increases the mobilization of tax revenues. We also consider the share of the agricultural sector in the GDP because this sector is often completely tax exempted in developing countries. Trade openness matters too since a large share of tax revenues are still coming from international transactions in these countries. The development of the financial sector improves information collection on firms' transactions and consequently the efficiency of tax collectors.³¹ We also control for the quality of institutions (measured by the different components of the ICRG index), which reflects the trust taxpayers have in their government, tax compliance, and the efficiency in tax revenue collection. Finally, we

²⁷ We convert all variables in Mansour (2014) being expressed in Local Current Unit (LCU) into current USD using the exchange rate. The database can be downloaded at: <https://ferdi.fr/en/indicators/tax-revenue-dataset-for-saharan-africa-1980-2010>

²⁸ The natural resource rent in current USD is obtained by multiplying the natural resource rent in the percentage of GDP by the GDP provided in Mansour (2014).

²⁹ The non-resource GDP corresponds to GDP in current USD less the natural resource rent in current USD we computed.

³⁰ A high level of development improves the contributive capacity of individuals and the demand for diversification of public goods, which improves tax compliance and favors revenue mobilization.

³¹ The development of the financial system provides also an incentive for firms to get out of the informal economy.

add an index of commodities' price, which follows the approach proposed by Deaton and Miller (2006). We compute a country-specific weighting scheme based on the share in exports of each commodity (coal, oil, natural gas, silver, copper, nickel, aluminium, lead zinc, tin uranium, and gold). The weights are fixed over the years and applied to the world prices of each commodity.³² Table 1.1 displays the sources of the variables and some descriptive statistics.

Table 1.1: Sources and descriptive statistics

Variables	Measure	Obs.	Mean	Std. Dev.	Min	Max	Source
MoF tax revenue	Corporate tax (% of GDP)	1154	1.636	1.238	0	9.057	Mansour (2014)
MoM tax revenue	Resources tax (% of GDP)	374	9.842	10.89	0	48.68	
Level of development	GDP per capita (PPP, constant 2011)	851	3,828	5,168	354.3	40,016	World Development Indicators, World Bank
Structure of the economy	Agriculture value added (% of GDP)	1146	28.09	15.64	0.892	72.03	
Trade openness	Total trade % of GDP	1144	73.27	49.20	6.320	531.7	
Financial development	Domestic credit to private sector (% of GDP)	1173	15.50	13.50	0	85.28	
Resource endowment	Total natural resources rents (% of GDP)	1226	11.42	12.06	0	89.17	
Quality of institutions	Law and order	738	2.919	1.076	0	6	
	Dummy for EITI	1271	0.037	0.189	0	1	Extractive Industries Transparency Initiative (EITI)
Politics	IMF program (Dummy)	1178	0.642	0.564	0	2	International Monetary Fund
	Ethnics of the Ministry of Finance (Dummy)	325	0.185	0.389	0	1	François et al. (2015)
Prices structures	Commodities price index	752	4.153	1.803	-1.133	8.561	World Trade Organization

Given our theoretical model, a non-zero parameter β means the existence of some strategic tax interactions among Ministries. If β is significantly positive (respectively negative), tax policies are strategic complements (resp. substitutes). We refine our analysis to test whether the abundance of natural resources triggers this competition. We test equation

(1.18) considering several sub-samples of countries according to the wealth of their natural resources to appreciate if this wealth impacts the estimation of β . We test also empirically the effect of natural resources' wealth on the existence of strategic interactions. More precisely, we estimate:

$$\tau_{it} = \beta_2 T_{it} + \delta E_{it} + \beta_1 E_{it} T_{it} + \rho X_{it} + \alpha_i + \theta_t + \varepsilon_{it}, \quad (\text{eq. 1.20})$$

³² Fixed weights induce the exogeneity of the shock variable. However, as Deaton and Miller (1996) recognized it, this assumption ignores potential important windfall events such as new natural resources' discoveries.

where E_{it} is a dummy variable, which takes the value 1 if natural resource rent exceeds 15 percent of GDP in country I at year t (and 0 otherwise). If the abundance of natural resources reinforces strategic interactions, we should observe the coefficient of $E_{it}T_{it}$ being more significant and higher than the coefficient of T_{it} ($\beta_1 > \beta_2$). Moreover, if Ministers interact only if there are natural resources in their country, β_2 may be no longer significant. In this case we will conclude that strategic interactions are contingent on a sufficient level of natural resources' rent and that strategic interactions exist only in natural resource-rich countries.

We also test a dynamic version of the model. We introduce the lagged dependent variable (τ_{it-1}) as a right-hand side to take into account the persistence of tax policies. The dynamic model can be written as follows:

$$\tau_{it} = \gamma\tau_{it-1} + \beta T_{it} + \rho X_{it} + \alpha_i + \theta_t + \varepsilon_{it} \quad (\text{eq. 1.21})$$

Since we introduce the lagged dependent variable as a right-hand side to consider the auto-regressive component of the time series, the fixed effect estimator is inconsistent (see Nickell, 1981). We use the GMM-System estimator, which allows controlling for both unobserved country-specific effects and potential endogeneity of the explanatory variables. Basically, Blundell and Bond (1998) show that this extended GMM estimator is preferable to that of Arellano and Bond (1991) when the dependent variable, the independent variables, or both are persistent.

Estimating this reaction function yields to an important econometric issue. Given potential strategic interactions, tax policies of the Ministries are jointly determined. So, Ministries' decisions are endogenous and correlated with the error term and ordinary least squares estimation of the parameters are inconsistent, requiring estimation methods based on instrumental variables method (IV). The GMM System procedure allows us to use internal instruments based on the lags of the explanatory variables.

Alternatively, we use two external instruments, which aim to capture the power of the MoF and correct for potential endogeneity biases. First, we use a completed version of the database proposed by Francois *et al.* (2015). These authors study the political power allocation in African governments among ethnics living in the country. They study the ethnicity of Ministries for 15 sub-Saharan African countries for the period 1960-2000. They show that the ethnic composition of the cabinet reflects the national ethnic fragmentation. Such an allocation is a tool used by the leader to keep his position and reduce the risk of a coup. Completing the previous database, we build a dummy variable indicating whether the MoF has the same ethnic origin than the President in office. We consider that ethnicity may impact the balance of taxing power

between the MoF and the MoM. The MoF belongs to the same ethnic group as the President in office in 16.62 percent of the studied cases.³³

Second, we construct a dummy variable indicating whether a country is under an IMF program at time t . Half of the countries of our sample had an IMF program over the studied period.³⁴ We consider that the participation to an IMF program has an impact on the empowerment of the MoF relative to the other Ministries and in particular the MoM. The intuition is that an IMF program reinforces the relative power of the MoF by limiting the spending capacities of the other Ministries.

1.4.2. Empirical results

Table 1.2 displays the results of (1.18) for countries with resource rent above 15 percent of GDP.³⁵ We include fixed effect and time dummies and introduce progressively several control variables to test the robustness of our results: per capita GDP for column 1; share of agriculture in GDP for column 2; trade openness for column 3; law and order (a component of the ICRG index) for column 4; domestic credit to private sector for column 5; the index of the price of commodity for column 6; and the compliance to the Extractive Industries Transparency Initiative (EITI)³⁶ for column 7. The results indicate that the coefficient β associated with the ETR of the non-resource sector is negative, significantly different from zero, and robust to the introduction of the previous control variables. A one percent increase in the ETR of the non-resource sector involves between 0.211 percent and 0.608 percent decrease in the ETR of the resource sector. These results validate the existence of the inter-ministerial tax competition characterized by the strategic substitutability of tax instruments.

As a robustness test, we consider a one-year reaction time delay of the response of the MoM to the MoF's tax policy. The coefficient associated with the lagged value of the ETR of the non-resource sector is negative and significant at 1 percent level (see column 8). It confirms the existence of inter-ministerial tax competition.

³³ For instance, the dummy variable takes the value 1 in Chad from 2006 to 2007 when the MoF was the nephew of the President in office, Idriss Déby. It takes the value 1 in Congo from 1970 to 1991 as the MoF and the president Denis Sassou-Nguesso were from the same ethnic group: the Mbochis, third ethnic group in Congo. On the contrary, the variable takes the value 0 in Guinea from 1982 to 1983: the MoF and the President were from the two largest and conflicting ethnic groups, respectively Peulh and Malinke.

³⁴ Some countries (4.53 percent of our sample) may even have two IMF programs at the same time.

³⁵ The online Appendix A.8 reviews the correlation of the studied variables. The coefficient between ETR of the resource sector and ETR of the non-resource sector is significantly positive.

³⁶ The EITI is a global initiative to disclose information relative to the extractive sector. In particular, a country is compliant when revenue reported as paid by firms operating in the sector is equal or very close to revenue reported as received by the government.

Table 1.2: Inter-ministerial competition in the determination of the ETR of natural resources and corporate taxes in resource-rich countries – OLS

Variables	ETR of the resource sector							
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
ETR of the non-resource sector	-0.211*	-0.492***	-0.441**	-0.501***	-0.501***	-0.608**	-0.493***	
	(0.125)	(0.173)	(0.174)	(0.153)	(0.155)	(0.243)	(0.157)	
GDP per capita, log (PPP, constant 2011)	0.653***	0.176	0.461	0.786*	0.785	0.590	0.383	0.652
	(0.117)	(0.554)	(0.574)	(0.464)	(0.833)	(1.428)	(1.048)	(0.851)
Agriculture value added (% of GDP)		0.020	0.026**	-0.012	-0.012	-0.032	-0.013	-0.010
		(0.012)	(0.013)	(0.017)	(0.018)	(0.044)	(0.019)	(0.019)
Total trade % of GDP			0.007	0.007*	0.007*	0.010	0.007*	0.008
			(0.004)	(0.003)	(0.004)	(0.013)	(0.004)	(0.004)
Law and order				-0.071	-0.071	-0.325	-0.060	-0.069
				(0.119)	(0.120)	(0.252)	(0.122)	(0.123)
Domestic credit to private sector (% of GDP)					0.000	-0.005	0.006	-0.001
					(0.017)	(0.023)	(0.020)	(0.018)
Commodity price index, log						0.470		
						(0.485)		
Dummy for EITI							0.151	
							(0.235)	
ETR of non-resource sector $_{(t-1)}$								-0.532***
								(0.177)
Constant	-2.377**	1.759	-1.178	-2.908	-2.898	-2.144	0.353	-1.844
	(1.018)	(4.554)	(4.845)	(3.943)	(6.907)	(11.54)	(8.614)	(7.050)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs. (Countries)	98 (7)	77 (7)	77 (7)	66 (5)	66 (5)	45 (5)	66 (5)	66 (5)
R-squared	0.531	0.464	0.492	0.640	0.640	0.819	0.644	0.626

Note: Standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). The table reports the results of the strategic interaction for countries with resources rent > 15%. The ETR of the resource sector corresponds to the natural logarithm of the ratio of resource tax revenue to total natural resource rent. The ETR of non-resource sector corresponds to the natural logarithm of the ratio of non-resource component of CIT revenue to non-resource GDP.

Table 1.3 shows the result from expression (1.19) with the same previous control variables. The MoF reacts negatively to the current MoM's tax policy decision (column 1) and also to a one-year delayed decision of the MoM (column 2). These results confirm the strategic substitutability of ministerial tax policies.

Table 1.3: Inter-ministerial competition in the determination of the ETR of natural resources and corporate taxes in resource-rich countries – OLS

Variables	ETR of the non-resource sector	
	[1]	[2]
ETR of the resource sector	-0.457*** (0.142)	
GDP per capita, log (PPP, constant 2011)	0.336 (0.804)	0.258 (0.741)
Agriculture value added (% of GDP)	0.020 (0.017)	0.032 (0.020)
Total trade % of GDP	0.002 (0.004)	0.000 (0.004)
Law and order	-0.205* (0.110)	-0.295** (0.113)
Domestic credit to private sector (% of GDP)	-0.005 (0.016)	-0.009 (0.015)
ETR of the resource sector $_{(t-1)}$		-0.227** (0.108)
Constant	-1.087 (6.613)	-1.366 (6.045)
Country FE	Yes	Yes
Time FE	Yes	Yes
Obs. (Countries)	66 (5)	66 (5)
R-squared	0.676	0.670

Note: Standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). The table reports the results of the strategic interaction for countries with resources rent $> 15\%$. The ETR of the resource sector corresponds to the natural logarithm of the ratio of resource tax revenue to total natural resource rent. The ETR of non-resource sector corresponds to the natural logarithm of the ratio of non-resource component of CIT revenue to non-resource GDP.

We refine our analysis to ascertain that the strategic interactions observed are generated by the presence of abundant natural resources (see Table 1.4). We first estimate (1.18) considering various sub-samples of countries depending on the relative size of their resource rent: above 20 percent of GDP (column 1), above 15 percent (column 2), and above 10 percent (column 3). We conclude that β is significant and negative, while it becomes positive for countries with a resource rent below 10 percent of GDP (column 4).

Table 1.4: Inter-ministerial tax competition and the abundance of natural resources

Variables	ETR of the resource sector			
	[1]	[2]	[3]	[4]
Resource rent threshold	> 20%	> 15%	> 10%	< 10%
ETR of the non-resource sector	-0.466** (0.171)	-0.501*** (0.155)	-0.391* (0.202)	1.321*** (0.208)
GDP per capita, log (PPP, constant 2011)	1.813* (0.895)	0.785 (0.833)	1.779 (1.120)	-5.689*** (1.248)
Agriculture value added (% of GDP)	0.023 (0.021)	-0.012 (0.018)	-0.037 (0.024)	0.075** (0.036)
Total trade % of GDP	0.014*** (0.004)	0.007* (0.004)	-0.000 (0.005)	0.030* (0.016)
Law and order	0.097 (0.134)	-0.071 (0.120)	-0.227 (0.166)	-0.044 (0.194)
Domestic credit to private sector (% of GDP)	-0.011 (0.020)	0.000 (0.017)	-0.022 (0.021)	0.021 (0.017)
Constant	-12.73 (7.632)	-2.898 (6.907)	-9.363 (8.915)	44.81*** (10.210)
Country FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Obs. (Countries)	57 (5)	66 (5)	103 (12)	83 (9)
R-squared	0.746	0.640	0.387	0.633

Note: Standard errors in parentheses (***) $p < 0.01$, (**) $p < 0.05$, (*) $p < 0.1$. The table reports the results of the strategic interaction for countries with resource rent threshold of 20%, 15%, 10%. The ETR of the resource sector corresponds to the natural logarithm of the ratio of resource tax revenue to total natural resource rent. The ETR of non-resource sector corresponds to the natural logarithm of the ratio of non-resource component of CIT revenue to non-resource GDP.

As a robustness check, we consider resource exports: a country is resource-rich if its natural resource exports exceed 25 percent of total exportation. Again, strategic substitutability of tax policies emerges only in natural resource-rich developing countries as previously defined (see online Appendix A.9).

Finally, Table 1.5 displays estimation results of the dynamic version of the model (1.21). The ETR of the non-resource sector is considered as an endogenous variable and we adopt the assumption of weak exogeneity of the lagged dependent variable while other explanatory variables are assumed to be strictly exogenous.³⁷ The lags of at least one earlier period for weak exogenous variables and two earlier periods for endogenous variables are used as instruments.

We notice first that the orthogonality conditions are respected. Indeed, the consistency of the estimator depends on whether or not lagged values of explanatory variables are valid instruments. With the Sargan test, we test the null hypothesis of the overall

³⁷ The lagged levels of variables are used as instruments in the regressions in level as well as in the regressions in difference. We collapse instruments and limit the number.

validity of the instruments' orthogonality conditions. The second test concerns the serial correlation of residuals. It examines the hypothesis that the residuals from the first-differentiated estimating equation are not second-order correlated. In our case, both statistics confirm the validity of the instruments used. The coefficient on the lagged dependent variable appears to be significant and positive, confirming the consistency of the auto-regressive specification. The coefficient of interest is still negative and significant (column 1) even after having corrected for potential endogeneity of the ETR of the non-resource sector (column 2).

Table 1.5: Inter-ministerial competition in the determination of the ETR of natural resources and corporate taxes in resource-rich countries - dynamic model

Variables	ETR of the resource sector	
	[1]	[2]
ETR of the resource sector ($t-1$)	0.474*** (0.158)	0.329*** (0.110)
ETR of the non-resource sector	-0.875** (0.344)	-0.805*** (0.236)
GDP per capita, log (PPP, constant 2011)	0.934*** (0.313)	0.990*** (0.170)
Agriculture value added (% of GDP)	0.023*** (0.007)	0.026*** (0.007)
Total trade % of GDP	0.0104*** (0.003)	0.010*** (0.003)
Law and order	-0.211* (0.120)	-0.273*** (0.065)
Domestic credit to private sector (% of GDP)	0.023 (0.019)	0.021 (0.016)
Constant	-6.302*** (2.230)	-6.197*** (1.401)
Obs. (Countries)	63 (5)	63 (5)
Sargan	1.883	2.832
Sargan (P-value)	0.170	0.586
AR1	-1.678	-1.911
AR1 (P-value)	0.093	0.056
AR2	-1.134	-1.306
AR2 (P-value)	0.257	0.192
Instruments	9	12

Note: Standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). The table reports the results of the strategic interaction for countries with resources rent $> 15\%$. The ETR of the resource sector corresponds to the natural logarithm of the ratio of resource tax revenue to total natural resource rent. The ETR of non-resource sector corresponds to the natural logarithm of the ratio of non-resource component of CIT revenue to non-resource GDP.

Table 1.6 presents the estimation results of the IV regressions with our external instrument based on the alignment between the ethnicity of the MoF and the President in office (see Table A.4.1 of Appendix A.4 for the first stage results). The coefficient

β associated with the ETR of the non-resource sector is still significant, negative, and robust to the introduction of various control variables. In the first stage, the fact that the MoF has the same ethnicity as the President is strongly and significantly associated with our interest variable. This effect is negative: belonging to an ethnic group different from the President's one reinforces the taxing power of the MoF. We can infer that the appointment of an MoF belonging to a different ethnic group than the President is a critical element of the power-sharing across the countries' ethnics. Thus, the ethnic misalignment of the MoF and the President reflects a more powerful MoF.

Table 1.6: Inter-ministerial competition in the determination of the ETR of natural resources and corporate taxes in resource-rich countries – G2SLS Ethnic affiliation (second stage)

Variables	ETR of the resource sector	
	[1]	[2]
ETR of the non-resource sector	-1.029** (0.472)	-1.023** (0.409)
GDP per capita, log (PPP, constant 2011)	1.637*** (0.405)	1.627*** (0.327)
Agriculture value added (% of GDP)	0.070*** (0.014)	0.070*** (0.013)
Total trade % of GDP	0.022*** (0.006)	0.022*** (0.006)
Law and order	-0.377*** (0.139)	-0.376*** (0.136)
Domestic credit to private sector (% of GDP)		0.001 (0.017)
Constant	-11.75*** (3.801)	-11.67*** (3.131)
Obs. (Countries)	66 (5)	66 (5)
R-squared	0.408	0.409
Time FE	Yes	Yes
Instrumental variable	Ethnic group	Ethnic group

Note: Standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). The table reports the second stage results of the strategic interaction for countries with resources rent $> 15\%$. The ETR of the resource sector corresponds to the natural logarithm of the ratio of resource tax revenue to total natural resource rent. The ETR of non-resource sector corresponds to the natural logarithm of the ratio of non-resource component of CIT revenue to non-resource GDP.

In Table 1.7, we include an additional external instrument for the ETR of the non-resource sector: a dummy variable indicating whether a country is participating in an IMF program at time t (see Table A.4.2 of Appendix A.4 for the first stage results). The results are robust, confirming the existence of strategic substitutes.

Table 1.7: Inter-ministerial competition in the determination of the ETR of natural resources and corporate taxes in resource-rich countries – G2SLS Ethnic affiliation and IMF program (second stage)

Variables	ETR of the resource sector	
	[1]	[2]
ETR of the non-resource sector	-0.974** (0.446)	-0.956** (0.375)
GDP per capita, log (PPP, constant 2011)	1.591*** (0.384)	1.578*** (0.303)
Agriculture value added (% of GDP)	0.069*** (0.014)	0.069*** (0.013)
Total trade % of GDP	0.022*** (0.006)	0.022*** (0.005)
Law and order	-0.371*** (0.134)	-0.370*** (0.131)
Domestic credit to private sector (% of GDP)		-0.000 (0.016)
Constant	-11.33*** (3.605)	-11.21*** (2.900)
Obs. (Countries)	66 (5)	66 (5)
R-squared	0.411	0.412
Time FE	Yes	Yes
Instrumental variable	Ethnic group and IMF program	Ethnic group and IMF program

Note: Standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). The table reports the second stage results of the strategic interaction for countries with resources rent $> 15\%$. The ETR of the resource sector corresponds to the natural logarithm of the ratio of resource tax revenue to total natural resource rent. The ETR of non-resource sector corresponds to the natural logarithm of the ratio of non-resource component of CIT revenue to non-resource GDP.

1.5. Conclusion

We proposed an analysis of tax policy as the result of an inter-ministerial competition: the MoF and the MoM compete and tax partly the same base. Our theoretical framework concludes with the strategic substitutability of Ministries' tax instruments: capital tax and royalty rates. Given our assumptions of a fixed net return of capital and an endogenous stock of capital in the economy, any increase in one tax instrument reduces invested capital in the economy leading the other Minister to reduce the tax rate under her control.

An analytical and numerical illustration allows us to appreciate the impact of a resource boom through an increase in commodity prices. Intragovernmental tax competition reduces total tax revenues. It also involves a concentration of the economic activity, appreciated through a higher stock of capital in the extractive industry, while the centralized tax regime allows a more balanced development of both economic sectors.

We test empirically the strategic substitutability of effective tax rates in the natural resource sector and the rest of the economy for 41 Sub-Saharan countries from 1980 to 2015. We confirm empirically the strategic substitutability of tax instruments. This provides an alternative view to the crowding-out effect between both sources of revenue emphasized by Bornhorst *et al.* (2009), Crivelli and Gupta (2014), and James (2015).

Our analysis offers a new potential explanation of the low quality of institutions in resource rich developing countries, particularly of their inefficient tax system. The fragmentation of the taxing power may also be fuelled by some lobbying activities, which strengthens with the increase in commodity prices or new resources' discoveries. This would lead the country into a trap where the economy reduces to the extractive industry as highlighted through our analytical illustration. This last result offers a complementary explanation of the Dutch disease. The observed deindustrialization of the national economy, which occurs after the discovery of some natural resources uses to be explained through the real exchange rate appreciation, which affects the international competitiveness of non-resource economic sectors. Following Robinson *et al.* (2006), we offer a more political explanation through the taxing power fragmentation among Ministries.

Our approach in terms of Ministries interacting with each other to define the effective national tax policy can be relevant beyond the case of resource-rich developing countries, especially in the study of some tax reform or some sectoral tax expenditures existing in all the countries. Indeed, the analysis of the budget process based on Wildavsky (1974) remains mainly driven by the distinction between the Guardian, the MoF, and the Spenders, the sectorial ministries. These spending correspond to the share of the allocated budget. However, another type of spending is tax expenditure. The latter, which can be significant in terms of revenue losses may result from the taxing power fragmentation and the induced inter-ministerial competition.

1.6. References

- Andersen, J. J. and S. Aslaksen (2008). Constitutions and the resource curse. *Journal of Development Economics* 87(2), 227-246.
- Arellano, M. and S. Bond (1991). Some tests of specification for panel data: Monte carlo evidence and an application to employment equations. *Review of Economic Studies* 58(2), 277-297.
- Bagnoli, M. and T. Bergstrom (2005). Log-concave probability and its applications. *Economic Theory* 26(2), 445-469.
- Berkowitz, D. and W. Li (2000). Tax rights in transition economies: a tragedy of the commons? *Journal of public economics* 76(3), 369-397.
- Besley, T. and T. Persson (2013). Chapter 2 - Taxation and development. In A. J. Auerbach, R. Chetty, M. Feldstein, and E. Saez (Eds.), *Handbook of Public Economics*, Volume 5, pp. 51-110. Elsevier.
- Blundell, R. and S. Bond (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics* 87(1), 115-143.
- Bornhorst, F., S. Gupta, and J. Thornton (2009). Natural resource endowments and the domestic revenue effort. *European Journal of Political Economy* 25(4), 439-446.
- Boschini, A. D., J. Pettersson, and J. Roine (2007). Resource curse or not: A question of appropriability. *Scandinavian Journal of Economics* 109(3), 593-617.
- Brennan, G. and J. Buchanan (1980). *The Power to Tax: Analytical Foundations of a Fiscal Constitution*. New York: Cambridge University Press.
- Bucovetsky, S. and A. Haufler (2007). Preferential Tax Regimes With Asymmetric Countries. *National Tax Journal* 60(4), 789-795.
- Bulow, J., J. Geanakoplos, and P. Klemperer (1985). Multimarket oligopoly: Strategic substitutes and complements. *Journal of Political Economy* 93(3), 488-511.
- Crivelli, E. and S. Gupta (2014). Resource blessing, revenue curse? Domestic revenue effort in resource-rich countries. *European Journal of Political Economy* 35, 88-101.
- Daniel, P., M. Keen, and C. McPherson (2010). *The taxation of petroleum and minerals: Principles, problems and practice*. New York: Routledge.

- Deaton, A. and R. Miller (1996). International commodity prices, macroeconomic performance and politics in Sub-Saharan Africa. *Journal of African Economies* 5(3), 99-191.
- Eaton, C. (2004). The elementary economics of social dilemmas. *Canadian Journal of Economics* 37(4), 805-829.
- Feger, T. and J. Asafu-Adjaye (2014). Tax effort performance in sub-Sahara Africa and the role of colonialism. *Economic Modelling* (38), 163-174.
- Francois, P., I. Rainer, and F. Trebbi (2015). How Is Power Shared in Africa? *Econometrica* 83(2), 465-503.
- Gagné, C. and I. Wooton (2011). The gains from preferential tax regimes reconsidered. *Regional Science and Urban Economics* 41(1), 59-66.
- James, A. (2015). US State fiscal policy and natural resources. *American Economic Journal: Economic Policy* 7(3), 238-257.
- Janeba, E. and M. Smart (2003). Is targeted tax competition less harmful than its remedies? *International Tax and Public Finance* 10(3), 259-280.
- Jinno, N. and A. DeWit (1998). Japan's taxing bureaucrats: Fiscal sociology and the property-tax revolt. *Social Science Japan Journal* 1(2), 233-246.
- Keen, M. (2001). Preferential regimes can make tax competition less harmful. *National Tax Journal* 54(4), 757-762.
- Keen, M. and K. A. Konrad (2013). Chapter 5 - The theory of international tax competition and coordination. In M. F. Alan J. Auerbach, Raj Chetty and E. Saez (Eds.), *Handbook of Public Economics*, Volume 5, pp. 257-328. Elsevier.
- Keen, M. and C. Kotsogiannis (2002). Does federalism lead to excessively high taxes? *American Economic Review* 92(1), 363-370.
- Keen, M. and M. Mansour (2010). Revenue mobilisation in Sub-Saharan Africa: Challenges from globalisation II - Corporate taxation. *Development Policy Review* 28(5), 573-596.
- Kempf, H. and G. Rota-Graziosi (2010). Endogenizing leadership in tax competition. *Journal of public economics* 94(9-10), 768-776.
- Mansour, M. (2014). A tax revenue dataset for Sub-Saharan Africa: 1980-2010. *Revue d'Economie du Développement* 22(3), 99-128.

Marceau, N. and M. Smart (2003). Corporate lobbying and commitment failure in capital taxation. *The American Economic Review* 93(1), 241-251.

McGuirk, E. (2013). The illusory leader: natural resources, taxation, and accountability. *Public Choice* 154, 285-313.

Mehlum, H., K. Moene, and R. Torvik (2006). Institutions and the resource curse. *Economic Journal* 116(508), 1-20.

Meltzer, A. H. and S. F. Richard (1981). A rational theory of the size of government. *Journal of Political Economy* 89(5), 914-927.

Nickell, S. (1981). Biases in dynamic models with fixed effects. *Econometrica* 49(6), 1417-1426.

Otto, J., C. Andrews, J. Tilton, F. Cawood, J. Stermole, F. Stermole, M. Doggett, and P. Guj (2013). *Mining royalties: A global study of their impact on investors, government and civil society*. Washington DC: World Bank.

Persson, T. and G. Tabellini (2003). *The economic effects of constitutions*. Cambridge, Massachusetts: MIT Press.

Robinson, J., R. Torvik, and T. Verdier (2006). Political foundations of the resource curse. *Journal of Development Economics* 79(2), 447-468.

Rota-Graziosi, G. (2019). The supermodularity of the tax competition game. *Journal of Mathematical Economics* 83, 25-35.

Sachs, J. and A. Warner (1995). Natural resource abundance and economic growth. NBER Working Papers 5398, National Bureau of Economic Research, Inc.

Slemrod, J. (2007). Cheating ourselves: The economics of tax evasion. *Journal of Economic Perspectives* 21(1), 25-48.

van der Ploeg, F. (2011). Natural resources: Curse or blessing? *Journal of Economic Literature* 49(2), 366-420.

Vives, X. (1999). *Oligopoly pricing. Old ideas and new tools*. Cambridge, Massachusetts: The MIT Press.

Wildavsky, A. (1974). *The politics of the budgetary process*. Boston: Little Brown Co.

A. Appendix to chapter I

A.1. Proof of Lemma 1.1

From (1.5) and (1.6), we deduce that

$$\frac{\partial k_E(t_E)}{\partial t_E} = \frac{1}{f_E''(k_E(t_E))} < 0, \quad (\text{eq. 1.22})$$

$$\frac{\partial k_M(t_M, \tau)}{\partial t_M} = \frac{1}{p(1-\tau)} \frac{1}{f_M''(k_M(t_M, \tau))} < 0, \quad (\text{eq. 1.23})$$

$$\frac{\partial k_M(t_M, \tau)}{\partial \tau} = \frac{r+t_M}{p(1-\tau)^2} \frac{1}{f_M''(k_M(t_M, \tau))} = \frac{r+t_M}{1-\tau} \frac{\partial k_M(t_M, \tau)}{\partial t_M} < 0, \quad (\text{eq. 1.24})$$

We notice that $\partial k_E(t_E)/\partial \tau = 0$ and $\partial^2 k_E(t_E)/\partial t_E \partial \tau = 0$. From (1.23) we obtain

$$\begin{aligned} \frac{\partial^2 k_M(t_M, \tau)}{\partial t_M \partial \tau} &= \frac{1}{p(1-\tau)^2} \frac{1}{f_M''(k_M(t_M, \tau))} - \frac{1}{p(1-\tau)} \frac{f_M'''(k_M(t_M, \tau))}{(f_M''(k_M(t_M, \tau)))^2} \frac{\partial k_M(t_M, \tau)}{\partial \tau} \\ &= \frac{1}{1-\tau} \left(1 - \frac{r+t_M}{p(1-\tau)} \frac{f_M'''(k_M(t_M, \tau))}{(f_M''(k_M(t_M, \tau)))^2} \right) \frac{\partial k_M(t_M, \tau)}{\partial t_M} \end{aligned}$$

Given the net return of capital given in (1.7) we obtain

$$\frac{\partial^2 k_M(t_M, \tau)}{\partial t_M \partial \tau} = \frac{1}{1-\tau} (1 - \Omega_M) \frac{\partial k_M(t_M, \tau)}{\partial t_M}, \quad (\text{eq. 1.25})$$

Where we define $\Omega_M = \frac{f_M'(k_M(t, \tau)) f_M'''(k_M(t, \tau))}{(f_M''(k_M(t, \tau)))^2}$. From the log-concavity of $f_M'(\cdot)$

(Assumption 1.2), we have

$$\Omega_M \leq 1, \quad (\text{eq. 1.26})$$

Which involves $\frac{\partial^2 k_M(t_M, \tau)}{\partial t_M \partial \tau} \leq 0$.

Regarding the concavity (convexity) of the demand for capital with respect to tax rates, we get:

$$\frac{\partial^2 k_E(t_E)}{\partial (t_E)^2} = - \frac{f_E'''(k_E(t_E))}{(f_E''(k_E(t_E)))^2} \frac{\partial k_E(t_E)}{\partial t_E} > 0, \quad (\text{eq. 1.27})$$

And

$$\begin{aligned}\frac{\partial^2 k_M(t_M, \tau)}{\partial (t_M)^2} &= \frac{1}{p(1-\tau)} \frac{f_M'''(k_M(t_M, \tau))}{(f_M''(k_M(t_M, \tau)))^2} \frac{\partial k_M(t_M, \tau)}{\partial t_M} \\ &= -\frac{1}{r} \Omega_M \frac{\partial k_M(t_M, \tau)}{\partial t_M} > 0.\end{aligned}\quad (\text{eq. 1.28})$$

Given (1.23), (1.24) and (1.26), we deduce that

$$\begin{aligned}\frac{\partial^2 k_M(t_M, \tau)}{\partial \tau^2} &= \frac{r+t_M}{(1-\tau)^2} \frac{\partial k_M(t_M, \tau)}{\partial t_M} + \frac{r+t_M}{1-\tau} \frac{\partial^2 k_M(t_M, \tau)}{\partial t_M \partial \tau} \\ &= \frac{r+t_M}{(1-\tau)^2} (2 - \Omega_M) \frac{\partial k_M(t_M, \tau)}{\partial t_M} < 0.\end{aligned}\quad (\text{eq. 1.29})$$

A.2. Proof of Proposition 1.1: strategic substitutability of tax rates

The negative spillover or equivalently plain substitutability in Eaton (2004) terminology is given by

$$\begin{aligned}\frac{\partial R^{MoF}(t, \tau)}{\partial \tau} &= t \frac{\partial k_M(t, \tau)}{\partial \tau} < 0, \\ \frac{\partial R^{MoM}(t, \tau)}{\partial t} &= \tau p f_M'(k_M(t, \tau)) \frac{\partial k_M(t, \tau)}{\partial t} < 0.\end{aligned}$$

From these FOCs (1.15) and (1.16), we determine the best reply function for each Minister, respectively denoted by $BR_t(\tau)$ and $BR_\tau(t)$ and defined as

$$\begin{cases} \frac{\partial R^{MoF}(BR_t(\tau), \tau)}{\partial t} = 0 \\ \frac{\partial R^{MoM}(t, BR_\tau(t))}{\partial \tau} = 0 \end{cases}$$

Following Bulow *et al.* (1985), we deduce the strategic substitutability of tax instrument from the sign of the best reply function. We have:

$$\frac{\partial BR_t(\tau)}{\partial \tau} = -\frac{\frac{\partial^2 R^{MoF}(t, \tau)}{\partial t \partial \tau}}{\frac{\partial^2 R^{MoF}(t, \tau)}{\partial t^2}}.$$

Since the SOC is respected: $\frac{\partial^2 R^{MoF}(t, \tau)}{\partial t^2} < 0$, we deduce that $\text{sign}\left\{\frac{\partial BR_t(\tau)}{\partial \tau}\right\} = \text{sign}\left\{\frac{\partial^2 R^{MoF}(t, \tau)}{\partial t \partial \tau}\right\}$. Given (1.23) and (1.24), we deduce that

$$\frac{\partial^2 R^{MoF}(t, \tau)}{\partial t \partial \tau} = \frac{\partial k_M(t, \tau)}{\partial \tau} + t \frac{\partial^2 k_M(t, \tau)}{\partial t \partial \tau} \leq 0.\quad (\text{eq. 1.30})$$

Similarly, we have

$$\begin{aligned} \frac{\partial^2 R^{MoM}(t, \tau)}{\partial t \partial \tau} &= f'_M(k_M(t, \tau)) \frac{\partial k_M(t, \tau)}{\partial t} + \tau f''_M(k_M(t, \tau)) \frac{\partial k_M(t, \tau)}{\partial \tau} \frac{\partial k_M(t, \tau)}{\partial t} \\ &\quad + \tau f'_M(k_M(t, \tau)) \frac{\partial^2 k_M(t, \tau)}{\partial \tau \partial t} \leq 0, \end{aligned}$$

since $f''_M(\cdot) < 0 \leq f'_M(\cdot)$, $\partial k_M(t, \tau)/\partial t < 0$, $\partial k_M(t, \tau)/\partial \tau < 0$, and $\partial^2 k_M(t, \tau)/\partial \tau \partial t \leq 0$.

A.3. Proof of Proposition 1.2

The FOCs of (1.17) are

$$k_E(t_E^2) + t_E^2 \frac{\partial k_E(t)}{\partial t} \Big|_{t_E^2} = 0. \quad (\text{eq. 1.31})$$

$$\tau^2 p f'_M(k_M(t_M^2, \tau^2)) \frac{\partial k_M(t, \tau^2)}{\partial t} \Big|_{t_M^2} < 0. \quad (\text{eq. 1.32})$$

$$p f_M(k_M(t_M^2, \tau^2)) + \tau^2 p f'_M(k_M(t_M^2, \tau^2)) \frac{\partial k_M(t, \tau)}{\partial \tau} \Big|_{\tau^2} = 0. \quad (\text{eq. 1.33})$$

Given the sign of (1.32), we deduce the corner solution for t_M^2 equal to 0.

The SOC of the MoF is given by

$$\begin{aligned} \frac{\partial^2 R^{MoF}(t_E, t_M, \tau)}{(\partial t_E)^2} &= 2 \frac{\partial k_E(t_E)}{\partial t_E} + t_E \frac{\partial^2 k_E(t_E)}{\partial (t_E)^2} \\ &= \frac{1}{f'_E(k_E(t_E))} \left(1 - t \frac{f'''_E(k_E(t_E))}{(f''_E(k_E(t_E)))^2} \right) \end{aligned}$$

From (), we deduce that $\frac{\partial^2 R^{MoF}(t_E, t_M, \tau)}{(\partial t_E)^2} < 0$.

The SOCs of the MoM are respectively:

$$\begin{aligned} \frac{\partial^2 R^{MoM}(t_E, t_M, \tau)}{(\partial t_M)^2} &= \tau f''_M(k_M(t_M, \tau)) \left(\frac{\partial k_M(t_M, \tau)}{\partial t_M} \right)^2 + \tau f'_M(k_M(t_M, \tau)) \frac{\partial k_M^2(t_M, \tau)}{\partial (t_M)^2} \\ &= \frac{\tau}{p(1-\tau)} \left(1 - \frac{f'_M(k_M(t_M, \tau)) f'''_M(k_M(t_M, \tau))}{(f''_M(k_M(t_M, \tau)))^2} \right) \frac{\partial k_M(t_M, \tau)}{\partial t_M} < 0, \end{aligned}$$

which derives from the log-concavity of $f'_M(\cdot)$.

$$\frac{\partial^2 R^{MoF}(t_E, t_M, \tau)}{(\partial \tau)^2} = f'_M(k_M(t_M, \tau)) \frac{\partial k_M(t_M, \tau)}{\partial t_M} + \tau f''_M(k_M(t_M, \tau)) \frac{\partial k_M(t_M, \tau)}{\partial \tau} \frac{\partial k_M(t_M, \tau)}{\partial t_M} + \tau f'_M(k_M(t_M, \tau)) \frac{\partial^2 k_M(t_M, \tau)}{\partial t_M \partial \tau} < 0,$$

given Lemma 1.

A.4. First stage of instrumental regressions

Table A.4.1: Inter-ministerial competition in the determination of the ETR of natural resources and corporate taxes in resource-rich countries – G2SLS Ethnic affiliation (first stage)

Variables	ETR of the non-resource sector	
	[1]	[2]
Ethnic group	-0.705** (0.342)	-0.844** (0.342)
GDP per capita, log (PPP, constant 2011)	0.746*** (0.116)	0.566*** (0.154)
Agriculture value added (% of GDP)	0.013 (0.113)	0.000 (0.113)
Total trade % of GDP	0.006 (0.002)	0.006 (0.004)
Law and order	-0.131 (0.133)	-0.111 (0.131)
Domestic credit to private sector (% of GDP)		0.027* (0.015)
Constant	-6.090*** (1.446)	-4.582*** (1.661)
Obs. (Countries)	66 (5)	66 (5)
R-squared	0.425	0.392
Time FE	Yes	Yes
Chi2 statistics	128	137

Note: Standard errors in parentheses (***) p<0.01, ** p<0.05, * p<0.1). The table reports the first stage results of the strategic interaction for countries with resources rent > 15%. The ETR of the resource sector corresponds to the natural logarithm of the ratio of resource tax revenue to total natural resource rent. The ETR of non-resource sector corresponds to the natural logarithm of the ratio of non-resource component of CIT revenue to non-resource GDP.

Table A.4.2: Inter-ministerial competition in the determination of the ETR of natural resources and corporate taxes in resource-rich countries – G2SLS Ethnic affiliation and IMF program (first stage)

Variables	ETR of the non-resource sector	
	[1]	[2]
Ethnic group	-0.708** (0.344)	-0.860** (0.345)
IMF Program	0.094 (0.206)	0.161 (0.204)
GDP per capita, log (PPP, constant 2011)	0.762*** (0.122)	0.578*** (0.156)
Agriculture value added (% of GDP)	0.015 (0.013)	0.004 (0.014)
Total trade % of GDP	0.007 (0.004)	0.007 (0.004)
Law and order	-0.135 (0.135)	-0.116 (0.131)
Domestic credit to private sector (% of GDP)		0.029* (0.016)
Constant	-6.379*** (1.595)	-4.954*** (1.735)
Obs. (Countries)	66 (5)	66 (5)
R-squared	0.438	0.410
Time FE	Yes	Yes
Chi2 statistics	126	137

Note: Standard errors in parentheses (***) $p < 0.01$, (**) $p < 0.05$, (*) $p < 0.1$). The table reports the first stage results of the strategic interaction for countries with resources rent $> 15\%$. The ETR of the resource sector corresponds to the natural logarithm of the ratio of resource tax revenue to total natural resource rent. The ETR of non-resource sector corresponds to the natural logarithm of the ratio of non-resource component of CIT revenue to non-resource GDP.

A.5. The Second Order Conditions of the Centralized Solution

The centralized solution is a multivariable maximization problem. The Hessian matrix denoted by H , should be negative definite: $\frac{\partial^2 R^T(t, \tau)}{\partial t^2} < 0$ and $|H| > 0$. We have

$$\begin{aligned}
 \frac{\partial^2 R^T(t, \tau)}{\partial t^2} &= 2 \frac{\partial k_M(t, \tau)}{\partial t} + 2 \frac{\partial k_E(t)}{\partial t} + \frac{\partial^2 k_E(t)}{\partial t^2} + \tau p f_M''(k_M(t, \tau)) \left(\frac{\partial k_M(t, \tau)}{\partial t} \right)^2 \\
 &\quad + \tau p f_M'(k_M(t, \tau)) \frac{\partial^2 k_M(t, \tau)}{\partial t^2} \\
 &= \left(2 - t \frac{f_E'''(k_E(t))}{(f_E''(k_E(t)))^2} \right) \frac{\partial k_E(t)}{\partial t} + \left[2 + \frac{\tau}{1 - \tau} (1 - \Omega_M) \right] \frac{\partial k_M(t, \tau)}{\partial t} \\
 &= \left(2 - t \frac{f_E'''(k_E(t))}{(f_E''(k_E(t)))^2} \right) \frac{\partial k_E(t)}{\partial t} + \left[2 + \frac{\tau}{1 - \tau} (1 - \Omega_M) \right] \frac{\partial k_M(t, \tau)}{\partial t}
 \end{aligned}$$

Given Assumption 1.2, we establish that \Rightarrow .

$$\left(f_E''(k_E(t))\right)^2 \geq f_E'(k_E(t))f_E'''(k_E(t)) = (r+t)f_E'''(k_E(t)) > tf_E'''(k_E(t)) \quad (\text{eq. 1.34})$$

We deduce

$$\frac{\partial^2 R^T(t, \tau)}{(\partial t)^2} < 0$$

The second derivative of total revenue with respect to the royalty rate (τ) yields:

$$\begin{aligned} \frac{\partial^2 R^T(t, \tau)}{\partial \tau^2} &= [t + 2pf_M'(k_M(t, \tau))] \frac{\partial k_M(t, \tau)}{\partial \tau} + \tau pf_M''(k_M(t, \tau)) \left(\frac{\partial k_M(t, \tau)}{\partial \tau}\right)^2 \\ &+ [t + \tau pf_M'(k_M(t, \tau))] \frac{\partial k_M^2(t, \tau)}{\partial \tau^2} \\ &= \left[t + 2pf_M'(k_M(t, \tau)) + \frac{\tau(r+t)}{(1-\tau)^2} \right] \frac{\partial k_M(t, \tau)}{\partial \tau} \\ &+ [t + \tau pf_M'(k_M(t, \tau))] \frac{\partial k_M^2(t, \tau)}{\partial \tau^2} < 0 \end{aligned}$$

Finally, we will assume that

$$|H| = \begin{vmatrix} \frac{\partial^2 R^T(t, \tau)}{\partial t^2} & \frac{\partial^2 R^T(t, \tau)}{\partial t \partial \tau} \\ \frac{\partial^2 R^T(t, \tau)}{\partial t \partial \tau} & \frac{\partial^2 R^T(t, \tau)}{\partial \tau^2} \end{vmatrix} > 0.$$

A.6. Second Order Conditions in the Tax Policy Regime 1

We have

$$\begin{aligned} \frac{\partial^2 R^{MoF}(t, \tau)}{(\partial t)^2} &= 2 \frac{\partial k_M(t, \tau)}{\partial t} + 2 \frac{\partial k_E(t)}{\partial t} + t \left(\frac{\partial^2 k_M(t, \tau)}{\partial t^2} + \frac{\partial^2 k_E(t)}{\partial t^2} \right) \\ &= \left(2 - \frac{t}{p(1-\tau)} \frac{f_M'''(k_M(t, \tau))}{(f_M''(k_M(t, \tau)))^2} \right) \frac{\partial k_M(t, \tau)}{\partial t} \\ &+ \left(2 - t \frac{f_E'''(k_E(t))}{(f_E''(k_E(t)))^2} \right) \frac{\partial k_E(t)}{\partial t} \end{aligned}$$

Given (1.2) and (1.4), we have

$$\begin{aligned} \frac{t}{p(1-\tau)} \frac{f_M'''(k_M(t, \tau))}{(f_M''(k_M(t, \tau)))^2} &\leq \frac{t}{p(1-\tau)} \frac{1}{f_M'(k_M(t, \tau))} \\ &= \frac{t}{r+t} \leq 1 \end{aligned}$$

Considering (1.34) we obtain

$$\frac{\partial^2 R^{MoF}(t, \tau)}{(\partial t)^2} < 0.$$

Regarding the MoM' SOC, we have

$$\begin{aligned} \frac{\partial^2 R^{MoM}(t^M, \tau)}{(\partial \tau)^2} = & 2pf'_M(k_M(t^M, \tau)) \frac{\partial k_M(t^M, \tau)}{\partial \tau} + \tau pf''_M(k_M(t^M, \tau)) \left(\frac{\partial k_M(t^M, \tau)}{\partial \tau} \right)^2 \\ & + \tau pf'_M(k_M(t^M, \tau)) \frac{\partial^2 k_M(t^M, \tau)}{\partial \tau^2} < 0, \end{aligned}$$

since $\frac{\partial^2 k_M(t, \tau)}{\partial \tau^2} = \frac{r+t}{(1-\tau)^2} \frac{\partial k_M(t, \tau)}{\partial t} + \frac{r+t}{1-\tau} \frac{\partial^2 k_M(t, \tau)}{\partial t \partial \tau} < 0$ given (1.24).

A.7. List of countries and their respective share of resources' rent.

Country	Resources rents (% of GDP)	Country	Resources rents (% of GDP)
Angola	27.532	Madagascar	11.012
Benin	4.645	Malawi	8.645
Botswana	3.580	Mali	11.404
Burkina Faso	16.864	Mauritius	0.001
Burundi	14.138	Mozambique	10.504
Cabo Verde	0.637	Namibia	2.353
Cameroon	8.441	Niger	13.980
Central African Republic	11.817	Nigeria	10.038
Chad	20.908	Rwanda	6.177
Comoros	3.216	Sao Tome and Principe	2.312
Congo, Rep.	39.197	Senegal	4.544
Cote d'Ivoire	5.544	Seychelles	0.117
Equatorial Guinea	29.174	Sierra Leone	25.215
Ethiopia	12.544	South Africa	5.715
Gabon	28.832	Swaziland	2.386
Gambia, The	7.026	Tanzania	5.990
Ghana	19.535	Togo	21.194
Guinea	22.511	Uganda	10.885
Guinea-Bissau	16.195	Zambia	15.551
Kenya	2.724	Zimbabwe	8.871
Lesotho	4.843		

A.8. Correlations

As previous stages of the empirical analysis, Tables 10 and 11 provide correlations of the key variables for the whole sample and resource-rich countries. The correlation coefficient between ETR of the resource sector and ETR of the non-resource sector is significantly positive. However, both ETR of resource and non-resource sectors are positively associated with the level of development and the trade openness and negatively correlated with the share of the agricultural sector. For resource-rich countries, we observe a positive correlation between ETRs, which are both positively associated with the GDP per capita and government stability and negatively linked to the share of the agricultural sector, corruption, and the commodity price index.

Table A.8.1: Correlation of the key variables (whole sample)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
ETR of the resource sector [1]	1								
ETR of the non-resource sector [2]	0.140*	1							
GDP per capita, log (PPP, constant 2011) [3]	0.342*	0.368*	1						
Agriculture value added (% of GDP) [4]	-0.123*	-0.341*	-0.847*	1					
Total trade % of GDP [5]	0.125*	0.204*	0.291*	-0.321*	1				
Domestic credit to private sector (% of GDP) [6]	-0.164*	0.290*	0.621*	-0.537*	0.280*	1			
Law and order [7]	-0.090	0.013	0.614*	-0.475*	0.233*	0.553*	1		
Commodity price index [8]	-0.366*	0.267*	-0.181*	0.122*	-0.084*	-0.033*	0.051*	1	
Total natural resources rents (% of GDP) [9]	0.296*	0.037	-0.139*	0.180*	0.019	-0.299*	-0.235*	0.002	1

* Significant at 10% level

Table A.8.2: Correlation of the key variables (resource-rich countries)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
ETR of the resource sector [1]	1								
ETR of the non-resource sector [2]	0.302*	1							
GDP per capita, log (PPP, constant 2011) [3]	0.339*	0.101	1						
Agriculture value added (% of GDP) [4]	-0.085	-0.292*	-0.839*	1					
Total trade % of GDP [5]	-0.065	-0.036	0.047	-0.252*	1				
Domestic credit to private sector (% of GDP) [6]	0.141*	0.275*	0.567*	-0.340*	0.066*	1			
Law and order [7]	-0.189*	0.112	0.546*	-0.349*	-0.002	0.437*	1		
Commodity price index [8]	-0.505*	0.462*	-0.132*	0.090*	-0.210*	0.068	0.081*	1	
Total natural resources rents (% of GDP) [9]	0.123	0.170*	0.061*	-0.257*	0.344*	-0.139*	-0.061*	-0.235*	1

* Significant at 10% level

A.9. Robustness

As a robustness check of the role of resources' abundance, we use resource export instead of resources' rent. Table 12 displays the results. The coefficient is negative and strongly significant for resource-rich developing countries, which means here that natural resource exports exceed 25 percent of total exportation. The coefficient becomes positive and significant for resource-poor developing countries.

Table A.9.1: Inter-ministerial tax competition and abundance of natural resources – robustness

Variables	ETR of the resource sector						
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
ETR of the non-resource sector	0.604*** (0.141)	0.656*** (0.152)	0.667*** (0.153)	0.693*** (0.160)	0.702*** (0.161)	0.838*** (0.171)	0.699*** (0.162)
ETR of the non-resource sector x Rich	-0.379*** (0.135)	-0.408*** (0.142)	-0.437*** (0.146)	-0.495*** (0.157)	-0.509*** (0.161)	-0.679*** (0.174)	-0.503*** (0.162)
Rich	0.247 (0.152)	0.229 (0.157)	0.218 (0.163)	0.232 (0.167)	0.221 (0.169)	-0.0939 (0.200)	0.218 (0.170)
GDP per capita, log (PPP, constant 2011)	0.414*** (0.150)	-1.377** (0.617)	-1.586** (0.652)	-1.542** (0.679)	-1.736** (0.798)	-2.280** (0.986)	-1.786** (0.810)
Agriculture value added (% of GDP)		0.0102 (0.0140)	0.00383 (0.0148)	-0.0165 (0.0195)	-0.0188 (0.0200)	-0.0429* (0.0233)	-0.0188 (0.0201)
Total trade % of GDP			-0.00566 (0.00516)	-0.00617 (0.00543)	-0.00617 (0.00545)	-0.0267** (0.0105)	-0.00585 (0.00552)
Law and order				-0.0964 (0.123)	-0.103 (0.127)	-0.361** (0.169)	-0.0955 (0.129)
Domestic credit to private sector (% of GDP)					0.00553 (0.0127)	-0.00164 (0.0147)	0.00661 (0.0130)
Commodity price index, log						0.423 (0.407)	
Dummy for EITI							0.0979 (0.244)
Constant	-0.785 (1.227)	13.57*** (4.952)	15.73*** (5.354)	16.02*** (5.575)	17.55*** (6.486)	22.61*** (7.260)	17.90*** (6.564)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs. (Countries)	229 (17)	208 (17)	204 (16)	187 (13)	186 (13)	147 (10)	186 (13)
R-squared	0.261	0.239	0.249	0.245	0.245	0.380	0.246

Note: Standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). The table reports the results of the strategic interaction. A country is considered resource rich if the natural resource exports exceed 25 percent of total exportation. The ETR of the resource sector corresponds to the natural logarithm of the ratio of resource tax revenue to total natural resource rent. The ETR of non-resource sector corresponds to the natural logarithm of the ratio of non-resource component of CIT revenue to non-resource GDP.

« Les hommes peuvent atteindre un but commun sans emprunter les mêmes voies. »
~ Amadou Hampaté Bâ, Ecrivain malien.

2. Chapter II: Revisiting the Relationship between Trade Liberalization and Taxation

This chapter is a joint work with Rabah Arezki (AFDB and Kennedy School of Government), and Grégoire Rota-Graziosi (CERDI-CNRS).

A slightly different version is under review at the Journal of Public Economics.

Abstract

This paper explores the dynamic effects of trade liberalization on tax revenue using a worldwide panel dataset. Results point to statistically significant negative effect of liberalization on (non- resource) tax revenues in the short term and no significant effect in the medium term. Liberalization also alter the tax structure tilting revenues toward indirect taxes away from direct ones. Economies which have implemented value added taxes prior to liberalization have mitigated its negative effects on tax revenues. The evidence is supportive of the complementarity role of state capacity to reap the benefits of liberalization.

JEL Classification Numbers: H2, H87, F13

Keywords: Tax, tax structure, openness, liberalization, natural resources

2.1. Introduction

Trade liberalization is expected to raise economic growth and welfare through more competition reducing domestic rents, raising the availability of capital and increased productivity. The empirical evidence between trade orientation and growth in developing countries is however ambiguous (Winters, 2004; Baldwin, 2003; Rodriguez and Rodrik, 2000).³⁸ There are several possible reasons for why that is so. Trade liberalization has not done away with pervasive distortions to trade especially in developing countries including because of limited enforcement and implementation of trade policies (Atkin and Khandelwal, 2020). In turn these distortions might limit the expansion of trade and its effect on welfare and growth. Trade liberalization has also important distributional consequences raising income inequality (Goldberg and Pavcnik, 2004). Trade liberalization may have ambiguous effect on (aggregate) informality (Ulyssea, 2018). One important related question is how trade liberalization affect public finances. The public finance channel of trade liberalization has received less attention yet it may have important economic and distributional implications. In the present paper, we systematically study the dynamic effects of trade liberalization on taxation.

There are several mechanisms through which trade liberalization affect taxation. Trade liberalization could lower economic growth for some developing countries and hence limit the expansion of domestic tax revenues (Rodriguez and Rodrik, 2000). Notwithstanding the contention on the effect of trade liberalization on growth, tax revenue losses following trade liberalization can be hard to replace by domestic sources. In other words, the “tax transition”, that is the rebalancing away from tariff revenues toward domestic ones, is often incomplete. Indeed, structural factors such as natural resources dependence, informality and weak state capacity are particularly pervasive in developing countries in turn limiting domestic revenue mobilization (Besley and Persson, 2014). What is more is the decrease in the cost of international capital mobility has fuelled intense tax competition in turn offering multiple opportunities for multinationals to shift profits in tax accommodating countries known as tax heaven (Dharmapala and Hines, 2009; Dharmapala, 2014 and 2019). The tax structure may also be impacted by trade liberalization.³⁹ Tax coordination and enforcement at the

³⁸ More generally, the empirical evidence linking trade and income vast. For instance, Frankel and Romer (1999) provide positive empirical evidence of the causal effect of trade on income though only moderately statistically significant.

³⁹ Hines and Summers (2009) find that countries with small open economies have relatively mobile tax bases; as a result, they rely much less heavily on corporate and personal income taxes than other countries. Martinez et al. (2011) show that over the past decades developing countries have experienced much lower ratios of direct over indirect taxes compared to advanced economies. The authors argue that this trend is driven by the willingness of

international level are difficult (Rota-Graziosi, 2019).⁴⁰ ⁴¹ Developing countries are particularly vulnerable to trade mis-invoicing or profit shifting from multinational corporations following trade liberalization because of relatively weak state capacity.

This paper specifically focuses on the dynamic effect of trade liberalization on non-resource tax revenue using a combination of tax revenue data from Government Revenue Dataset (GRD) of the ICTD/UNIWIWER and the extended version of the Sachs and Warner indicator of liberalization by Wacziarg and Welch (2008) [hereafter SW/WW]. Results point to significant negative effect of liberalization on (non-resource) tax revenues in the short term and no significant effect in the medium term. Liberalization also alters the tax structure tilting revenues toward indirect taxes away from direct ones. Economies which have implemented value added taxes prior to liberalization have mitigated its negative effects on tax revenues. The evidence is supportive of the complementarity role of state capacity to reap the benefits of liberalization.

This paper is related to the literature on determinants of tax ratio and tax effort linked to the seminal work by Lotz and Morss (1970). The literature documents an average positive relationship between openness and tax revenues albeit the relationship appears weaker for poorer economies (Baunsgaard and Keen, 2010; Cage and Gadenne, 2014). Unlike the existing cross-country studies of trade orientation and taxation, we use a policy-based measure of trade orientation—allowing to pin down the exact timing of change in trade policy—instead of outcome measures of trade such as trade-to-GDP. Our results point to a lack of robustness of the positive association between outcome-based measure of liberalization and tax revenues. Instead our results point a significant and robust negative effect of trade liberalization on tax revenues using policy-based measure of liberalization. In addition, the paper contributes to the literature by exploring more systematically the dynamic effect of trade liberalization and the evolution of tax structure.

This paper also distinguishes between tax revenue from natural resource versus tax collected outside the resource sector. The distinction between the two sources of revenue is important also because of large fluctuations in international prices in natural resources. Indeed, when using non-resource tax revenues as dependent variable instead

developing countries to favor foreign direct investment and economic growth but also by considerations linked to state and administrative capacity.

⁴⁰ On June 5th, 2021, the Group of Seven has agreed to set a [global corporate tax rate to a minimum of 15 percent](#). Treasury Secretary Janet Yellen stated that the deal will end "[30-year race to the bottom on corporate tax rates](#)". Implementation and enforcement of such deal is however going to be challenging.

⁴¹ Egger et al. (2019) find a differential effect of higher trade and factor mobility on relative tax burdens in 1980–1993 versus 1994–2007 in the Organization for Economic Cooperation and Development.

of aggregate tax revenues, the positive association between the outcome-based measure of trade liberalization and tax revenues is no longer robust. Collier (2006) argues that governments in resource-rich countries tax less and face little scrutiny as revenue from natural resources transit directly through government coffers. Importantly, James (2015) provides empirical evidence that the behavior of US States is consistent with theory that in response to an exogenous increase in resource-based government revenue, a benevolent government will partially substitute away from taxing income. The literature on the so-called resource curse point to the key role of pre-existing institutions in determining the performance of resource rich economies relative to resource poor ones (see Robinson et al, 2006; Mehlum, et al., 2006). In this paper, we provide evidence that implementation of value added tax prior to trade liberalization help limit the negative effect of liberalization on tax revenues.

The remainder of the paper is as follows. Section 2.2 presents the data and the empirical framework. Section 2.3 presents our main results. Section 2.4 presents extensions. Section 2.5 concludes.

2.2. Data and Empirical Analysis

In this section, we present the data and the empirical framework used to explore the link between trade liberalization and tax revenues.

2.2.1. Data

In this sub-section we present the data used to construct the variables used in our empirical framework. Table B.1.1 provides basic statistics related to the variable used in the analysis.

Government revenues and its composition are from GRD obtained from ICTD/UNUWIDER. We use GRD to construct non-resource tax revenues including as a ratio to non-resource GDP. Non-resource GDP is calculated using GDP in purchasing power parity (PPP) minus the value of natural resource rents from the World Bank, World Development Indicators.⁴²

Market orientation is proxied using the extended version of the Sachs and Warner indicator of liberalization by Wacziarg and Welch (2008) shown in Table B.1.2. The indicator covers 140 countries over 1950 to 2004. It is a dichotomic variable that classifies a country as open or not. In a given year, the indicator takes the value 1 if: i) the average tariff rate on imports is below 40%; ii) nontariff barriers cover less than

⁴² Natural resource rents are implicitly valued in PPP because of their tradable nature and pricing in US dollars.

40% of imports; iii) the country is not a socialist economy; iv) the state does not hold a monopoly of the major exports; and v) the black-market premium is below 20%.

To address issue of endogeneity associated with trade liberalization, we use an instrument based on "learning from neighbors" derived from the reduced-form specification presented in Buera et al. (2011). The authors posit that countries learn from their neighbors and provides evidence that the choice of market orientation of a given country is associated with the fraction of neighboring countries opening up and whether they successfully perform following liberalization or status quo.

Specifically, $OPEN_{i,t}$, the trade liberalization measure for country i at time t , is as follows:

$$E[OPEN_{i,t}|\dots] = \varphi_1 OPEN_{i,t-1} + \varphi_2 \hat{E}_{i,t-1}[z|OPEN = 1] + \varphi_3 \hat{E}_{i,t-1}[z|OPEN = 0] + \varphi_4 \overline{OPEN}_{i,t-1} \quad (\text{eq. 2.1})$$

where $\hat{E}_{i,t-1}[z|OPEN = 1]$ and $\hat{E}_{i,t-1}[z|OPEN = 0]$ are the distance weighted average growth rate over the previous 3 years respectively for open economies and closed economies, while $\overline{OPEN}_{i,t-1}$ is a distance weighted measure of neighbor trade liberalization.⁴³

In addition to our policy-based measure of liberalization, we use an outcome-based measure of trade that is total trade to GDP measured as the sum of exports and imports over GDP. Trade to GDP data are obtained from World Bank, World Development Indicators. We also construct a non-resource trade variable as total goods trade excluding fuel, ores and metals export also obtained from World Bank, World Development Indicators.

Control variables included in the empirical analysis are obtained from World Bank, World Development Indicators. The variables are as follows:

- GDP growth measures the expansion of the economy hence of its tax base. GDP growth is expected to be positively related to tax revenues. Considering that trade liberalization may tend to increase tax revenues through higher growth, controlling for GDP growth allows to shut down that "growth channel".⁴⁴
- The structure of the economy is proxied by the share of agriculture value added in total GDP. The share of agriculture is expected to be negatively related to tax

⁴³ Data on distance to build the instrument for trade liberalization are obtained from CEPII.

⁴⁴ It is noteworthy that the coefficient associated with economic growth could be biased downward due to potential reverse causality. Indeed, lower taxes could stimulate investment and in turn economic growth including through tax incentives.

revenues. Indeed, the primary sector, which many developing countries depend upon, is difficult to tax also because of the informal nature of the sector. What is more is that the primary sector is often largely tax exempt in developing countries. For instance, in most Sub-Saharan countries agriculture is either tax exempt or out-of-scope of the value added tax (VAT).⁴⁵ In addition, governments often have a naïve approach to tax incidence on food products. Indeed, governments often assume that consumer prices would fully reflect tax exemption without any consideration related to elements of market structure—including producers and traders margins as discussed in Bergquist and Dinerstein (2020).

- Inflation is measured as annual percent change in consumer prices. Inflation is expected to have a negative effect on tax revenue. Tanzi (1978) points to the key role of the initial tax burden and the lag with which tax revenue are collected. The author and subsequent analysis show that higher inflation is associated with higher revenue loss.⁴⁶
- Development assistance and official aid are measured as a share of GDP.⁴⁷ Aid is expected to have a negative effect on tax revenues. Aid is largely tax exempt and may also potentially lead to reduced domestic tax effort (Caldeira et al., 2020). The existing empirical evidence is however ambiguous.⁴⁸
- The dates of introduction of VAT adoption are obtained from Seelkopf et al. (2019) and Genschel and Seelkopf (2019). The dates of introduction are presented in Table B.1.2 alongside the dates of (first) trade liberalization episodes.

2.2.2. Empirical Framework

In this sub-section, we present our empirical framework to test the relationship between trade liberalization and tax revenues as well as the latter subcomponents. The main specification is as follows:

$$Y_{i,t} = \gamma OPEN_{i,t-1} + \beta X_{it-1} + \alpha_i + \theta_t + \varepsilon_{i,t} \quad (\text{eq. 2.2})$$

where $Y_{i,t}$ is tax revenues excluding social contribution and grant in percentage of GDP for country i at time t as well as non-resource tax excluding social contribution in percentage of GDP. We also use as dependent the tax structure including the ratio

⁴⁵ This particularly true in French speaking African countries. However, countries such as Nigeria or Ghana raise VAT on rice imports to protect their local production and achieve their self-sufficiency. These policies transform VAT into a quasi-tariff and trigger significant rice smuggling across borders—between Benin and Nigeria for instance.

⁴⁶ See for Instance Crivelli and Gupta (2014).

⁴⁷ Thereafter we use just “aid” in lieu of the phrase development assistance and official aid.

⁴⁸ Morrissey (2015) provides a review of empirical literature linking development aid and tax revenues.

between direct and indirect taxes. $OPEN_{i,t-1}$ for country i at time $t-1$ is a dummy that takes the value of 1 if the country is open, or zero otherwise, X_{it-1} is a set of control variables described above, α_i and θ_t are respectively country and time fixed effects, and $\varepsilon_{i,t}$ is the error term.

To explore the dynamic effect of liberalization on tax revenues we use the Local Projection Method (LP) developed by Jordà (2005) to estimate impulse responses. In the identification strategy, we rely on trade liberalization as an external shock. Local projection requires estimation of a series of regressions for each horizon h . The model applied to our specification presented in (2.2) is as follows:

$$Y_{i,t+h} = \gamma_h OPEN_{i,t-1} + \beta_h X_{it-1} + \alpha_{i,h} + \theta_{t,h} + \varepsilon_{i,t+h}, \quad h = 0, 1, \dots, 10 \quad (\text{eq. 2.3})$$

To test for the heterogeneity of the effect of liberalization, we add an interaction term between trade liberalization and the adoption of VAT to (2.2). VAT is relatively easier to collect as its collection is essentially delegated to the private sector. VAT has become an important part of domestic tax revenue mobilization.

2.3. Main Results

In this section, we present the results of our empirical framework exploring the relationship between trade liberalization and tax revenues.

2.3.1. Tax Revenues and Trade Liberalization

Table 2.1 presents the regression results using ordinary least square with tax revenues—including revenues related to natural resources—as a dependent variable and trade liberalization as an independent variable as well as a variety of control variables. The coefficients associated with trade liberalization are negative and statistically significant across all specifications. In Column (1) without control variable, the coefficient associated with trade liberalization is -0.641. The negative and statistically significant coefficient indicates that on average countries which have liberalized have experienced a decrease in tax revenues over the medium run. The result suggests that the loss of revenues from lower tariffs is not more than compensated by an increase in the tax base. When controlling for GDP growth, Column (2) shows that the coefficient associated with trade liberalization is -0.874. The increase in absolute value of the coefficient confirms that the counterfactual whereby the growth channel of trade liberalization would be shut down would worsen the effect of liberalization on tax revenues. The individual coefficient associated with GDP growth is indeed positive and statistically significant across all columns in Table 2.1.

Columns (3) in Table 2.1 shows that also controlling for the share of the agriculture sector leads to a decrease in absolute value of the coefficient associated with trade liberalization. Indeed, the coefficient associated with the agriculture sector is associated with lower tax revenues. Hence controlling for the size of the sector limits the negative effect of trade liberalization on tax revenues. Column (4) controls further for both inflation, development assistance and official aid lead to a decrease in the absolute value of the coefficient associated with trade liberalization. The individual coefficient associated with inflation is positive but not significant while the coefficient associated with development aid is negative and statistically significant. All in all, our main results show a robust and negative effect of liberalization on tax revenues.

Quantitatively, trade liberalization which implies a jump from zero to 1 for the dichotomous variable used in the regression suggests that the decrease in tax revenues ranges from 0.60 to 0.87 percent of GDP. Quantitatively, the decrease in tax revenue may appear relatively small also considering the results capture the medium run effect. Yet it is important to bear in mind that the effect of trade liberalization is firmly negative as opposed to positive as existing empirical evidence as pointed to. Trade liberalization is significantly associated with a decrease in tax revenues.

Table 2.1: Trade Liberalization and Aggregate Tax Revenues—Ordinary Least Square

Revenue excluding grants and social contributions to GDP	(1)	(2)	(3)	(4)
Sachs-Warner/Wacziarg-Welch index of liberalization ₍₋₁₎	-0.641*** (0.243)	-0.874*** (0.250)	-0.729*** (0.267)	-0.555** (0.266)
Real GDP growth (Annual percent change) ₍₋₁₎		0.042*** (0.014)	0.032** (0.014)	0.031* (0.016)
Agriculture, value added (% of GDP) ₍₋₁₎			-0.193*** (0.019)	-0.134*** (0.021)
Inflation, consumer prices (annual %) ₍₋₁₎				0.000 (0.000)
Net official development assistance and official aid received (% of GDP) ₍₋₁₎				-0.037** (0.017)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	2,710	2,578	2,229	1,595
Number of Country	136	136	129	96
R-squared	0.026	0.032	0.078	0.087

Notes: The table reports results for regressions with tax revenues excluding grants and social contributions to GDP as dependent variable with as independent variables SW/WW liberalization indicator as well as several controls. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 2.2 confirms our main result using as dependent variables tax revenues excluding natural resources. Developing countries are often dependent on revenues from natural resources. Considering that natural resources are subject to exogenous price and quantity shocks, in the form of fluctuations in international prices and discoveries of resources, excluding receipts from natural resources from government tax revenues allows to capture tax mobilization efforts more appropriately. Column (1) in Table 2.2 shows that the coefficient associated with trade liberalization is -0.889 that is higher in absolute value than the coefficient reported in Column (1) in Table 1 suggesting that tax revenue mobilization is weaker when removing natural resources from tax revenues. When controlling for GDP growth in Column 2 of Table 2.2 the coefficient becomes larger in absolute values as expected. Adding more controls in Columns (3) and (4) confirms the negative association between trade liberalization and (non-resource) tax revenues.

Table 2.2: Trade Liberalization and Non-Resource Tax Revenues—Ordinary Least Square

Non-resource tax excluding social contributions to GDP	(1)	(2)	(3)	(4)
Sachs-Warner/Wacziarg-Welch index of liberalization ₍₋₁₎	-0.889*** (0.167)	-1.005*** (0.171)	-0.382** (0.178)	-0.287 (0.188)
Real GDP growth (Annual percent change) ₍₋₁₎		0.027*** (0.010)	0.022** (0.010)	-0.002 (0.012)
Agriculture, value added (% of GDP) ₍₋₁₎			-0.111*** (0.013)	-0.055*** (0.015)
Inflation, consumer prices (annual %) ₍₋₁₎				0.001* (0.000)
Net official development assistance and official aid received (% of GDP) ₍₋₁₎				-0.026* (0.014)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	2,844	2,711	2,226	1,540
Number of Country	135	135	128	96
R-squared	0.024	0.030	0.061	0.064

Notes: The table reports results for regressions using as dependent variable non-resource tax revenues excluding grants and social contributions over GDP with as independent variables SW/WW liberalization indicator as well as other controls. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

Our main result is in stark contrast with existing evidence pointing to a positive and significant relationship between trade liberalization and tax revenues.⁴⁹ The literature

⁴⁹ Baunsgaard and Keen (2010) find an average positive relationship between trade openness—proxied by the sum of exports and imports of goods and services over GDP—and tax revenues albeit the relationship appears weaker for poorer economies.

finding a positive association typically uses outcome base measures of trade liberalization while we use a measure based on policy changes. Interestingly, Cage and Gadenne (2014) find that trade liberalization led to larger and longer-lived declines in tax revenues in developing countries since 1970 than in today's rich countries in the 19th and 20th centuries. Table 2.3 presents results using an outcome-based measure of trade liberalization—that is the sum of exports and imports of goods and services as a share of GDP. The sign of the coefficient associated with the outcome-based measure is positive and significant across all columns. Column 1 in Table 2.3 indicates that an increase in trade liberalization going from zero that is autarky to say 100 percent of GDP would lead to an increase in tax revenues of 0.7 percent of GDP. Columns 2-4 in Table 2.3 confirm the positive and statistically significant association between trade orientation and tax revenue—with Column 4 in Table 2.3 pointing to a maximum effect of 2 percent of GDP increase in tax revenues following an increase from zero to 100 percent in trade orientation.

Table 2.3: Trade Liberalization and Aggregate Tax Revenues—Outcome based Measure of Liberalization

Revenue excluding grants and social contributions to GDP	(1)	(2)	(3)	(4)
Total trade % of GDP ⁽⁻¹⁾	0.007** (0.003)	0.008*** (0.003)	0.012*** (0.003)	0.019*** (0.004)
Real GDP growth (Annual percent change) ⁽⁻¹⁾		0.023** (0.011)	0.057*** (0.013)	0.050*** (0.015)
Agriculture, value added (% of GDP) ⁽⁻¹⁾			-0.148*** (0.014)	-0.117*** (0.015)
Inflation, consumer prices (annual %) ⁽⁻¹⁾				-0.000 (0.000)
Net official development assistance and official aid received (% of GDP) ⁽⁻¹⁾				-0.010 (0.015)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	5,066	4,974	4,477	3,158
Number of Country	181	180	173	142
R-squared	0.075	0.083	0.114	0.150

Notes: The table reports results for regressions using as dependent variable tax revenues excluding social contributions over GDP with as independent variables an outcome based measure of liberalization that is the sum of exports and imports of goods and services over GDP as well as several controls. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

However, the evidence pointing to a positive association between trade orientation and tax revenues is not robust. When subtracting natural resource rents from tax revenues the results from the regression linking trade liberalization and tax revenues shown in Table 2.4 appear no longer statistically significant. Indeed, Table 2.4 shows that while the coefficients associated with trade liberalization are positive for Columns 1, 2 and 4 and negative in Column 3. The coefficients associated with the outcome-based measure of trade liberalization are not statistically significant for all columns. Non resource tax revenues variable is a better proxy for tax revenue mobilization. Indeed, as mentioned earlier, developing countries are often subject to quantity and price shocks in the resource sector which tend to drive aggregate tax revenues. Hence policy-based measures of liberalization are better suited to capture the precise timing and actual impulse toward liberalization--doing away with the vagaries from the resource sector.

Table 2.4: Trade Liberalization and Non-Resource Tax Revenue—Outcome based Measure of Liberalization

Non-resource tax excluding social contributions to GDP	(1)	(2)	(3)	(4)
Total trade % of GDP ₍₋₁₎	0.001 (0.002)	0.002 (0.002)	-0.002 (0.002)	0.002 (0.002)
Real GDP growth (Annual percent change) ₍₋₁₎		0.008 (0.007)	0.028*** (0.009)	0.010 (0.010)
Agriculture, value added (% of GDP) ₍₋₁₎			-0.116*** (0.009)	-0.086*** (0.010)
Inflation, consumer prices (annual %) ₍₋₁₎				0.001** (0.000)
Net official development assistance and official aid received (% of GDP) ₍₋₁₎				-0.014 (0.010)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	5,029	4,923	4,324	3,017
Number of Country	177	175	169	139
R-squared	0.088	0.093	0.155	0.213

Notes: The table reports results for regressions using as dependent variable non-resource tax revenues excluding grants and social contributions over GDP with as independent variables an outcome based measure of liberalization that is the sum of exports and imports of goods and services over GDP as well as several controls. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

The non-robust nature of the relationship casts doubts on the existing evidence pointing to a positive relationship between tax revenues and trade liberalization albeit the existing evidence points to a weaker relationship for developing countries (see Baunsgaard and Keen, 2010). In Appendix B.2, we perform several checks around the relationship between trade orientation and tax revenues. Table B.2.1 confirms the positive relationship between total tax revenues and trade orientation when using the

same sample as our Table 2.1 in the main text.⁵⁰ But again, Table B.2.2-- restricting the sample to the one available for Table 2.2 in the main text--shows that when using non-resource tax revenues as dependent variable the positive relationship between trade orientation and tax revenues is not robust.

In Appendix B.2, Table B.2.3 and Table B.2.4 further explore the robustness of the relationship between tax revenues and the outcome-based measure of trade liberalization by subtracting natural resource exports from the trade orientation measure—that is the sum of exports and imports of goods and services as a share of GDP. Table B.2.3 shows that the relationship between aggregate tax revenues and trade orientation is now negative and statistically significant. Table B.2.4 uses as dependent non resource tax revenues and find that the relationship between the latter and non-resource trade orientation is not statistically significant and the sign oscillates between negative and positive. These results echo the main results of this paper that trade liberalization does not statistically significantly increase tax revenues. The results presented in the paper go further and confirm the robustness of the negative relationship between our policy-based measure of trade liberalization and tax revenues.

2.3.2. Exploring the Dynamics

This sub-section explores the dynamics of the relationship between tax revenues and trade liberalization. We present impulse responses using local projection method following Jordà (2005). The identification strategy relies on trade liberalization as an external shock. LP allows to identify the effect of liberalization at different horizons.

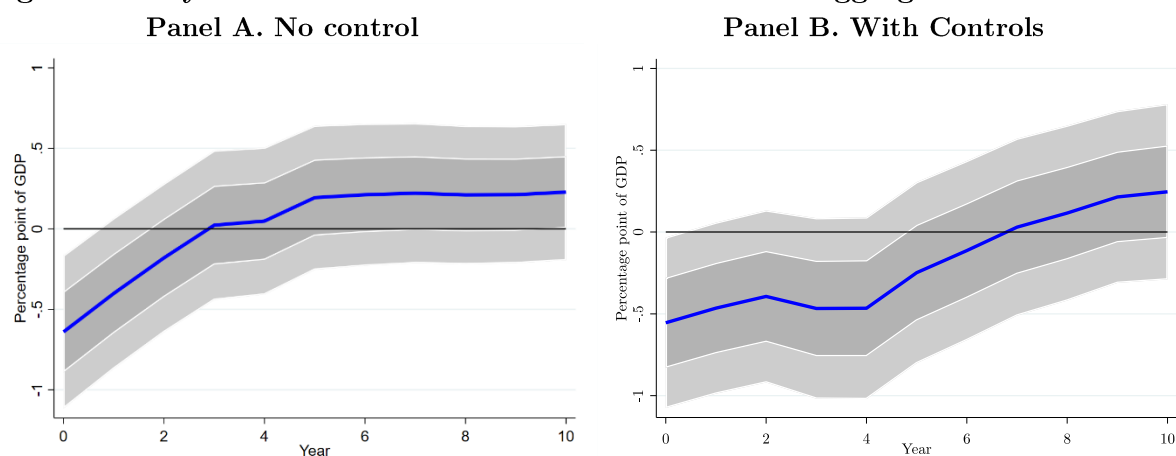
Figure 2.1 shows that the negative effect of trade liberalization on aggregate tax revenues is negative and statistically significant for at least the first three years after liberalization. That result pointing to a negative effect of trade liberalization holds whether the regression does include or not control variable(s)--as shown in Panel A without inclusion of control variable or as shown in Panel B with inclusion of control variables. After three years, the effect of liberalization turns positive but is only statistically significant at 90 percent level after five years as shown in Panel A of Figure 2.1. When including control variables, the effect of trade liberalization on tax revenues become positive after seven years but is not statistically significant at conventional levels as shown in Panel B of Figure 2.1. These results confirm our main findings which point to a statistically significant and negative effect of trade liberalization on tax revenues shown in the previous sub-section. The earlier results should be understood as "averaging" the dynamic effects of liberalization over the

⁵⁰ The SW/WW trade liberalization measure used as our policy-based measure throughout the paper is available up to 2004 hence restricting the overall sample.

medium run and are thus consistent with the dynamic effects presented in this subsection distinguishing between the short and medium run.

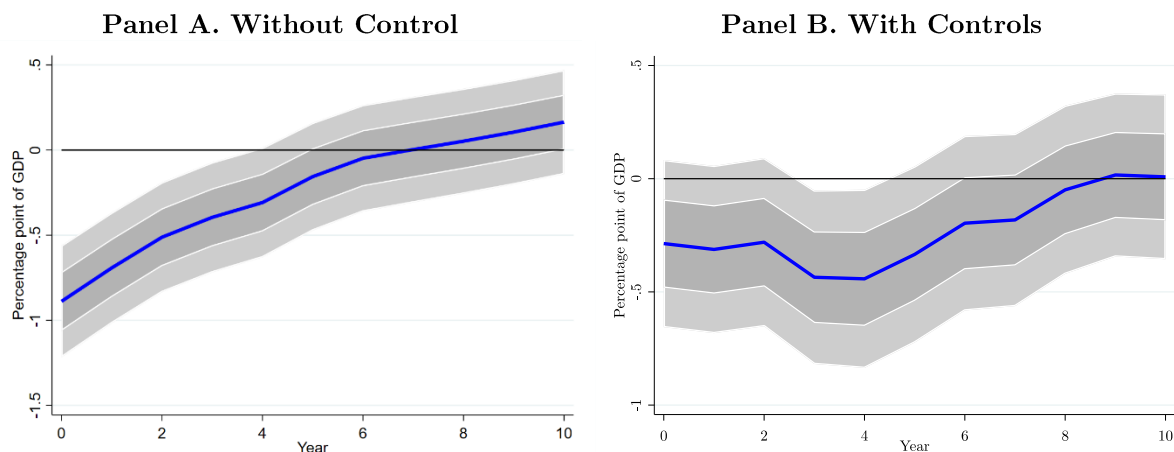
The economic interpretation of the negative effect of liberalization in the short run is explained by a loss in tax revenues from tariff removal that is not compensated by increase in the tax base. Over the medium run, the effect of liberalization on tax revenues turns positive as the tax base gradually increase. Yet there are important sources of leakages both domestic and international that show in the weak statistical significance of the effects of liberalization over the medium run.

Figure 2.1: Dynamic Effects of Trade Liberalization on Aggregate Tax Revenues



Notes: The graph shows impulse response functions. We regress government revenue excluding grants and social contributions to GDP on SW/WW liberalization indicator as well as several controls unless otherwise indicated. 95% / 90% error bands displayed. Panel A presents impulse responses with no control variable. Panel B presents impulse response with all control variables including real GDP growth, agriculture value added, inflation and net development aid and assistance.

To explore further whether our main result is robust we use as dependent non-resource tax revenues instead of aggregate tax revenues in estimating the dynamic effects of trade liberalization. Figure 2.2 confirms our earlier result pointing to a negative effect of trade liberalization which are statistically significant and longer lasting than in Figure 2.1. Indeed, the negative effect is statistically significant and lasts up to five years in Panel A of Figure 2.2 when no control variable is included. The negative effect of liberalization is statistically significant and lasts for over ten years when including control variables as shown in Panel B of Figure 2.2 albeit the effect becomes insignificant after eight years. These results confirm our main findings that trade liberalization has a negative effect over the short run and has no statistically significant effect over the medium run.

Figure 2.2: Dynamic Effects of Trade Liberalization on Non-Resource Tax Revenues

Notes: The graph shows impulse response functions. We regress non resource tax revenues as share of GDP on SW/WW liberalization indicator as well as several controls unless otherwise indicated. 95% / 90% error bands are displayed. Panel A presents impulse responses with no control variable. Panel B presents impulse response with control variables including real GDP growth, agriculture value added, inflation and net development aid and assistance.

2.3.3. Addressing Endogeneity

In this sub-section, we present our main results addressing the issue of endogeneity stemming from the reverse causality running from tax revenues to trade liberalization. That reverse causality may introduce a downward bias in the estimation of the coefficient associated with trade liberalization. As discussed earlier, to address issue of endogeneity associated with trade liberalization, we use an instrument based on learning from neighbors derived from the reduced-form specification presented in Buera et al. (2011). The instrument rests of the fact that a given country get influenced in terms of policy through observing neighbor's policy actions or lack thereof and subsequent performance. In Appendix B.3, Table B.3.1 and Table B.3.2 provide the first stage estimations of the regressions using respectively aggregate tax revenues and non-resource tax revenues. The F-statistics are above ten for all columns in both tables indicating that the instrument is strong.

Table 2.5 presents the results of the two-stage least square estimation using aggregate tax revenues as dependent variable. It shows that across all specifications the coefficients associated with trade liberalization in the second stage is negative and statistically significant. Column 1 in Table 2.5 indicates that a jump from autarky to fully liberalized would increase tax revenues by minus 1 percent of GDP over the medium. The coefficients through Columns 1 to 4 are much larger in absolute value that we found in earlier results not addressing endogeneity. The coefficient in Column 2 is higher in absolute value than in Column 1. That is resulting from the shutting down of the growth channel of liberalization. Columns 3 and 4 also confirm the

negative and statistically significant causal effect of trade liberalization on tax revenues.

Table 2.5: Trade Liberalization and Aggregate Tax Revenues—Two Stage Least Square Estimation

Revenue excluding grants and social contributions to GDP	(1)	(2)	(3)	(4)
Sachs-Warner/Wacziarg-Welch index of liberalization ₍₋₁₎	-1.009*** (0.370)	-1.363*** (0.390)	-1.489*** (0.416)	-1.072*** (0.414)
Real GDP growth (Annual percent change) ₍₋₁₎		0.039** (0.018)	0.027 (0.018)	0.026 (0.021)
Agriculture, value added (% of GDP) ₍₋₁₎			-0.242*** (0.025)	-0.193*** (0.028)
Inflation, consumer prices (annual %) ₍₋₁₎				0.000 (0.000)
Net official development assistance and official aid received (% of GDP) ₍₋₁₎				-0.022 (0.024)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	1,999	1,912	1,678	1,153
Number of countries	100	100	94	66
R-squared	0.0302	0.0348	0.0884	0.117

Notes: The table reports the estimates of the second stage of a two stage least square regression with tax revenue excluding grants and social contributions to GDP as dependent variable and with SW/WW liberalization indicator as well as several controls as independent variables. For trade liberalization we use an instrument based on learning from neighbors derived from the reduced-form specification presented in Buera et al. (2011). *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

We now turn to testing the robustness of our two-stage least square estimation using non resource tax revenues as dependent variable. Table 2.6 presents the results, which confirm the negative effect of trade liberalization for all Columns 1 to 4. Columns 1 and 2 are statistically significant while Columns 3 and 4 are not. Column 1 indicates that an effort at fully liberalizing the economy would yield a decrease in non-resource tax revenues of about 1 percent of GDP over the medium run consistent with Table 2.5. Column 2 also shows the coefficients is higher after controlling for GDP growth. Columns 3-4 confirm the negative relationship between trade liberalization and non-resource tax revenues. Overall, these results confirm that trade liberalization causes no significant increase in tax revenues contrary to existing evidence.

Table 2.6: Trade Liberalization and Non-Resource Tax Revenues—Two Stage Least Square Estimation

Non-resource tax excluding social contributions to GDP	(1)	(2)	(3)	(4)
Sachs-Warner/Wacziarg-Welch index of liberalization ₍₋₁₎	-0.977*** (0.248)	-1.058*** (0.260)	-0.314 (0.268)	-0.270 (0.283)
Real GDP growth (Annual percent change) ₍₋₁₎		0.018 (0.013)	0.008 (0.012)	-0.016 (0.014)
Agriculture, value added (% of GDP) ₍₋₁₎			-0.123*** (0.017)	-0.083*** (0.020)
Inflation, consumer prices (annual %) ₍₋₁₎				0.001* (0.000)
Net official development assistance and official aid received (% of GDP) ₍₋₁₎				-0.025 (0.020)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	2,117	2,035	1,698	1,141
Number of countries	99	99	93	66
R-squared	0.0234	0.0252	0.0513	0.0712

Notes: The table reports the estimates of the second stage of a two stage least square regression with non-resource tax revenues over GDP as dependent variable and with SW/WW liberalization indicator as well as several controls as independent variables. For trade liberalization we use an instrument based on learning from neighbors derived from the reduced-form specification presented in Buera et al. (2011). *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

2.4. Extensions

In this section we now turn to exploring two extensions. First, we explore the extent to which the structure of tax revenues is altered following trade liberalization. Second, we test whether element of state capacity in the tax sector lead to heterogenous effect of liberalization on tax revenues. Specifically, we test whether the effect of trade liberalization on tax revenues differ depending on whether VAT has been implemented prior to liberalization.

2.4.1. Trade Liberalization and Tax Structure

This sub-section presents the results of the estimation of the effect of trade liberalization on tax structure. Table 2.7 shows that trade liberalization alter the tax structure tilting revenues toward indirect taxes and away from direct ones. Such shift in the structure reduces the redistributive capacity of national tax systems. Indeed, that is the case considering the Personal Income Tax (PIT) is typically progressive, while VAT being a consumption tax disproportionately affects relatively poor households. Columns 1-4 in Table 2.7 show that trade liberalization has a negative and statistically significant effect on direct taxes as share of total non-resource tax

revenues. The coefficients are statistically significant across all these columns except Column 4. Columns 5-8 in Table 2.7 shows that indirect taxes as a share of total tax revenues increase following trade liberalization. The results are statistically significant across all these columns except Column 8. These results confirm that trade liberalization leads to a shift in the structure of taxation toward indirect taxes and away from direct ones.

To further explore the effect of trade liberalization on tax revenue structure, we estimate the effect of trade liberalization on direct tax revenue. Table 2.8 shows that corporate income tax decrease following trade liberalization. Columns 1-4 in Table 2.8 presents the results of the effect of trade liberalization on PIT as a share of GDP. Results appear not robust with sign flipping across specifications.⁵¹

Columns 5-8 in Table 2.8 presents the results of the effect of trade liberalization on Corporate Income Tax (CIT) as share of GDP. Results point to robust negative and statistically significant effect of trade liberalization on CIT revenues. Trade liberalization increases competition and welfare, which reduces rents and taxable income of domestic corporations.⁵² Trade liberalization also allows multinational companies to engage into more aggressive tax planning, which affects CIT revenues--while being welfare worsening for the source country. The increase in capital mobility and the advent of tax havens make the technology of tax avoidance more pervasive. Issues of state capacity could make these matters matter worse through leakages in tax revenues following liberalization. We turn to the issue of state capacity in the tax area next.

⁵¹ The design of PIT has evolved following trade liberalization. It has switched from a comprehensive approach to income to a dual or semi-dual income approach. Initiated first in Scandinavian countries in 1990's the dual income tax has considered the lower international mobility cost of capital with respect to labor. The dual income tax kept the progressivity of tax rate on wages only, while the other sources of income--portfolio, land ownership and profit—are taxed under a flat and generally lower rate except for profit, which is in line with the Corporate Income Tax rate. Such evolution has eroded the redistributive capacity of PIT.

⁵² For Auriol and Warlters (2005) argue that weak capacity in tax administration may explain why developing countries raise high entry costs through the presence of fees in order to reduce the number of formal firms, increase their market power and their taxable income, and consequently CIT revenue. However, Auriol and Warlters (2005) do not consider the potential leakages associated with the risk of tax avoidance.

Table 2.7: Trade Liberalization and Tax Structure--Non-Resource Tax Composition

	Direct taxes excluding social contributions and resource revenue to non-resource tax excluding social contributions				Non-resource component of Indirect tax to non-resource tax excluding social contributions			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sachs-Warner/Wacziarg-Welch index of liberalization ⁽⁻¹⁾	-2.467***	-1.738***	-1.431***	-0.773	2.457***	1.654***	1.696***	0.631
	(0.385)	(0.384)	(0.441)	(0.535)	(0.392)	(0.391)	(0.452)	(0.546)
Real GDP growth (Annual percent change) ⁽⁻¹⁾		-0.049**	-0.039	-0.062*		0.085***	0.083***	0.108***
		(0.022)	(0.024)	(0.032)		(0.023)	(0.025)	(0.032)
Agriculture, value added (% of GDP) ⁽⁻¹⁾			-0.032	-0.046			0.036	0.064
			(0.032)	(0.041)			(0.032)	(0.042)
Inflation, consumer prices (annual %) ⁽⁻¹⁾				0.002***				-0.003***
				(0.001)				(0.001)
Net official development assistance and official aid received (% of GDP) ⁽⁻¹⁾				0.023				-0.016
				(0.038)				(0.038)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,562	2,454	2,013	1,411	2,519	2,412	1,968	1,386
Number of countries	132	132	125	93	130	130	123	92
R-squared	0.037	0.031	0.031	0.065	0.037	0.032	0.033	0.077

Notes: The table reports results from the regression as dependent variables: i) the ratio of direct taxes excluding social contributions and resource revenue over non-resource tax excluding social contributions; ii) the ratio non-resource component of Indirect tax over non-resource tax excluding social contributions. The independent variable of interest is SW/WW liberalization indicator as well as several controls. The country year observation Turkmenistan-2004 has been removed from the sample used in Columns (1) to (4) due to internal inconsistency in the GRD dataset. The following country-year observations have been removed from the sample used In Columns (5)-(8) due inconsistency in the GRD dataset. Bahamas-1989, Guinea-1985, Turkmenistan-2004, Vanuatu-1994, 1995, and 1996. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 2.8: Trade Liberalization and Structure of Taxation—Direct Tax Composition

	Personal income tax to non-resource tax excluding social contributions				Non-resource component of corporations and other enterprises tax to non-resource tax excluding social contributions			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sachs-Warner/Wacziarg-Welch index of liberalization ⁽⁻¹⁾	0.102 (0.353)	0.636* (0.341)	-0.092 (0.364)	-0.389 (0.390)	-3.052*** (0.459)	-2.808*** (0.467)	-2.360*** (0.566)	-1.184* (0.626)
Real GDP growth (Annual percent change) ⁽⁻¹⁾		0.014 (0.019)	0.020 (0.019)	-0.039* (0.022)		-0.087*** (0.026)	-0.088*** (0.030)	-0.038 (0.034)
Agriculture, value added (% of GDP) ⁽⁻¹⁾			-0.041 (0.026)	-0.016 (0.027)			-0.058 (0.040)	-0.050 (0.044)
Inflation, consumer prices (annual %) ⁽⁻¹⁾				-0.001 (0.000)				0.004*** (0.001)
Net official development assistance and official aid received (% of GDP) ⁽⁻¹⁾				-0.044* (0.025)				0.122*** (0.039)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,121	2,026	1,645	1,117	2,026	1,947	1,582	1,037
Number of countries	127	127	121	90	123	123	116	85
R-squared	0.012	0.015	0.018	0.027	0.037	0.044	0.040	0.080

Notes: The table reports results from regressions using as dependent variables: i) the ratio of personal income tax over non-resource tax excluding social contributions and ii) the ratio of non-resource component of corporations and other enterprises tax over non-resource tax excluding social contributions. The independent variable of interest is SW/WW liberalization indicator as well as several controls. The country year observation Botswana 1990 has been removed from the sample used in Columns (5) to (8) due to internal inconsistency in the GRD dataset. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level

2.4.2. Trade Liberalization and VAT

Since its introduction in 1954, VAT quickly became a major tax. VAT has been adopted by more than 160 countries. Keen and Lockwood (2010) estimated that VAT constitutes more than 20 percent of world's tax revenue. In most countries over 50 percent of the VAT revenues are collected at the border, hence its importance in the analysis of trade liberalization. Importantly, the implementation of VAT also allows to capture the state capacity in the tax area.

In this sub-section we explore whether VAT mediates the relationship between trade liberalization and tax revenues. To do so we augment our main specification shown in (2.2) with an interaction term between trade liberalization episodes and VAT adoption as an additional independent variable. The interaction allows us to test specifically whether countries which have implemented VAT prior to liberalization have fared better in terms of tax revenue mobilization.

Table 2.9 and Table 2.10 present the results using aggregate tax revenues and non-resource tax revenues respectively. In Table 2.9, the interaction is positive but not statistically significant across all Columns from 1 to 4. The positive sign indicates that the presence of VAT boosts revenue mobilization following liberalization albeit not significantly. In Table 2.10, the interaction is also positive and statistically significant across all Columns from (1) to (4).

When removing natural resource rents from aggregate tax revenues, VAT appears to play an important role in mediating the effect of liberalization on tax revenues. Regression results presented in Table 2.10 adjust tax revenues for natural resource rents. Across all columns the interaction terms associated between trade liberalization and VAT implementation are positive and significant pointing to important role of VAT in mitigating the negative effect of liberalization on tax revenues. Quantitatively, the interaction effect is large. Take two countries experiencing liberalization and differing only in whether they have implemented VAT prior to liberalization. According to the estimated coefficient presented in Column 1 in Table 2.10, the country without VAT would face a loss in tax revenues of minus 1.952 percent of GDP while the country with VAT will face a loss of (only) minus 0.371 percent of GDP ($= -1.952 + 1.581$). These results are in line with Ebrill et al. (2001) and Keen and Lockwood (2010) who suggest a revenue gain associated with the adoption of VAT. Our results here more specifically suggest that having implementing VAT prior to liberalization allows countries to perform better in terms of tax revenue mobilization everything else being equal. An alternative explanation is that VAT, which remains heavily collected at the border, substitutes for tariffs. The issue of VAT credit refunds in developing countries reinforces this view of a VAT as a quasi-tariff in less developed countries (Cnossen, 2019).

In Appendix B.4, we probe these results further. We split countries according to whether they opened before or after the adoption of VAT. Table B.4.1 and Table B.4.1 presents the results for aggregate tax revenues and non-resource tax revenues respectively. The results suggest that countries that did not have VAT before openness are the one suffering the most in term of revenue lost. In other word, setting up domestic tax sources may ease the revenue loss associated with liberalization. VAT implementation helps the domestic tax system “cope” with trade liberalization.⁵³

Table 2.9: Trade Liberalization and Aggregate Tax Revenues—VAT Adoption

Revenue excluding grants and social contributions to GDP	(1)	(2)	(3)	(4)
Sachs-Warner/Wacziarg-Welch index of liberalization ₍₋₁₎	-1.050*** (0.315)	-1.142*** (0.321)	-0.907*** (0.346)	-0.768** (0.359)
Sachs-Warner/Wacziarg-Welch index of liberalization ₍₋₁₎ x Dummy VAT	0.632** (0.308)	0.419 (0.309)	0.266 (0.325)	0.295 (0.330)
Real GDP growth (Annual percent change) ₍₋₁₎		0.042*** (0.014)	0.032** (0.014)	0.031* (0.016)
Agriculture, value added (% of GDP) ₍₋₁₎			-0.192*** (0.019)	-0.133*** (0.021)
Inflation, consumer prices (annual %) ₍₋₁₎				0.000 (0.000)
Net official development assistance and official aid received (% of GDP) ₍₋₁₎				-0.037** (0.017)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	2,697	2,565	2,224	1,590
Number of countries	135	135	128	95
R-squared	0.027	0.032	0.078	0.087

Notes: The table reports results from the regressions using as dependent variable the ratio of government revenue excluding grants and social contributions over GDP with as independent variables SW/WW liberalization indicator plus an interaction term between the latter and the adoption of VAT as well as several controls. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

⁵³ In the context of World Bank’s programs, Rajaram (1994) argues that tariff reform aimed at reducing domestic protection holds the threat of widening the fiscal deficit by causing tariff revenue to decline. He further argues that because the success of an adjustment program depends critically on the correction of fiscal imbalances to achieve stabilization, tariff reforms must be coordinated with tax policy.

Table 2.10: Trade Liberalization and Non-Resource Tax Revenues—VAT Adoption

Non-resource tax excluding social contributions to GDP	(1)	(2)	(3)	(4)
Sachs-Warner/Wacziarg-Welch index of liberalization ₍₋₁₎	-1.952*** (0.217)	-1.908*** (0.221)	-1.212*** (0.234)	-1.186*** (0.270)
Sachs-Warner/Wacziarg-Welch index of liberalization ₍₋₁₎ x Dummy VAT	1.581*** (0.208)	1.343*** (0.210)	1.197*** (0.222)	1.160*** (0.251)
Real GDP growth (Annual percent change) ₍₋₁₎		0.027*** (0.010)	0.023** (0.010)	-0.003 (0.011)
Agriculture, value added (% of GDP) ₍₋₁₎			-0.105*** (0.013)	-0.054*** (0.015)
Inflation, consumer prices (annual %) ₍₋₁₎				0.001* (0.000)
Net official development assistance and official aid received (% of GDP) ₍₋₁₎				-0.022 (0.014)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	2,831	2,698	2,221	1,552
Number of countries	134	134	127	95
R-squared	0.045	0.045	0.074	0.074

Notes: The table reports results from the regressions using as dependent variable the ratio of non-resource tax revenues to GDP with as independent variables SW/WW liberalization indicator plus an interaction term between the latter and the adoption of VAT as well as several controls. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

2.5. Conclusion

This paper explored the dynamic effects of trade liberalization on tax revenues using a worldwide panel dataset. Results point to significant negative effects of liberalization on (non-resource) tax revenues in the short term and no significant effect in the medium term. Liberalization also alter the tax structure tilting revenues toward indirect taxes away from direct ones. Economies which have implemented value added taxes prior to liberalization have mitigated its negative effects on tax revenues. The evidence is supportive of the complementarity role of state capacity to reap the benefits of liberalization.

Further research could look at the issue at tax spillovers stemming from belonging to custom and monetary unions. Indeed, many countries around the world belong to monetary and customs unions, which entails deeper economic integration and in turn leading to important spillover from tax policy. A network analysis of tax spillovers in these unions could allow the identification of weakest-links. That is countries which

exposes all the other customs union members to risks of indirect or direct tax base erosion. This analysis would rely on the existence of tax treaties, which link these countries inside unions to tax havens.

2.6. References

- Atkin, D., and Khandelwal, A. K. (2020). How distortions alter the impacts of international trade in developing countries. *Annual Review of Economics*, 12, 213-238.
- Auriol, E. and Warlters, M. (2005). Taxation base in developing countries. *Journal of Public Economics*, 89(4), 625-646.
- Baldwin, R. E. (2003). Openness and Growth: What's the Empirical Relationship?. *NBER Working Paper*, 9578, National Bureau of Economic Research
- Baunsgaard, T., and Keen, M. (2010). Tax revenue and (or?) trade liberalization. *Journal of Public Economics*, 94(9-10), 563-577.
- Bergquist, L. and Dinerstein, M. (2020). Competition and entry in agricultural markets: Experimental evidence from Kenya. *American Economic Review*, 110(2), 3705-46
- Besley, T., and Persson, T. (2014). Why do developing countries tax so little?. *Journal of Economic Perspectives*, 28(4), 99-120.
- Buera, F. J., Monge-Naranjo, A., and Primiceri, G. E. (2011). Learning the wealth of nations. *Econometrica*, 79(1), 1-45.
- Caldeira, E., Geourjon, A.-M. and Rota-Graziosi, G. (2020). Taxing aid: The end of a paradox? *International tax and Public Finance*, 27, 240-250.
- Cagé, J., and Gadenne, L. (2018). Tax revenues and the fiscal cost of trade liberalization, 1792–2006. *Explorations in Economic History*, 70, 1-24.
- Cnossen, S., (2019). *Modernizing VATs in Africa*. Oxford University Press.
- Collier, P. (2006). Is aid oil? An analysis of whether Africa can absorb more aid. *World development*, 34(9), 1482-1497.
- Crivelli, E., and Gupta, S. (2014). Resource blessing, revenue curse? Domestic revenue effort in resource-rich countries. *European Journal of Political Economy*, 35, 88-101.
- Dharmapala, D. (2014). What do we know about base erosion and profit shifting? A review of the empirical literature. *Fiscal Studies*, 35(4), 421-448.

Dharmapala, D. (2019, May). Profit shifting in a Globalized World. *AEA Papers and Proceedings*, 109, 488-92.

Dharmapala, D., and Hines Jr, J. R. (2009). Which countries become tax havens?. *Journal of Public Economics*, 93(9-10), 1058-1068.

Ebrill, M., Keen, M., and Perry, V. (2001). *The modern VAT*. International Monetary Fund.

Egger, P. H., Nigai, S., and Strecker, N. M. (2019). The taxing deed of globalization. *American Economic Review*, 109(2), 353-90.

Frankel, J. A., and Romer, D. H. (1999). Does trade cause growth?. *American Economic Review*, 89(3), 379-399.

Genschel, P., & Seelkopf, L. (2019). Codebook – Tax Introduction Dataset (TID). Version May 2019.

Goldberg, P., and Pavcnik, N. (2004). Trade, Inequality, and Poverty: What Do We Know? Evidence from Recent Trade Liberalization Episodes in Developing Countries. *NBER Working Paper*, 10593, National Bureau of Economic Research.

Hines Jr, J. R., and Summers, L. H. (2009). How Globalization Affects Tax Design. *Tax Policy and the Economy*, 23(1), 123-158.

International Center for Tax and Development/The United Nations University World Institute for Development Economics Research (ICTD/UNI-WIDER) (2017). “Government Revenue Dataset.” <https://www.wider.unu.edu/project/government-revenue-dataset>.

James, A. (2015). US state fiscal policy and natural resources. *American Economic Journal: Economic Policy*, 7(3), 238-57.

Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American Economic Review*, 95(1), 161-182.

Keen, M., and Lockwood, B. (2010). The value added tax: Its causes and consequences. *Journal of Development Economics*, 92(2), 138-151.

Lotz, J. R., and Morss, E. R. (1970). A theory of tax level determinants for developing countries. *Economic Development and Cultural Change*, 18(3), 328-341.

Martinez-Vazquez, J., Vulovic, V., and Liu, Y. (2011). Direct versus indirect taxation: trends, theory, and economic significance In *The Elgar guide to tax systems*, Edward Elgar Publishing, pp.37-92.

Mehlum, H., Moene, K., and Torvik, R. (2006). Institutions and the resource curse. *The Economic Journal*, 116(508), 1-20.

Morrissey, O. (2015). Aid and government fiscal behavior: Assessing recent evidence. *World Development*, 69, 98-105.

Rajaram, A. (1994). Tariff and tax reforms-do World Bank recommendations integrate revenue and protection objectives?. *The Economic Studies Quarterly*, 45(4), 321-338.

Robinson, J. A., Torvik, R., and Verdier, T. (2006). Political foundations of the resource curse. *Journal of Development Economics*, 79(2), 447-468.

Rodriguez, F., and Rodrik, D. (2000). Trade policy and economic growth: a skeptic's guide to the cross-national evidence. *NBER macroeconomics annual*, 15, 261-325.

Rota-Graziosi, G. (2019). The supermodularity of the tax competition game. *Journal of Mathematical Economics*, 83, 25-35.

Seelkopf, L., Bubek, M., Eihmanis, E., Ganderson, J., Limberg, J., Mnaili, Y., Zuluaga, P., and Genschel, P. (2019). The rise of modern taxation: A new comprehensive dataset of tax introductions worldwide. *The Review of International Organizations*, 1-25.

Tanzi, V., 1978. Inflation, real tax revenue, and the case for inflationary finance: theory with an application to Argentina. *Staff papers*, 25(3), pp.417-451.

Ulyssea, G. (2018). Firms, informality, and development: Theory and evidence from Brazil. *American Economic Review*, 108(8), 2015-47.

Wacziarg, R., and Welch, K. H. (2008). Trade liberalization and growth: New evidence. *The World Bank Economic Review*, 22(2), 187-231.

Winters, L. A. (2004). Trade liberalisation and economic performance: an overview. *The Economic Journal*, 114(493), F4-F21.

World Bank, World Development Indicators:
<https://databank.worldbank.org/source/world-development-indicators>

B. Appendix to chapter II

B.1. Appendix: Data

Table B.1.1: Summary Statistics

	Obs.	Mean	Std. Dev.	Min	Max
Sachs-Warner/Wacziarg-Welch index of liberalization	6268	0.44	0.50	0.00	1.00
Revenue excluding grants and social contributions	5789	22.98	11.12	0.68	109.04
Non-resource tax excluding social contributions	5689	16.32	7.81	0.00	56.92
Direct taxes excluding social contributions, including resource revenue	5017	6.56	5.08	0.00	34.71
Non-Resource Component of Indirect Tax	5114	10.10	4.82	0.02	45.40
Total trade % of GDP	5979	86.15	56.96	0.02	860.80
Real GDP growth (Annual percent change)	6553	3.50	6.52	-66.70	148.00
Agriculture, value added (% of GDP)	5392	16.62	14.75	0.00	93.98
Inflation, consumer prices (annual %)	7096	24.82	352.47	-60.50	23773.13
Net official development assistance and official aid received (% of GDP)	5524	7.09	10.63	-2.27	139.89

Notes: The table shows basic summary statistics for the variables used in this paper.

Table B.1.2: VAT Introduction Year and (First) Liberalization Episode

Country	Year in which the economy has liberalized (if liberalized before 1950, use 1950 as year of opening)	Year in which VAT was introduced	Country	Year in which the economy has liberalized (if liberalized before 1950, use 1950 as year of opening)	Year in which VAT was introduced
Albania	1992	1995	Japan	1964	1988
Argentina	1991	1975	Kazakhstan	2001	1992
Armenia	1995	1992	Kenya	1963	1990
Australia	1964	1999	Kyrgyz Republic	1994	1992
Austria	1960	1973	Korea, Rep.	1968	1976
Azerbaijan	1995	1992	Liberia	1998	
Belgium	1959	1971	Sri Lanka	1950	2002
Benin	1990	1991	Lithuania	1993	1994
Burkina Faso	1998	1993	Luxembourg	1959	1970
Bangladesh	1996	1991	Latvia	1993	1992
Bulgaria	1991	1994	Morocco	1956	1985
Bolivia	1956	1973	Moldova	1994	1992
Brazil	1991	1966	Madagascar	1996	1994
Barbados	1966	1997	Mexico	1986	1980
Botswana	1979	2002	Macedonia, FYR	1994	2000
Canada	1952	1991	Mali	1988	1991
Switzerland	1950	1995	Mozambique	1995	1999
Chile	1976	1975	Mauritania	1995	1995
Cote d'Ivoire	1994	1992	Mauritius	1968	1998
Cameroon	1993	1999	Malawi	1997	1989
Congo, Dem. Rep.	2001	2010	Malaysia	1963	2014
Congo, Rep.	2002	1997	Niger	1994	1986
Colombia	1986	1975	Nigeria	2002	1994
Cabo Verde	1991	2002	Nicaragua	1950	1970
Costa Rica	1952	1975	Netherlands	1959	1969
Cyprus	1960	1990	Norway	1950	1970
Czech Republic	1993	1993	Nepal	1991	1997
Germany	1959	1968	New Zealand	1986	1986

Denmark	1959	1967	Pakistan	2001	1995
Dominican Republic	1992	1983	Panama	1996	1977
Ecuador	1950	1970	Peru	1950	1973
Egypt, Arab Rep.	1995	1991	Philippines	1988	1988
Spain	1959	1986	Papua New Guinea	1999	1999
Estonia	1999	1992	Poland	1990	1993
Ethiopia	1997	2003	Portugal	1950	1986
Finland	1960	1994	Paraguay	1989	1993
France	1959	1968	Romania	1992	1993
United Kingdom	1950	1973	Singapore	1965	1994
Georgia	1996	1992	Sierra Leone	2001	2009
Ghana	1985	1998	El Salvador	1950	1992
Guinea	1986	1996	Slovak Republic	1992	1993
Gambia, The	1985	2012	Slovenia	1991	1999
Guinea-Bissau	1987		Sweden	1960	1969
Greece	1959	1986	Syrian Arab Republic	1950	
Guatemala	1950	1983	Thailand	1950	1991
Guyana	1988	2007	Tajikistan	1996	1992
Hong Kong SAR, China	1950		Trinidad and Tobago	1992	1990
Honduras	1950	1976	Tunisia	1989	1988
Croatia	2000	1995	Turkey	1950	1985
Haiti	1999	1982	Taiwan, China	1963	1986
Hungary	1990	1988	Tanzania	1995	1998
Indonesia	1970	1985	Uganda	1988	1996
India	1997	2017	Uruguay	1990	1968
Ireland	1966	1972	United States	1950	
Israel	1985	1975	Venezuela, RB	1950	1993
Italy	1959	1973	Yemen, Rep.	1967	1999
Jamaica	1962	1991	South Africa	1991	1991
Jordan	1965	2001	Zambia	1993	1995

Sources: Tax Introduction Database for VAT introduction year, see Seelkopf et al. (2019) and Genschel and Seelkopf (2019). The (first) liberalization episodes are from Sachs and Warner/Wacziarg and Welch (2008) (SW/WW).

B.2. Appendix: Robustness Checks—Outcome-Based Measure of Liberalization

Table B.2.1: Trade Liberalization and Aggregate Tax Revenues—Sample Adjustment

Revenue excluding grants and social contributions to GDP	(1)	(2)	(3)	(4)
Total trade % of GDP ⁽⁻¹⁾	0.008** (0.003)	0.009*** (0.004)	0.016*** (0.004)	0.015*** (0.004)
Real GDP growth (Annual percent change) ⁽⁻¹⁾		0.015 (0.011)	0.035** (0.014)	0.033** (0.015)
Agriculture, value added (% of GDP) ⁽⁻¹⁾			-0.186*** (0.018)	-0.129*** (0.019)
Inflation, consumer prices (annual %) ⁽⁻¹⁾				-0.000 (0.000)
Net official development assistance and official aid received (% of GDP) ⁽⁻¹⁾				-0.008 (0.017)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	3,286	3,203	2,803	2,025
Number of Countries	177	176	167	127
R-squared	0.025	0.029	0.073	0.077

Notes: The table reports results for regressions using as dependent variable tax revenues excluding social contributions over GDP with as independent variables an outcome based measure of liberalization that is the sum of exports and imports of goods and services over GDP as well as several controls. The sample is adjusted to match the sample using SW/WW liberalization indicator shown in Table 1 of the main text. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table B.2.2: Trade Liberalization and Non-Resource Tax Revenues—Sample Adjustment

Non-resource tax excluding social contributions to GDP	(1)	(2)	(3)	(4)
Total trade % of GDP ⁽⁻¹⁾	-0.004 (0.002)	-0.002 (0.002)	0.004 (0.003)	0.007** (0.003)
Real GDP growth (Annual percent change) ⁽⁻¹⁾		-0.015** (0.007)	0.022** (0.009)	-0.001 (0.010)
Agriculture, value added (% of GDP) ⁽⁻¹⁾			-0.125*** (0.012)	-0.063*** (0.013)
Inflation, consumer prices (annual %) ⁽⁻¹⁾				0.001* (0.000)
Net official development assistance and official aid received (% of GDP) ⁽⁻¹⁾				-0.012 (0.012)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	3,330	3,243	2,735	1,944
Number of Countries	174	172	163	125
R-squared	0.014	0.016	0.064	0.052

Notes: The table reports results for regressions using as dependent variable non-resource tax revenues excluding grants and social contributions over GDP with as independent variables an outcome based measure of liberalization that is the sum of exports and imports of goods and services over GDP as well as several controls. The sample is adjusted to match the availability of SW/WW liberalization indicator as shown in Table 2 of the main text. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table B.2.3: Trade Liberalization and Aggregate Tax Revenues—Non-Resource Trade

Revenue excluding grants and social contributions to GDP	(1)	(2)	(3)	(4)
Non-resource trade (% GDP) ⁽⁻¹⁾	-0.009*** (0.003)	-0.010*** (0.003)	-0.023*** (0.004)	-0.022*** (0.005)
Real GDP growth (Annual percent change) ⁽⁻¹⁾		0.044*** (0.016)	0.071*** (0.016)	0.058*** (0.019)
Agriculture, value added (% of GDP) ⁽⁻¹⁾			-0.148*** (0.021)	-0.130*** (0.022)
Inflation, consumer prices (annual %) ⁽⁻¹⁾				-0.001** (0.000)
Net official development assistance and official aid received (% of GDP) ⁽⁻¹⁾				-0.004 (0.025)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	3,890	3,855	3,390	2,424
Number of countries	178	177	169	137
R-squared	0.071	0.076	0.120	0.140

Notes: The table reports results for regressions using as dependent variable tax revenues excluding grants and social contributions over GDP with as independent variables an outcome based measure of liberalization. The outcome measure is the difference between sum of exports and imports of merchandise excluding exports of natural resources over GDP as well as several controls. We use available data from World Bank, World Development Indicators on resource exports as a share of merchandise exports and merchandise exports and imports in US dollars to compute the outcome base measure. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table B.2.4: Trade Liberalization and Non-Resource Tax Revenue—Non-Resource Trade

Non-resource tax excluding social contributions to GDP	(1)	(2)	(3)	(4)
Non-resource trade (% GDP) ⁽⁻¹⁾	-0.003 (0.002)	-0.003 (0.002)	-0.008*** (0.003)	0.002 (0.004)
Real GDP growth (Annual percent change) ⁽⁻¹⁾		0.031*** (0.010)	0.064*** (0.012)	0.031** (0.014)
Agriculture, value added (% of GDP) ⁽⁻¹⁾			-0.125*** (0.015)	-0.120*** (0.016)
Inflation, consumer prices (annual %) ⁽⁻¹⁾				-0.001 (0.001)
Net official development assistance and official aid received (% of GDP) ⁽⁻¹⁾				-0.011 (0.019)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	3,918	3,875	3,323	2,344
Number of countries	175	173	165	134
R-squared	0.103	0.110	0.156	0.196

Notes: The table reports results for regressions using as dependent variable non-resource tax revenues excluding grants and social contributions over GDP with as independent variables an outcome based measure of liberalization that is the sum of exports and imports of goods and services excluding natural resource exports over GDP as well as several controls. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

B.3. Appendix: First Stage of the Two Stage Least Square Estimation

Table B.3.1: Trade Liberalization and Aggregate Tax Revenues—First Stage Regression

Sachs-Warner/Wacziarg-Welch index of liberalization ⁽⁻¹⁾	(1)	(2)	(3)	(4)
Sachs-Warner/Wacziarg-Welch index of liberalization ⁽⁻²⁾	0.811***	0.797***	0.780***	0.793***
	(0.014)	(0.014)	(0.016)	(0.018)
Distance-weighted growth open Economies ⁽⁻²⁾	-0.438*	-0.683***	-0.681***	-0.540*
	(0.231)	(0.246)	(0.258)	(0.325)
Distance-weighted growth closed Economies ⁽⁻²⁾	0.003	0.022	0.020	-0.165
	(0.170)	(0.175)	(0.185)	(0.222)
Distance-weighted average openness ⁽⁻²⁾	0.067*	0.059	0.045	0.073
	(0.038)	(0.039)	(0.043)	(0.053)
Real GDP growth (Annual percent change) ⁽⁻¹⁾		0.002***	0.002**	0.002**
		(0.001)	(0.001)	(0.001)
Agriculture, value added (% of GDP) ⁽⁻¹⁾			0.003***	0.004**
			(0.001)	(0.002)
Inflation, consumer prices (annual %) ⁽⁻¹⁾				0.000***
				(0.000)
Net official development assistance and official aid received (% of GDP) ⁽⁻¹⁾				0.003**
				(0.001)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	1,999	1,912	1,678	1,153
Number of countries	100	100	94	66
F-stat	219.1	202.0	146.2	100.0
R-squared	0.773	0.767	0.738	0.752

Notes: The table reports results for the first stage regression corresponding to the second stage when using as dependent variable tax revenues excluding grants and social contributions over GDP with as independent variable SW/WW liberalization indicator as well as several controls. The first stage uses as dependent variable SW/WW trade liberalization indicator regressed on a set of variables based on learning from neighbors derived from the reduced-form specification presented in Buera et al. (2011). The *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table B.3.2: Trade Liberalization and Non-Resource Tax Revenues—First Stage Regression

Sachs-Warner/Wacziarg-Welch index of liberalization ⁽⁻¹⁾	(1)	(2)	(3)	(4)
Sachs-Warner/Wacziarg-Welch index of liberalization ⁽⁻²⁾	0.803*** (0.013)	0.789*** (0.014)	0.778*** (0.016)	0.782*** (0.019)
Distance-weighted growth open Economies ⁽⁻²⁾	-0.430* (0.234)	-0.663*** (0.250)	-0.528** (0.267)	-0.369 (0.368)
Distance-weighted growth closed Economies ⁽⁻²⁾	-0.032 (0.168)	-0.008 (0.173)	-0.079 (0.185)	-0.326 (0.232)
Distance-weighted average openness ⁽⁻²⁾	0.113*** (0.035)	0.117*** (0.036)	0.111*** (0.040)	0.111** (0.052)
Real GDP growth (Annual percent change) ⁽⁻¹⁾		0.002** (0.001)	0.002** (0.001)	0.001 (0.001)
Agriculture, value added (% of GDP) ⁽⁻¹⁾			0.002* (0.001)	0.004** (0.002)
Inflation, consumer prices (annual %) ⁽⁻¹⁾				-0.000 (0.000)
Net official development assistance and official aid received (% of GDP) ⁽⁻¹⁾				0.004** (0.002)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	2,117	2,035	1,698	1,141
Number of countries	99	99	93	66
F-stat	233.9	219.1	160.0	103.7
R-squared	0.773	0.769	0.753	0.761

Notes: The table reports results for the first stage regression corresponding to the second stage when using as dependent variable non-resource tax revenues excluding grants and social contributions over GDP with as independent variable SW/WW liberalization indicator as well as several controls. The first stage uses as dependent variable SW/WW trade liberalization indicator regressed on a set of variables based on learning from neighbors derived from the reduced-form specification presented in Buera et al. (2011). The *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

B.4. Appendix: Tax Revenues and Trade Liberalization—Before and After VAT Implementation

Table B.4.1: Trade Liberalization and Aggregate Tax Revenue—VAT Adoption

	Liberalization after VAT adoption				Liberalization before VAT adoption			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Revenues excluding grants and social contributions to GDP								
Sachs-Warner/Wacziarg-Welch index of liberalization ⁽⁻¹⁾	-0.285 (0.549)	-0.409 (0.553)	0.030 (0.528)	-0.775* (0.427)	-1.261*** (0.300)	-1.566*** (0.312)	-1.786*** (0.364)	-0.415 (0.437)
Real GDP growth (Annual percent change) ⁽⁻¹⁾		0.092** (0.036)	0.069** (0.034)	0.058* (0.030)		0.081*** (0.020)	0.075*** (0.022)	0.022 (0.028)
Agriculture, value added (% of GDP) ⁽⁻¹⁾			-0.213*** (0.041)	-0.152*** (0.038)			-0.155*** (0.024)	-0.052 (0.032)
Inflation, consumer prices (annual %) ⁽⁻¹⁾				-0.000 (0.001)				-0.000 (0.000)
Net official development assistance and official aid received (% of GDP) ⁽⁻¹⁾				-0.067 (0.044)				-0.021 (0.025)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	607	590	541	499	1,440	1,391	1,153	697
Number of countries	33	33	31	29	69	69	65	42
R-squared	0.123	0.137	0.163	0.133	0.053	0.058	0.089	0.076

Notes: The table reports results for regressions using as dependent variable tax revenues excluding grants and social contributions over GDP with as independent variable SW/WW liberalization indicator as well as several controls for observations including liberalization either prior to or following VAT adoption. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table B.4.2: Trade Liberalization and Non-Resource Tax Revenue—VAT Adoption

Non-resource tax revenues excluding social contributions to GDP	Liberalization after VAT adoption				Liberalization before VAT adoption			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sachs-Warner/Wacziarg-Welch index of liberalization ⁽⁻¹⁾	-0.189	-0.200	0.184	-0.330	-1.606***	-1.882***	-1.684***	-0.651*
	(0.320)	(0.326)	(0.288)	(0.270)	(0.244)	(0.250)	(0.280)	(0.352)
Real GDP growth (Annual percent change) ⁽⁻¹⁾		0.030	0.013	-0.008		0.077***	0.089***	0.041*
		(0.020)	(0.019)	(0.019)		(0.017)	(0.017)	(0.023)
Agriculture, value added (% of GDP) ⁽⁻¹⁾			-0.081***	-0.050**			-0.144***	-0.055**
			(0.023)	(0.024)			(0.019)	(0.026)
Inflation, consumer prices (annual %) ⁽⁻¹⁾				-0.000				0.002
				(0.000)				(0.002)
Net official development assistance and official aid received (% of GDP) ⁽⁻¹⁾				-0.081***				0.000
				(0.029)				(0.026)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	644	628	562	508	1,548	1,490	1,142	668
Number of countries	33	33	31	29	68	68	64	42
R-squared	0.072	0.079	0.072	0.064	0.066	0.077	0.139	0.166

Notes: The table reports results for regressions using as dependent variable non resource tax revenues excluding grants and social contributions over GDP with as independent variable SW/WW liberalization indicator as well as several controls for observations including liberalization either prior to or following VAT adoption. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

PART II: POLITICAL INSTABILITY AND ITS EFFECTS ON TAX REVENUE

« On a beau prodiguer des conseils à l'homme stupide, il ne les écoute jamais. » ~
Proverbe malien.

3. Chapter III: Contagious protests

This chapter is a joint work with Rabah Arezki (AFDB and Kennedy School of Government), Simeon Djankov (London School of Economics and Peterson Institute for International Economics), and Ha Nguyen (World Bank).

A slightly different version is published as a world Bank Policy Research Working Paper and is under review at the Economic Journal.

Abstract

This paper explores the spillover of protests across countries using data on nonviolent and spontaneous demonstrations for 200 countries from 2000 to 2020. Using an autoregressive spatial model, the analysis finds strong evidence of “contagious protests,” with a catalyzing role of social media. In particular, social media penetration in the source and destination of protests leads to protest spillovers between countries. There is evidence of parallel learning between streets of nations alongside the already documented learning between governments.

Keywords: street protest; contagion; social media.

JEL Codes: C21, D74, D8, E71.

3.1. Introduction

History provides examples of media incentivizing street protests, which spread across borders. The popular discontent that ended communism in Eastern Europe began in Poland in the early 1980s and swept through Hungary, East Germany, Bulgaria, Czechoslovakia, and Romania. Radio Free Europe played a critical role as a vehicle for the spread of the information about protests and catalyzed its spillovers across borders (Puddington 2000), as did a network of radio stations of the Catholic Church (Stehle 1982). Fast forward 30 years to the wave of street protests that sparked the Arab Spring in 2011 following the death of a Tunisian street vendor who set himself ablaze— after having been harassed and humiliated by municipal officials. These protests established social media as the new conduit for the spread of protests. In 2019, a second wave of protests that started in Sudan and Algeria spread to other Arab countries, including the Arab Republic of Egypt, Lebanon and Iraq, eventually resulting in a global contagion of protests spanning from Chile to the Russian Federation to Hong Kong SAR, China. Just as the global pandemic put a damper on street protests, the death of George Floyd in US police custody powered a global protest movement against police brutality and racial injustice. Again, social media was the main channel of protest engagement.

In this paper we systematically explore spillovers of spontaneous street protests across countries, with social media acting as the catalyst. We use data on nonviolent and unorganized demonstrations for 200 countries for the period 2000 to 2020. Using an autoregressive spatial model, we find strong evidence for contagious protests with a catalyzing role of social media. Social media penetration in the source and destination of protests leads to protest spillovers between countries. There is evidence for parallel learning between streets of nations alongside the previously documented learning between governments.

Our research is related to three strands of previous work. First, our paper is related to the emerging literature on social media and protests. Battaglini (2017) argues that protests are a way to signal private information to policy makers, in which social media is a good medium for policy makers to aggregate information. A field experiment in Hong Kong SAR shows that one's turnout decision depends on others' turnout decisions (Cantoni *et al.*, 2019). Broadband internet is shown to be positively associated with local online grassroots protest movements in Italy (Campante *et al.*, 2018). The diffusion of VK, Russia's dominant online social network, increased protest turnout in Russia (Enikolopov *et al.*, forthcoming). Where internet coverage is low, such as in Africa, mobile phones' diffusion increased protest turnout (Manacorda and Tesei, 2020).

Our paper is also related to the literature on learning and networks. Buera *et al.* (2011) study how countries learn from the successes of neighbors' past economic policies. Chen and Suen (2016) theorize that a successful revolution could lead to revisions in beliefs of both protesters and governments and hence may lead to a series of revolutions in other countries. König *et al.* (2017) examine how networks (of military alliances and enmities) affect the intensity of the conflict in the Democratic Republic of Congo. Harari and Ferrara (2018) examine how local conflicts in one gridded cell in Africa spill over to neighboring cells.

A strand of the literature studies spillovers from protests. Several papers have documented that protests in Tunisia and Egypt have inspired protesters elsewhere (Bamert *et al.*, 2015; Hale 2013; Lynch, 2013; Saidemand, 2012). Similar spillovers were observed from other revolutionary periods, such as the Eastern European democratization in the 1990s and the revolutionary wave of 1848 in Europe (Hale, 2013; Weyland, 2010, 2012).

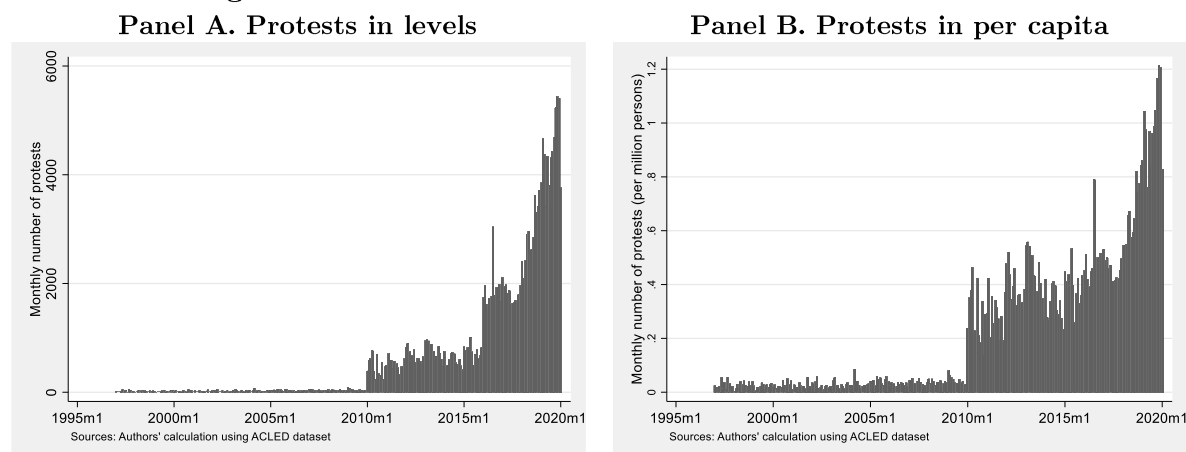
The remainder of the paper is organized as follows. Section 3.2 presents the data and the empirical strategy. Section 3.3 shows the results. Section 3.4 presents robustness checks. Section 3.5 concludes.

3.2. Data and Empirical Strategy

Data on protests are from the Armed Conflict Location & Event Data (ACLED) Project. Protests are defined in the data set as “non-violent demonstrations, involving typically unorganized action by members of society.” This category covers peaceful protests, protests with interventions (e.g. arrests), and protests in which excessive force was used against protesters (e.g. causing injuries and deaths). Note that this definition does not include violent demonstrations and mob violence. The data coverage starts in 1997 but is severely imbalanced, rendering difficult the use of earlier years to conduct the spatial analysis. We aggregate the number of protests at the monthly (and quarterly) level.

Figure 3.1 shows the evolution of the number of protests at a monthly frequency as recorded by ACLED—in absolute number (Panel A) and in per million capita (Panel B). Note that starting in 2010 and subsequent years more countries were added to the data set—see Table C.1.1 for the list of countries included in the data set. That explains the big jump in the series in the year 2010. We hence restrict our sample to start in January 2010 when using the ACLED dataset.⁵⁴

⁵⁴ Note that for countries added to the data set after 2010, we consider these country-year pairs as missing observations (and not zeros) before they are added to the data set. However, our results remain robust when using data from ACLED starting in January 1997.

Figure 3.1: Evolution of the Total Number of Protests

For the sample starting in January 2010 to January 2020, the average number of protests per month per country is 21. In 34 percent of country-month pairs (2,910 of 8,549), there is no occurrence of protest. Figure C.5.1 presents the histogram of the entire distribution of available occurrence of protests from ACLED see Table C.1.3 for summary statistics of actual protests). The distribution supports the use of the Zero-Inflated Poisson estimator, which we discuss in the next section.

We construct an alternative measure of protests capturing the intensity of media chatter around protests. The rationale for the news-based measure of protests is first and foremost that it allows to significantly expand the scope of the data on protests over space and time. This measure accounts for the saliency of specific protests. For instance, a protest sparked by a popular figure is likely reported and discussed more extensively in the news media. The news data are from Dow Jones FACTIVA, which is a global repository of over one billion articles published across the world and reported in 28 different languages. For each language, the following words are translated: (i) “street” and (ii) “protests” or “protest”. The search for each language is constructed such that the word “street” and at least one relating to “protest” appear. For example, in English, the precise search query is: [(“street”) AND (“protest” OR “protests”)].

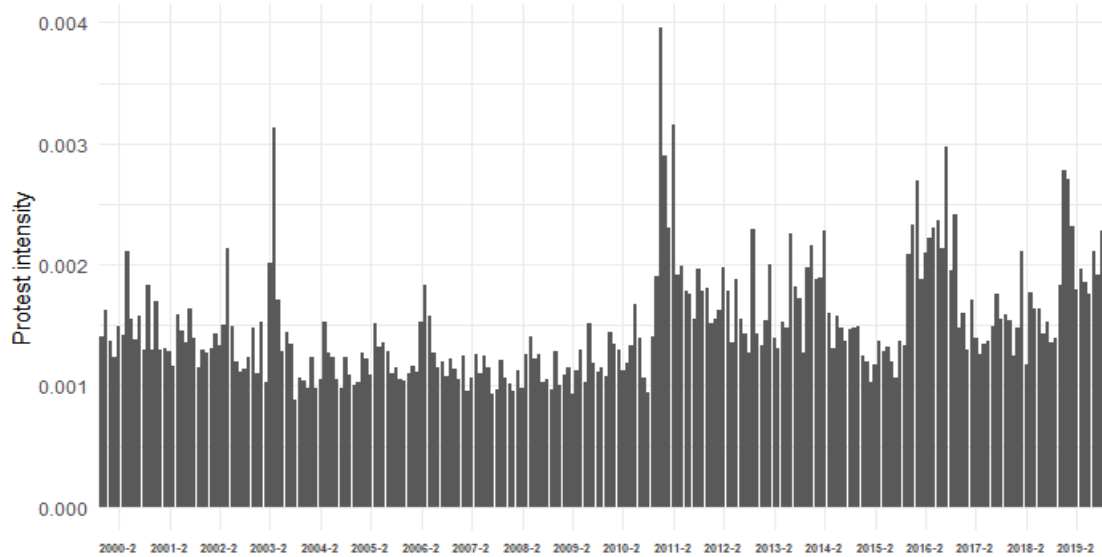
This search is performed for all countries and all languages in the Dow Jones database, over the period from January 1, 2000 to December 31, 2019. In addition, we gather the number of total articles in the Dow Jones FACTIVA for each country and each month. A measure of normalized article counts is then constructed by taking the ratio between the number of articles mentioning “street protests” and the total number of articles for each country-month pair multiplied by 100. Formally, for country i in month t the intensity of media chatter around protests is as follows:

$$News_Protest_{i,t} = \frac{\textit{street protest article count}_{i,t}}{\textit{total article count}_{i,t}} \times 100$$

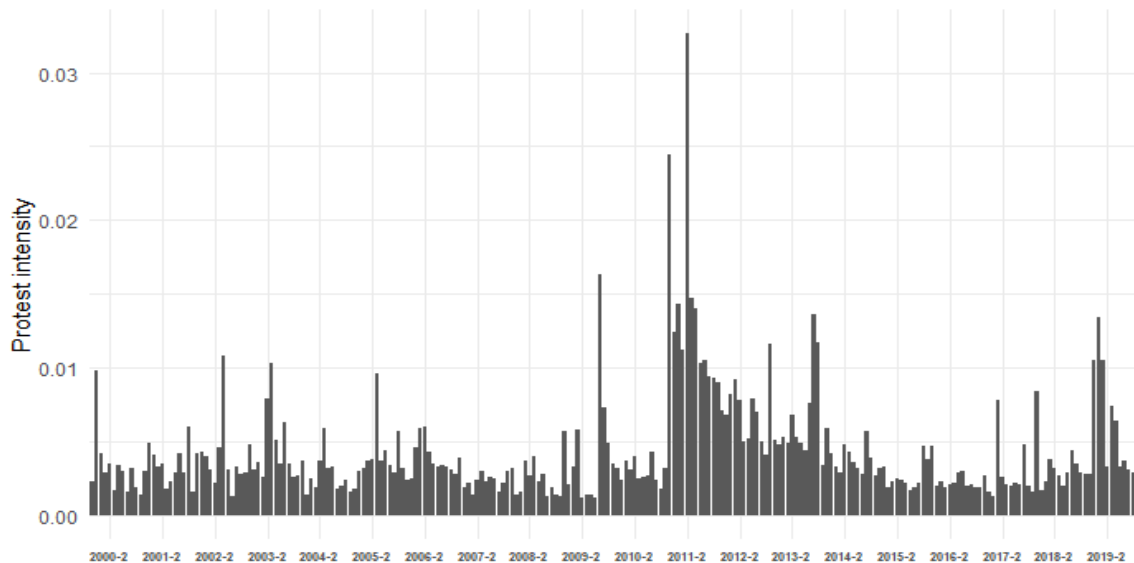
The news-based protest data provide us with a balanced panel for 207 countries from January 1, 2000 to December 31, 2019 (see Table C.1.2 for the list of countries). The coverage is more comprehensive than for ACLED and allows us to exploit time and space variation. Figure C.5.2 presents the histogram of the entire distribution of news-based protests. In 33.4 percent of country-month pairs (16,568 of 49,678), there is zero news about protest (see Table C.1.3 for summary statistics). The distribution is also skewed toward zero, which supports the use of the Zero-Inflated Poisson estimator.

The evolution of the measure is presented in Figure 3.2 in monthly frequency (Panel A). We also illustrate the evolution of the measure for countries in the Middle East and North Africa (Panel B). Both panels show a clear uptick in the chatter about protests around the Arab Spring in 2011 and the second wave of protests that started in 2019. The uptick in Panel A around 2003 reflects global protests against the war in Iraq.

Figure 3.2: News-Based Measure of Street Protests
Panel A. Global Perspective



Panel B. Middle East and North Africa countries

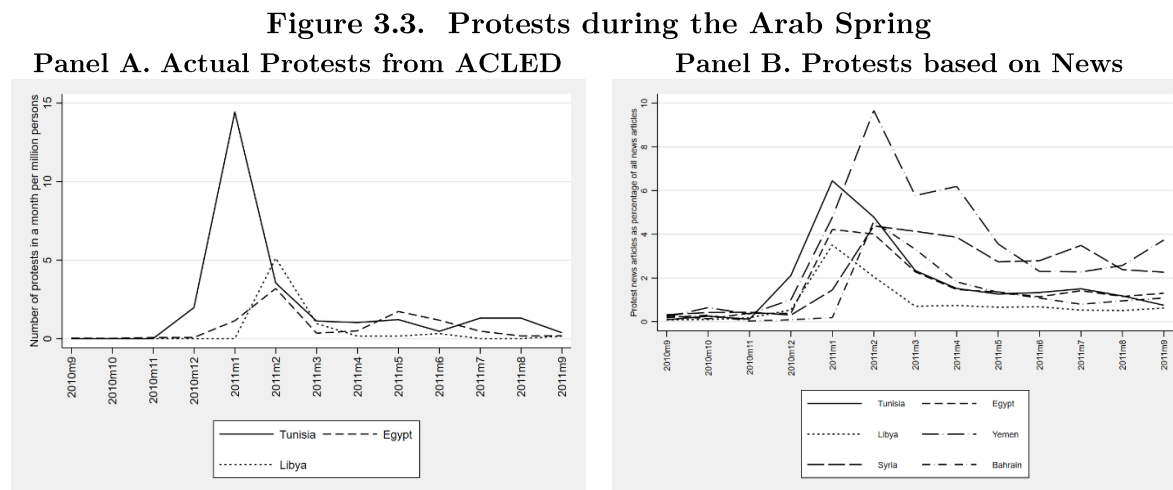


Sources: Dow Jones Factiva and authors' own calculations.

Note: Middle East and North Africa region includes Algeria, Bahrain, Djibouti, the Arab Republic of Egypt, the Islamic Republic of Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, the Syrian Arab Republic, Tunisia, United Arab Emirates, West Bank and Gaza, and the Republic of Yemen.

We next compare the ACLED account of actual protests (Panel A in Figure 3.3) with our alternative source of protests based on news (Panel B in Figure 3.3) around the time of the Arab Spring. Panel A in Figure 3.3 shows a spike in the number of protests—plotted as the number of protests in per capita terms—in Tunisia, which occurred after the death of Mohamed Bouazizi on December 17, 2010. Panel B in Figure 3.3 confirms the spike in the news about protests in Tunisia around that period. The protest quickly spread from Tunisia to Bahrain, Egypt, Libya, the Syrian Arab Republic, and the Republic of Yemen. The availability of data from ACLED limits us

to Egypt and Libya only. Panel A in Figure 3.3 confirms that both Egypt and Libya experienced spikes in actual protests following Tunisia's unrest. The news-based measure appears to be a good proxy to the actual protest data, which suffer from limitations in terms of coverage.



Source: ACLED, FACTIVE and authors' own calculations.

We use data on social media penetration to explore the role of social media as a catalyst for the spread of protests across country borders. Specifically, we use the number of Facebook subscribers as a fraction of the population to capture social media penetration in a country. Among different platforms of social media, Facebook accounts for the lion's share in pretty much all regions in the world (see Appendix C.6).⁵⁵ In previous anecdotal studies, Facebook use was found in different studies to be linked with protest activity (see Valenzuela *et al*, 2012 for the case of Chile and for Egypt see New York Times, 2011). A preliminary look at the data suggests a correlation between protests and Facebook penetration (see Appendix C.7). In particular, the cross-country correlation between Facebook penetration and the average number of monthly protests (per million persons) is 0.41.

To capture the role of other potential catalysts for protests, we use a variety of other measures. Polity data are from the Polity IV project, which gathers information about authority characteristics of states for 195 countries. Polity IV provides a democracy index ranging from -10 to 10. We use the average value of the democracy index over the period 1997 to 2018 to create a dummy variable on *Common Polity*. The dummy takes the value of 1 if the average democracy index is above 0, and the dummy takes the value of 0 otherwise. Two countries are considered "close" in terms of polity if the dummy for each country takes the same value. Corruption data are from Transparency international's Corruption Perception Index (CPI). The data cover 189 countries. The

⁵⁵ China is an important exception where Facebook and other global platforms have been blocked. Facebook was banned after June 2009 riots in Western China when the platform was used among protesters.

Common Corruption dummy takes the value of 1 if both countries under consideration are relatively corrupt, i.e., the corruption indices of both countries for the last two years are less than the median value. Table C.1.3 presents summary statistics of actual protests, news-based protests, polity IV, corruption perception index, and social media penetration in 2018.

We next present the test as to whether protests in period, $t-1$, in the rest of world (i.e., for all other countries j in the rest of the world) lead to protests in the current period, t , in country i . The number of protests per capita is skewed to the left, with a majority of countries having no protest (see Table C.1.3).

The framework is an autoregressive spatial model following Lesage and Pace (2009). The Zero-Inflated Poisson (ZIP) model mixes two zero generating processes. The first process generates zeros. The second process is governed by a Poisson distribution with an estimation as follows:

$$y_t = \exp(\rho W y_{t-1} + \delta I y_{t-\tau} + FE_i + FE_t + u_t). \quad (\text{eq. 3.1})$$

where y_t is an N-by-1 vector that contains the number of protests *per capita* in N countries at current month t . y_{t-1} is an N-by-1 vector that contains the number of protests *per capita* in N countries in the past month. In subsequent robustness checks, we use quarterly frequency instead of monthly. In addition to the Zero-Inflated Poisson estimator, we use the standard Poisson as an alternative estimator. We also use an alternative measure of protests based on the intensity of media chatter around protests.

W is an N-by-N spatial weight matrix that captures geographic proximity between countries. In the baseline specification, we measure the spatial spillovers using geographical distance. The diagonal elements are zero. The off-diagonal elements are the inverse of the distance between country capitals (i.e., $\frac{1}{\text{distance}_{i,j}}$). Next, the weight matrix is standardized so that the sum of row is unity. ρ captures the importance of spatial dependence in protest spillover from foreign countries. I is an N-by-N identity matrix. δ^τ captures the autoregressive effects of domestic protests *per capita* in previous months. FE_i and FE_t are vectors of country and month fixed effects. Data on distance and language are obtained from CEPII.

To account for the role that social media could play as a catalyst for protests, we use information about social media penetration in both source and destination of protests. Specifically, we test whether source countries with higher social media penetration are more likely to send stronger protest spillover to other countries. The econometric specification is as follows:

$$y_t = \exp(\rho Z y_{t-1} + \delta I y_{t-1} + FE_i + FE_t + u_t) \quad (\text{eq. 3.2})$$

The only difference between (3.1) and (3.2) is the spatial weight matrix. Z now is also an N-by-N spatial weight matrix but is different from W . The diagonal elements are zero. The off-diagonal elements are the inverse of the distance multiplied by common social media penetration (i.e., $\frac{1}{distance_{i,j}} \times common\ social\ media_{i,j}$). The weight matrix is then also standardized so that the sum of row is unity. The idea is to account for protests in countries with a common level of social media penetration. $common\ social\ media_{i,j}$ is a dummy which takes the value of 1 if both countries i and j have relatively large penetration of social media and 0 if at least one country's social media penetration is below that threshold. The hypothesis we test is that the set of countries subject to potential protest spillover is limited to countries with social media penetration beyond a certain threshold.

To account for similarities between political systems and other factors that could play an important role in driving spillovers, we use the following dummies in the estimation:

- *Common Polity* $_{i,j}$ is a dummy which takes the value of 1 if country i and country j are either both democracies or both autocracies. The hypothesis we want to test is whether protest spillovers take place between countries with “close” polity.
- *Common Corruption* $_{i,j}$ is a dummy which takes the value of 1 if both countries i and j have a high level of corruption. The hypothesis we want to test is whether protest spillovers take place between countries with “close” levels of perceived corruption.
- *Common Language* $_{i,j}$ is a dummy which takes the value of 1 if both countries i and j have the same language. The hypothesis we want to test is whether protest spillovers take place between countries with similar languages.

3.3. Results

The results for geographic proximity point to statistically insignificant protest spillovers from neighboring countries for both measurement of geographic proximity (see columns [1] and [2] of Table 3.1). Column [1] captures the spillovers of protests from neighboring countries (i.e., sharing borders) where protests are measured as the simple average of the number of protests per million capita. After controlling for domestic protests in the previous months, protests in neighboring countries are found to have a statistically insignificant effect on protests in the country under consideration. Similarly, column [2] indicates that the spillovers from inverse distance-weighted global protests in the previous months are statistically insignificant.

Table 3.1: Contagion, Distance and Social Media—Actual Protests

Zero-Inflated Poisson	Protests per million persons (t)				
	Distance Only		Distance*Common Social Media		
			Social Media Penetration Threshold		
			> 10%	> 20%	> 30%
	[1]	[2]	[3]	[4]	[5]
Protests pc (t-1)	0.033*** (0.006)	0.031*** (0.004)	0.031*** (0.004)	0.032*** (0.004)	0.032*** (0.004)
Neighbor's simple average protests pc*(t-1)	0.012 (0.015)				
Inverse-distance weighted protests pc*(t-1)		0.022 (0.022)			
Inverse-Distance-Common Social Media weighted Protest pc*(t-1)			0.030 (0.026)	0.044* (0.023)	0.047** (0.022)
Constant	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	7,728	8,256	5,340	3,324	2,652
Number of countries	92	97	67	47	40
N_zero	2776	2822	1584	781	626
Chi-square	18514	22090	16763	11038	9742
Log likelihood	-5150	-5865	-4595	-3466	-2836

Note: Robust standard errors in parentheses (**p<0.01, ** p<0.05, * p<0.1). Protests pc captures the number of protests per million persons. * denotes foreign protests. In columns [3],[4],[5], the threshold for a country to be defined to have large Facebook penetration is 10%, 20% and 30% respectively. Data are from January 2010 to January 2020.

The effects of protest spillovers become significant when the commonality in social media penetration between countries is considered as well. Columns [3],[4],[5] of Table 3.1 differ in the threshold of the definition for large social media penetration. In column [3], a country is defined to have large social media penetration if it has more than 10% of its population subscribed to Facebook in 2018. In columns [4] and [5], the threshold is 20% and 30% respectively. The dummy *common social media*_{i,j} takes the value of 1 if both countries have large social media penetrations and 0 otherwise.

The larger the threshold, the smaller the number of countries included in the sample— which by construction only includes countries with social media above the threshold. We can interpret the results as protest spillovers within a selected number of “connected” countries with high social media penetration. The three columns show that commonality in social media penetration between source and destination country of protests plays an important role in protest spillovers. The coefficients for (inverse distance-social media) weighted average global protests in the previous month now are statistically significant. The coefficient is more significant with larger magnitude for

larger common social media thresholds, and largest at the 30% threshold (see column [5]).⁵⁶

The coefficient of 0.047 implies that a one standard deviation increase in foreign protests, which is 3.1 more protests per million persons, leads to 1.15 more domestic protests per million persons. This is 37% of the standard deviation of a country's monthly protests. To put this in perspective, at the onset of the Arab Spring, protests in Tunisia jumped from zero in November 2010 to close to 15 protests per million persons in January 2011, which is 5 times the standard deviation of protests in our sample.

Social media is found to play a significant role in driving spillover of protests using the news-based measure. News-based protest about neighboring countries in the previous month has statistically significant effect on current month domestic news-based protest (see Column [1] of Table 3.2), but global protest using inverse distance-weighted in previous month has statistically insignificant effect (Column [2]). We observe large and consistent news-based protest spillovers for countries with strong media penetrations. This is true for all three thresholds of social media (columns [3] to [5]). The coefficient of 0.912 in column [5] implies that one standard deviation increase in previous month's foreign news-based protests, which is 0.632 percentage point increase, leads to a 1.78 percentage points increase in the contemporaneous month of its own news-based protests. This is equivalent to about 3 times the standard deviation of news-based protests.^{57,58} Our results are consistent with the social media being a catalyst for both push and pull factors behind protests, i.e. social media makes it much easier for protesters in one country to raise their voice, and for sympathizers in other countries to read, learn and emulate.

⁵⁶ When we run the regressions with distance alone on the samples in columns [3],[4],[5], the coefficients of foreign protests (per million persons) are not significant (Table C.2.1). Appendix C.3 shows that our main results are robust to using an earlier cross-section of data for [Facebook penetration](#) for the year 2010 for 61 countries for both actual protests (Table C.3.1) and news-based protests (Table C.3.2).

⁵⁷ Note that changes in sample size are not driving the significance of the role of social media. Indeed, Appendix Table C.2.2 shows that coefficients associated with distance-weighted foreign protests remain insignificant and are smaller when using the samples presented in Columns [3] to [5] in Table 3.1.

⁵⁸ The samples used in Columns [3] to [5] in Table 3.1 only include countries above the social media thresholds—weights are not defined otherwise. Results remain robust when we impose undefined weights as zeros when countries having relatively low social media penetration are included in the samples (Appendix C.4).

Table 3.2: Contagion, Distance and Social Media—News based Protests

Zero-Inflated Poisson	News-based protests				
	Distance Only		Distance*Common Social Media		
			Social Media Penetration Threshold		
			> 10%	> 20%	> 30%
	[1]	[2]	[3]	[4]	[5]
News-based protests(t-1)	0.238*** (0.014)	0.160*** (0.012)	0.234*** (0.014)	0.374*** (0.021)	0.372*** (0.022)
Neighbor's simple news-based protests*(t-1)	0.098*** (0.034)				
Inverse distance weighted news-based protests*(t-1)	0.128 (0.152)				
Inverse-Distance-Common Social Media weighted News-based protests*(t-1)			0.889*** (0.137)	0.872*** (0.155)	0.912*** (0.156)
Constant	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	36,806	49,469	31,348	26,218	24,318
Number of countries	154	207	165	138	128
N_zero	8045	16469	9050	7273	6495
Chi-square	26983	23141	29855	17864	17386
Log likelihood	-16695	-22067	-12989	-10529	-9772

Note: Robust standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). *News-based protests* captures the number of articles mentioning street protests in a country as percentage of total number of articles covering the country. * denotes foreign *news-based protests*. In columns [3],[4],[5], the threshold for a country to be defined to have large Facebook penetration is 10%, 20% and 30% respectively. Since Facebook was launched in 2004, data in these 3 columns are restricted from January 2004 to December 2019.

We examine the role of Polity characteristics, Corruption level and Language in protest spillovers. They are found to play an insignificant role in the spillover of actual protests (Columns [1] to [3] of Table 3.3), except for the spillover of news-based protests where they have some importance (columns [4] to [6]).

Table 3.3: Contagion, Polity, Corruption, and Language

Zero-Inflated Poisson	Protests per million persons			News-based protests		
	[1]	[2]	[3]	[4]	[5]	[6]
Protest <i>pc</i> (t-1)	0.031*** (0.005)	0.031*** (0.005)	0.032*** (0.004)			
News-based protests (t-1)				0.236*** (0.013)	0.234*** (0.014)	0.164*** (0.012)
Inverse-distance-Common Polity weighted Protest <i>pc</i> *(t-1)	0.009 (0.018)					
Inverse-distance-Corruption weighted Protest <i>pc</i> *(t-1)		0.002 (0.015)				
Inverse-distance-Common Language weighted Protest <i>pc</i> *(t-1)			0.018* (0.010)			
Inverse-distance-Common Polity weighted news-based protests*(t-1)				0.467*** (0.078)		
Inverse-distance-Corruption weighted news-based protests*(t-1))					0.224*** (0.074)	
Inverse-distance-Common Language weighted news-based protests*(t-1)						0.174*** (0.051)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,184	6,048	6,936	38,718	18,499	41,582
Number of countries	95	72	76	162	124	174
N_zero	2822	2117	2602	8241	4023	14946
Chi-square	21384	13219	18698	31139	19957	19197
Log likelihood	-5697	-3658	-4730	-509.1	-289.6	-527.0

Note: Robust standard errors in parentheses (***) $p < 0.01$, (**) $p < 0.05$, (*) $p < 0.1$). *Protests pc* capture the number of protests per million persons. *News-based protests* captures the number of articles mentioning street protests in a country as percentage of total number of articles covering the country. * denotes foreign.

Regarding the news discussions of street protests, polity, corruption, and common language are found to have significant effects on the spillover of global protest discussions. Between them, *Common Polity* seems to have the largest effects (columns [4] to [6] of Table 3.3). The coefficient of 0.467 implies that one standard deviation increase in previous month’s foreign news-based protests, which is 0.632 percentage point increase, leads to 1.34 percentage points increase in the contemporaneous month of its own news-based protests.

3.4. Robustness Checks

We conduct several robustness checks. First, we examine protest spillover at the quarterly frequency. Second, we employ the Standard Poisson estimator. Our results are robust to these checks.

We find that the spillovers are weaker when using quarterly frequency. This is true for both measures of protests. Table 3.4 shows that past foreign protests, even with large social media penetration, are no longer having spillover effects on domestic protests (columns [1] to [3] of Table 3.4). The coefficients remain positive but are not statistically significant.

In terms of news-based protests, foreign protests are found to have statistically significant spillover effects on domestic protests at all three thresholds of social media penetration (see columns [4] to [6]). This finding could reflect the stronger tendency for news-based protests to spread than actual protests do. However, the coefficients associated with the effects for the last quarter’s discussions about foreign protests are smaller than those of the last month’s (see Table 3.2 for a comparison). The effect using quarterly frequency tends to “dilute” the effect captured at the monthly frequency.

Table 3.4: Contagion, Distance, and Social Media—Quarterly Frequency

Zero-Inflated Poisson	Protests per million persons			News-based protests		
	[1]	[2]	[3]	[4]	[5]	[6]
Social Media Penetration Threshold	> 10%	> 20%	> 30%	> 10%	> 20%	> 30%
Protest pc (t-1)	0.010*** (0.002)	0.010*** (0.002)	0.010*** (0.002)			
News-based protests (t-1)				0.193*** (0.032)	0.413*** (0.033)	0.412*** (0.035)
Inverse-distance-Common Social Media weighted Protest pc*(t-1)	0.039 (0.029)	0.040 (0.025)	0.038 (0.024)			
Inverse-distance-Common Social Media weighted news-based protests*(t-1)				0.440** (0.208)	0.536** (0.237)	0.662*** (0.233)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,780	1,108	884	10,395	8,694	8,064
Number of countries	67	47	40	165	138	128
N_zero	310	174	145	1813	1477	1291
Chi-square	11224	7293	6535	14666	8477	8142
Log likelihood	-2805	-2117	-1751	-4286	-3466	-3224

Note: Robust standard errors in parentheses (***) p<0.01, ** p<0.05, * p<0.1). *Protests pc* capture the number of protests per million persons. Data are from January 2010 to January 2020. *News-based protests* captures the number of articles mentioning

street protests in a country as percentage of total number of articles covering the country. Since Facebook was launched in 2004, data in columns [4] to [6] are restricted from January 2004 to December 2019. *denotes foreign.

We also test the presence for spillover of last month’s foreign protests in both actual protests and news-based protests, using the Standard Poisson estimator. A standard Poisson estimator is less suitable to the Zero-Inflated Poisson Estimator because the former does not address the issue of excessive zeros in the dependent variable. Nevertheless, the standard Poisson estimator yields a similar magnitude for the actual protest spillovers to that by the Zero-Inflated Poisson Estimator (see columns [2] and [3] of Table 3.5). The Standard Poisson Estimator also yields similar magnitude for the spillover of news-based protests (columns [4] to [6] of Table 3.5). At all thresholds of common social media, the coefficients are significant.

Table 3.5: Contagion, Distance, and Social Media—Poisson Estimator

Zero-Inflated Poisson	Protests per million persons			News-based protests		
	[1]	[2]	[3]	[4]	[5]	[6]
Social Media Penetration Threshold	> 10%	> 20%	> 30%	> 10%	> 20%	> 30%
Protest pc (t-1)	0.031*** (0.001)	0.032*** (0.002)	0.032*** (0.002)			
News-based protests (t-1)				0.234*** (0.020)	0.374*** (0.027)	0.372*** (0.028)
Inverse-distance-Common Social Media weighted Protest pc*(t-1)	0.029 (0.032)	0.031*** (0.028)	0.046* (0.026)			
Inverse-distance-Common Social Media weighted news-based protests*(t-1)				0.889*** (0.175)	0.872*** (0.214)	0.912*** (0.219)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,340	3,324	2,652	31,348	26,218	24,318
Number of countries	67	47	40	165	138	128
Chi-square	221625	397000	164076	117912	33160	53553
Log likelihood	-4418	-3339	-2729	-12563	-10174	-9443

Note: Robust standard errors in parentheses (***) p<0.01, ** p<0.05, * p<0.1). *Protests pc* capture the number of protests per million persons. *News-based protests* captures the number of articles mentioning street protests in a country as percentage of total number of articles covering the country. Since Facebook was found in 2004, data in columns [4] to [6] are restricted from January 2004 to December 2019. *denotes foreign.

3.5. Conclusions

The frequent shutdown of internet by governments in times of protests illuminates the catalyzing role of social media. Governments often argue that limited social media access is necessary for public safety or curbing the spread of misinformation. It seems, however, that a bigger concern is the organizing role of social media in anti-government protests.

3.6. References

- Bamert J, Gilardi F and Wasserfallen F. 2015. "Learning and the diffusion of regime contention in the Arab Spring," *Research and Politics*: 1-9.
- Battaglini, M. 2017. "Public Protests and Policy Making" *The Quarterly Journal of Economics*, pp 485–549.
- Buera, F, A Monge-Naranjo and G E. Primiceri. 2011. "Learning the Wealth of Nations," *Econometrica*, vol. 79(1), pages 1-45.
- Cantoni, Davide, David Y Yang, Noam Yuchtman, Y Jane Zhang. 2019. "Protests as Strategic Games: Experimental Evidence from Hong Kong's Antiauthoritarian Movement". *The Quarterly Journal of Economics*, Volume 134, Issue 2, May 2019.
- Campante, Filipe, Ruben Durante and Francesco Sobbrío. 2018. "Politics 2.0: The Multifaceted Effect of Broadband Internet on Political Participation." *Journal of the European Economic Association*, 16 (4), pp 1094–1136.
- Chen H. and W. Suen. 2016. "Falling Dominoes: A Theory of Rare Events and Crisis Contagion," *American Economic Journal: Microeconomics*, 8(1), pages 228-255.
- Enikolopov, R., A. Makarin and M. Petrova (forthcoming). "Social Media and Protest Participation: Evidence from Russia." *Econometrica*.
- Hale HE. 2013. "Regime change cascades: What we have learned from the 1848 revolutions to the 2011 Arab uprisings." *Annual Review of Political Science* 16: 331–353.
- Harari, M. and E. La Ferrara, 2018. "Conflict, Climate and Cells: A disaggregated analysis." *The Review of Economics and Statistics* 100(4), p 594-608.
- König, M., D. Rohner, M. Thoenig, and F. Zilibotti. 2017. "Network in conflict: Theory and Evidence from the Great War of Africa". *Econometrica*, Vol. 85, No. 4, 1093–1132.
- Manacorda, M. and A. Tesei. 2020. "Liberation Technology: Mobile Phones and Political Mobilization in Africa." *Econometrica*, 85(4): 533-567.
- LeSage, J. and R. Kelley Pace. 2009. *Introduction to Spatial Econometrics*. Chapman and Hall.
- Lynch M. 2013. *The Arab Uprising: The Unfinished Revolutions of the New Middle East*. New York: Public Affairs.

Puddington, A. 2000. "Broadcasting Freedom: The Cold War Triumph of Radio Free Europe and Radio Liberty".

Saideman SM. 2012. "When conflict spreads: Arab spring and the limits of diffusion." *International Interactions* 38(5): 713–722.

Stehle H. 1982, Church and Pope in the Polish Crisis. *The World Today*, 38 (4) 139-148.

Valenzuela, S, A. Arriagada, and A. Scherman. 2012. "The social media basis of youth protest behavior: The case of Chile." *Journal of communication* 62.2 pp 299-314.

Weyland, K. 2010. "The diffusion of regime contention in European democratization, 1830–1940." *Comparative Political Studies* 43(8-9): 1148–1176.

Weyland K. 2012. "The Arab spring: Why the surprising similarities with the revolutionary wave of 1848?" *Perspectives on Politics* 10(4): 917–934.

C. Appendix to chapter III

C.1. Appendix: Country list and summary statistics

Table C.1.1: Countries included in the ACLED dataset with at least 1 protest

Country	First month in the dataset	Country	First month in the dataset
Afghanistan	1/2017	Libya	1/1997
Albania	1/2018	Madagascar	1/1997
Algeria	1/1997	Malawi	1/1997
Angola	1/1997	Malaysia	1/2018
Armenia	1/2018	Mali	1/1997
Azerbaijan	1/2018	Mauritania	1/1997
Bahrain	1/2016	Moldova	1/2018
Bangladesh	1/2010	Montenegro	1/2018
Belarus	1/2018	Morocco	1/1997
Benin	1/1997	Mozambique	1/1997
Bosnia and Herzegovina	1/2018	Myanmar	1/2010
Botswana	1/1997	Namibia	1/1997
Bulgaria	1/2018	Nepal	1/2010
Burkina Faso	1/1997	Niger	1/1997
Burundi	1/1997	Nigeria	1/1997
Cambodia	1/2010	North Macedonia	1/2018
Cameroon	1/1997	Oman	1/2016
Central African Republic	1/1997	Pakistan	1/2010
Chad	1/1997	West Bank and Gaza	1/2016
Croatia	1/2018	Philippines	1/2016
Cyprus	1/2018	Qatar	1/2016
Congo, Dem. Rep.	1/1997	Congo, Rep.	1/1997
Djibouti	1/1997	Romania	1/2018
Egypt, Arab Rep.	1/1997	Russian Federation	1/2018
Equatorial Guinea	1/1997	Rwanda	1/1997
Eritrea	1/1997	Saudi Arabia	1/2015
Eswatini	1/1997	Senegal	1/1997
Ethiopia	1/1997	Serbia	1/2018
Gabon	1/1997	Sierra Leone	1/1997
Gambia, The	1/1997	Somalia	1/1997
Georgia	1/2018	South Africa	1/1997
Ghana	1/1997	South Sudan	1/1997
Greece	1/2018	Sri Lanka	1/2010
Guinea	1/1997	Sudan	1/1997
Guinea-Bissau	1/1997	Syrian Arab Republic	1/2017
India	1/2016	Tajikistan	1/2018
Indonesia	1/2015	Tanzania	1/1997
Iran, Islamic Rep.	1/2016	Thailand	1/2010
Iraq	1/2016	Togo	1/1997
Israel	1/2016	Tunisia	1/1997
Côte d'Ivoire	1/1997	Turkey	1/2016
Jordan	1/2016	Turkmenistan	1/2018
Kazakhstan	1/2018	Uganda	1/1997
Kenya	1/1997	Ukraine	1/2018
Kosovo	1/2018	United Arab Emirates	1/2016
Kuwait	1/2016	Uzbekistan	1/2018
Kyrgyzstan	1/2018	Vietnam	1/2010
Lao PDR	1/2010	Yemen, Rep.	1/2015
Lebanon	1/2016	Zambia	1/1997
Lesotho	1/1997	Zimbabwe	1/1997
Liberia	1/1997		

Table C.1.2: Countries included in the news-based protest dataset

Afghanistan, Albania, Algeria, Andorra, Angola, Anguilla, Antigua and Barbuda, Argentina, Armenia, Aruba, Australia, Austria, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bermuda, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, British Virgin Islands, Brunei, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Cape Verde, Cayman Islands, Central African Republic, Chad, Chile, China, Colombia, Comoros, Congo Republic, Costa Rica, Cote d'Ivoire, Croatia, Cuba, Cyprus, Czech Republic, Democratic Republic of the Congo, Denmark, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Estonia, Eswatini, Ethiopia, Faroe Islands, Fiji, Finland, France, French Polynesia, Gabon, Gambia, Georgia, Germany, Ghana, Gibraltar, Greece, Greenland, Grenada, Guatemala, Guinea-Bissau, Guinea, Guyana, Haiti, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kiribati, Kuwait, Kyrgyzstan, Laos, Latvia, Lebanon, Lesotho, Liberia, Libya, Lithuania, Luxembourg, Macau, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Marshall Islands, Mauritania, Mauritius, Mexico, Micronesia, Moldova, Mongolia, Montserrat, Morocco, Mozambique, Myanmar, Namibia, Nauru, Nepal, Netherlands, New Caledonia, New Zealand, Nicaragua, Niger, Nigeria, North Korea, North Macedonia, Northern Mariana Islands, Norway, Oman, Pakistan, Palau, Palestine, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Puerto Rico, Qatar, Romania, Russia, Rwanda, Saint Lucia, Samoa, San Marino, Sao Tome and Principe, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Singapore, Slovakia, Slovenia, Solomon Islands, Somalia, South Africa, South Korea, Spain, Sri Lanka, St. Helena, St. Kitts and Nevis, St. Vincent and the Grenadines, Sudan, Suriname, Sweden, Switzerland, Syria, Taiwan, Tajikistan, Tanzania, Thailand, Timor-Leste, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Turks and Caicos Islands, Tuvalu, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan, Vanuatu, Venezuela, Vietnam, Yemen, Zambia, Zimbabwe

Table C.1.3: Summary Statistics

	Protests (per million persons)	Protests news (%)	Corruption Perception Index	Polity IV	Facebook Penetration in 2018 (%)
Number of Obs.	8524	49678	3150	162	192
Mean	0.791	0.197	42.388	3.530	41.738
Std. Dev.	3.118	0.632	20.948	6.105	23.446
Min	0.000	0.000	4	-10	0.211
p10	0.000	0.000	21	-6.909	8.169
p25	0.000	0.000	26	-1.364	18.528
Median	0.116	0.075	36	5.818	47.199
p75	0.554	0.202	55	8.909	60.937
p90	1.643	0.438	76	10	72.615
Max	124.192	57.143	100	10	95.906
Number of Countries	101	207	184	162	192
Unit	Country-Month	Country-Month	Country average	Country average	Country

C.2. Appendix: Contagion and distance using reduced sample

Table C.2.1: Actual Protests using Reduced Sample

	[1]	[2]	[3]
Zero-Inflated Poisson	Protests per million persons (t)		
Social Media Penetration Threshold	> 10%	> 20%	> 30%
Protest pc (t-1)	0.030*** (0.005)	0.031*** (0.004)	0.031*** (0.004)
Inverse-Distance-weighted Protest pc*(t-1)	-0.002 (0.037)	0.042 (0.033)	0.044 (0.033)
Constant	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes
Observations	5,340	3,324	2,652
Number of countries	67	47	40
N_zero	1584	781	626
Chi-square	14778	11188	9926
Log likelihood	-4673	-3470	-2840

Note: This panel reports the regressions on the samples of columns [3] to [5] of Table 3.1. The results point to insignificant effect of the inverse-distance weighted average protests (per million persons). Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). *Protests pc* captures the number of protests per million persons. * denotes foreign protests.

Table C.2.2: News Coverage using Reduced Sample

	[1]	[2]	[3]
Zero-Inflated Poisson	News-based protests (t)		
Social Media Penetration Threshold	> 10%	> 20%	> 30%
News-based protests(t-1)	0.231*** (0.014)	0.371*** (0.021)	0.370*** (0.021)
Inverse-distance-weighted news-based protests*(t-1)	0.432*** (0.112)	0.229 (0.141)	0.217 (0.145)
Constant	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes
Observations	31,348	26,218	24,318
Number of countries	165	138	128
N_zero	9050	7273	6495
Chi-square	29724	18124	17650
Log likelihood	-12994	-10537	-9782

Note: This panel reports the regressions on the samples of columns [3] to [5] of Table 3.2. The results point to largely insignificant effect of the inverse-distance weighted average news-based protests. Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). *News-based protests* captures the number of articles mentioning street protests in a country as percentage of total number of articles covering the country. * denotes foreign *news-based protests*.

C.3. Appendix: Contagion, distance and social media—2010 Facebook penetration

Table C.3.1: Contagion, Distance, and Social Media—Actual Protests

	[1]	[2]
Zero-Inflated Poisson		
Social Media Penetration Threshold in July 2010	> 5%	> 10%
Protest pc (t-1)	0.037*** (0.003)	0.038*** (0.003)
Inverse-Distance-Common Social Media weighted Protest pc*(t-1)	0.054* (0.029)	0.052* (0.028)
Constant	Yes	Yes
Country fixed effects	Yes	Yes
Month fixed effects	Yes	Yes
Observations	1,056	552
Number of countries	18	13
N_zero	160	88
Chi-square	7017	3817
Log likelihood	-1244	-860.5

Note: This panel includes countries having social media penetration in July 2010 larger than 5% and 10% thresholds. The results point to still positive and marginally significant effect of the inverse-distance-social media weighted average global protests (per million persons). Robust standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). *Protests pc* captures the number of protests per million persons. * denotes foreign protests. 10% threshold (13 countries) includes Israel, Turkey, Bahrain, Qatar, Croatia, Malaysia, Greece, Lebanon, Kuwait, Philippines, Tunisia, Jordan, and Indonesia. 5% threshold (18 countries) includes Israel, Turkey, Bahrain, Qatar, Croatia, Malaysia, Greece, Lebanon, Kuwait, Philippines, Tunisia, Jordan, Indonesia, Romania, Thailand, South Africa, Morocco, and Oman.

Table C.3.2: Contagion, Distance and Social Media—News based Protests

	[1]	[2]
Zero-Inflated Poisson		
Social Media Penetration Threshold	> 5%	> 10%
Protest news(t-1)	0.467*** (0.029)	0.452*** (0.029)
Inverse-Distance-Common Social Media protest news*(t-1)	0.456*** (0.109)	0.373*** (0.099)
Constant	Yes	Yes
Country fixed effects	Yes	Yes
Month fixed effects	Yes	Yes
Observations	10,038	8,604
Number of countries	42	36
N_zero	545	392
Chi-square	11179	10963
Log likelihood	-4099	-3527

Note: This panel includes countries having social media penetration in July 2010 larger than 5% and 10% thresholds. The results point to positive and highly significant effect of the inverse-distance-social media weighted average global protests news. Robust standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Protest news captures the number of articles mentioning street protests in a country as percentage of total number of articles covering the country. * denotes foreign protest news. 10% threshold includes Hong Kong, Canada, United Kingdom, United States, Chile, Sweden, Australia, Israel, Ireland, Belgium, Turkey, Taiwan, France, Bahrain, Slovenia, Qatar, Italy, Slovakia, Croatia, Argentina, Malaysia, Greece, Austria, Venezuela, Spain, Lebanon, Colombia, Kuwait, Estonia, Philippines, Tunisia, Jordan, Hungary, Germany, Mexico, and Indonesia. 5% threshold includes the latter countries plus Poland, Romania, Thailand, South Africa, Morocco, and Oman.

C.4. Appendix: Contagion, Distance, and Social Media

Table C.4.1: Actual Protests---including Countries with Social Media Penetration below Thresholds

	[1]	[2]	[3]
Zero-Inflated Poisson	Protests per million persons (t)		
Social Media Penetration Threshold	> 10%	> 20%	> 30%
Protest pc (t-1)	0.031*** (0.004)	0.031*** (0.004)	0.031*** (0.004)
Inverse-Distance-Common Social Media weighted Protest pc*(t-1)	0.030 (0.024)	0.022 (0.020)	0.023 (0.019)
Constant	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes
Observations	7,812	7,812	7,812
Number of countries	92	92	92
N_zero	2603	2603	2603
Chi-square	21691	21761	21712
Log likelihood	-5573	-5573	-5573

Note: This panel reports the regressions in columns [3] to [5] of Table 3.1 but including countries having social media penetration below the thresholds (by assigning undefined weights to zero). The results point to still positive but insignificant effect of the inverse-distance-social media weighted average global protests (per million persons). Robust standard errors in parentheses (***) p<0.01, ** p<0.05, * p<0.1). *Protests pc* captures the number of protests per million persons. * denotes foreign protests.

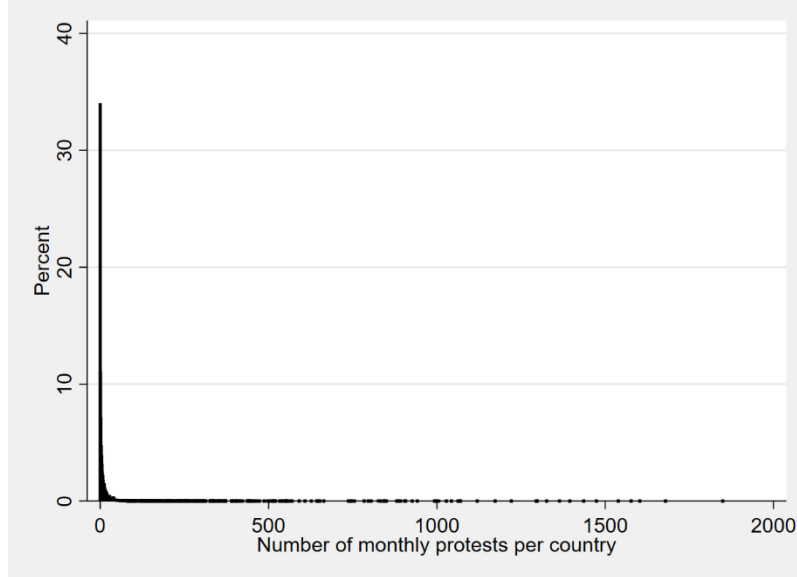
Table C.4.2: News based Protests – Including Countries with Social Media Penetration below Thresholds

	[1]	[2]	[3]
Zero-Inflated Poisson	News-based protests (t)		
Social Media Penetration Threshold	> 10%	> 20%	> 30%
News-based protests(t-1)	0.236*** (0.013)	0.234*** (0.013)	0.234*** (0.013)
Inverse-Distance-Common Social Media news-based protests*(t-1)	0.510*** (0.132)	0.540*** (0.120)	0.495*** (0.118)
Constant	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes
Observations	45,886	45,886	45,886
Number of countries	192	192	192
N_zero	14686	14686	14686
Chi-square	30003	29919	29898
Log likelihood	-19695	-19693	-19694

Note: This panel reports the regressions in columns [3] to [5] of Table 3.2 but including countries having social media penetration below the thresholds (by assigning undefined weights to zeros). The results point to positive and highly significant effect of the inverse-distance-social media weighted average global protests news. Robust standard errors in parentheses (***) p<0.01, ** p<0.05, * p<0.1). *News-based protests* captures the number of articles mentioning street protests in a country as percentage of total number of articles covering the country. * denotes foreign *news-based protests*.

C.5. Appendix: Distribution of Protests

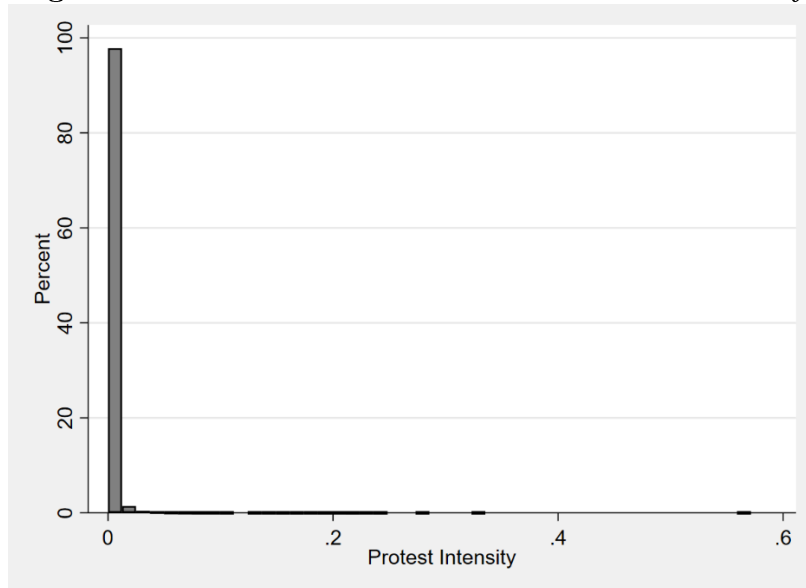
Figure C.5.1: Distribution of Number of Protests per Country per Month



Source: ACLED and authors' own calculation.

Note: In 34 percent of country-month pairs (2910 out of 8549), there is no occurrence of protest.

Figure C.5.2: Distribution of Protests News Intensity



Source: Dow Jones' FACTIVA and authors' own calculation.

Note: Protest intensity is measured as the number of street news-based protests articles divided by the number of total news articles in that country and month. In 33.4 percent of country-month pairs (16568 out of 49678), there is zero news-based protests.

C.6. Appendix: Market Shares of Facebook

Figure C.6.1: Facebook versus other Social Media Platforms

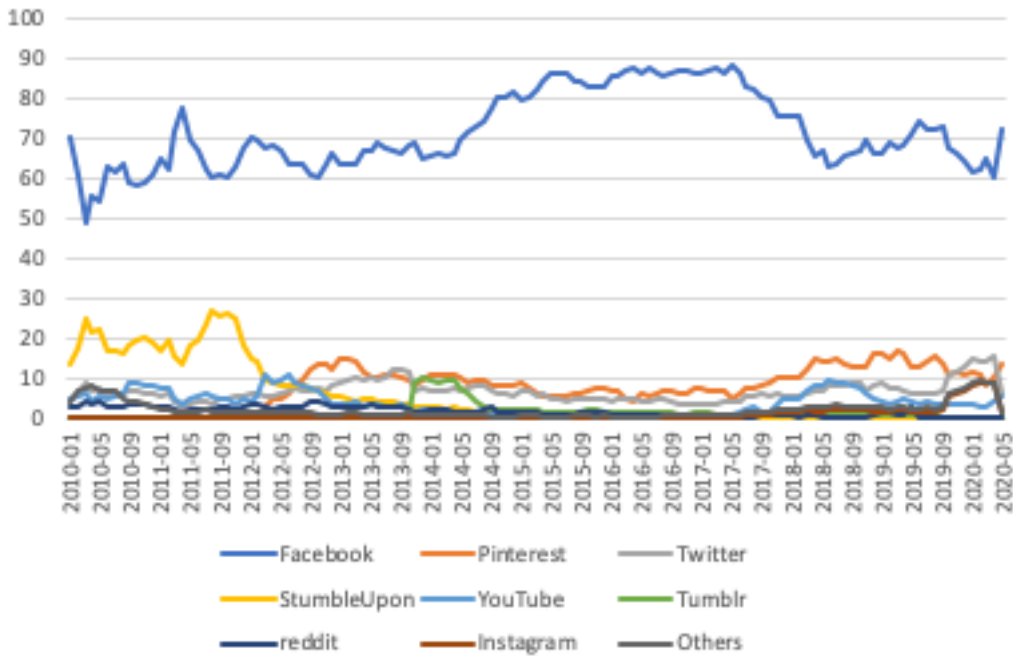
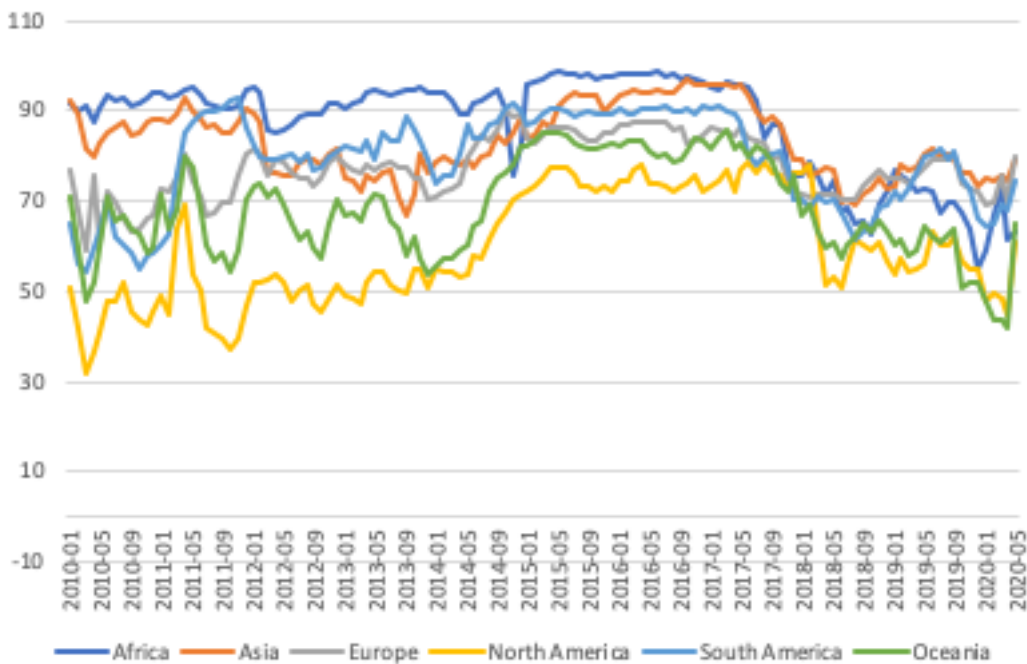


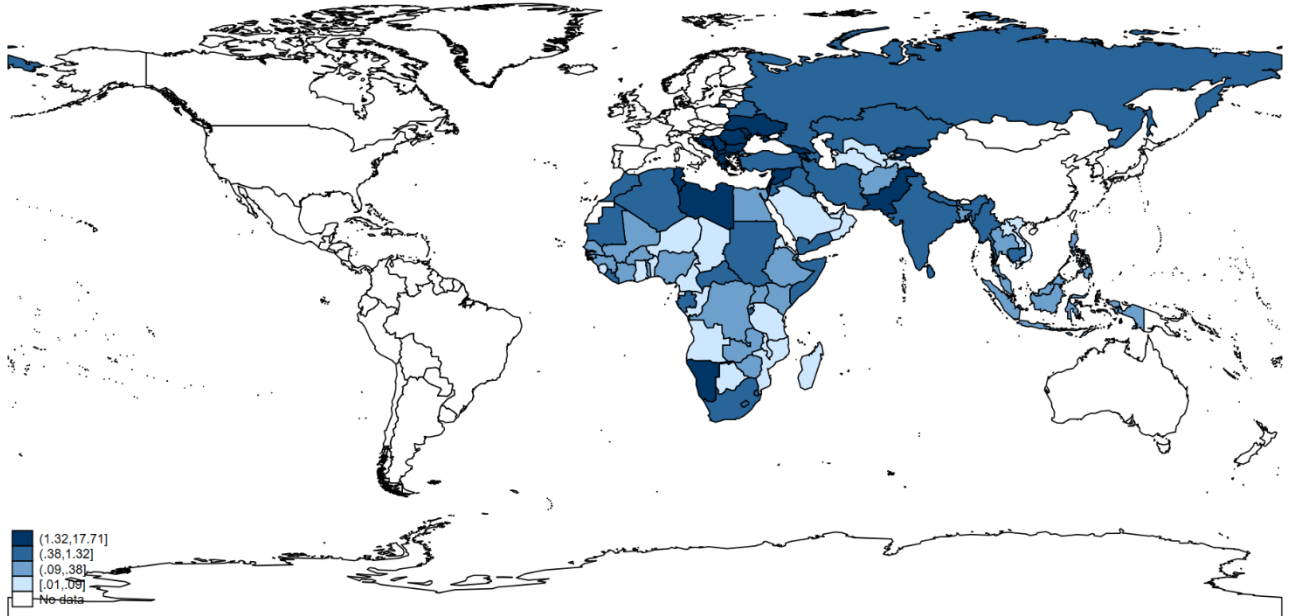
Figure C.6.2: Facebook’s Market Share in Different Regions



Source: statcounter.com [<https://gs.statcounter.com/social-media-stats#monthly-200903-202005>]

C.7. Appendix: Facebook Penetrations and Protests

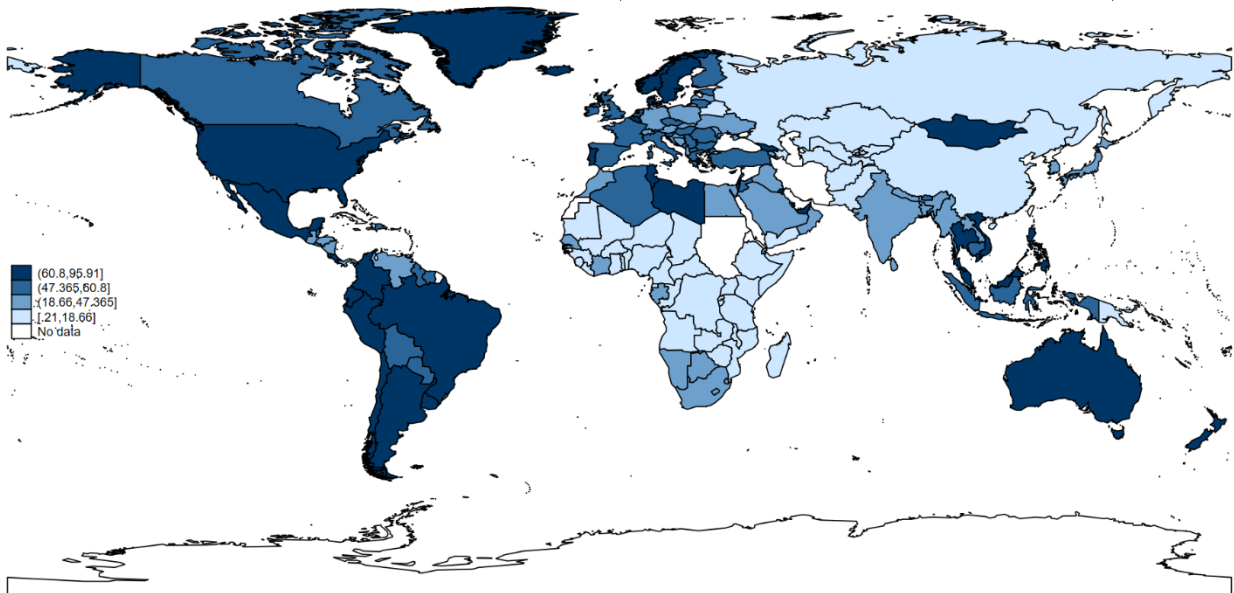
Figure C.7.1: Average Number of Protests per Million Persons Per Month



Source: ACLED.

Note: Include countries with at least 1 protest. Data coverage starts from January 2010.

Figure C.7.2: Facebook Penetration (% of Population, December 2018)



Source: www.napoleoncat.com.

“You cannot wage war without the sound of gunpowder.” ~ A Malian Proverb

4. Chapter IV: Exploring Tilly's Theory: Violent Conflicts and Tax Revenue in Sub-Saharan Africa

My very first experience of violent conflict occurred when I was 5. I was coming back from school and saw two groups fighting – Ganda Koy, a self-defence militia against the rebels. Even though I was fortunate to not have developed any trauma related to this particular event, this does not detract from the importance of this event in my quest for peace in all circumstances. The events of 2012 in Mali, and in particular the desolation, grief and sorrow that followed them were the decisive moment to focus my attention on violent conflicts and their human and economic consequences. The sacrifice of a woman begging several men to rape her rather than her daughter, her inability to fight them and prevent them from raping her teenage daughter. The grief in her voice as she explained that she didn't care about herself as she was being raped but her eyes remained frozen on her teenage girl being raped. Imagine the very first sexual experience of a little girl being a rape, war is not good and above all, nothing could justify it.

Abstract

This article explores the relationship between violent conflicts and tax revenue in Sub-Saharan countries. In a first stage, we estimate the effects of conflicts for 42 countries using panel data analysis. I find that an outbreak of violent conflicts leads to an average 1.5 percent loss of tax revenue per capita. The results show that due to the outbreak of violence government cannot successfully raise revenue, and because the conflict also negatively affects key macroeconomic variables, the tax base shrinks and the overall loss is higher. The results also point to an important role of some specificities of Sub-Saharan countries such as ethnic division and natural resource endowment. Drawing on these results, I conduct a case study for Central African Republic, Cote d'Ivoire, Congo Republic, Guinea and Guinea-Bissau in a second stage using synthetic control method. The results show that the 2002 conflict in Cote d'Ivoire and the 1998 conflict in Guinea-Bissau led to a significant drop in tax revenue. The outbreak of conflict did not have significant effects on tax revenue for the remaining three countries.

Keywords: Tax, Internal conflict, Government revenue, Sub-Saharan Africa

JEL Codes: H2 ; H56 ; H11 ; F5

4.1. Introduction

A widely accepted belief is that wars make states stronger through its effects on public expenditure and taxation. Indeed, wars triggered many tax-policy reforms around the world, many of which persisted and remained even after the war. For instance, the share of countries using withholding taxes doubled during World War II, the American civil war saw the United States adopt an income tax (see Besley and Persson, 2014; Hill, 1894; Tilly, 1985). Two important features drives tax policy in time of war: the sheer necessity to finance war and the shared sacrifice or as called by Feldman and Slemrod (2009) “we’re in this together” mentality. Studies extending the war-making/state-making framework to developing countries have resulted in mixed conclusions about whether the process is occurring in similar fashion to that in Europe (Taylor and Botea, 2008). Moreover, empirical evidence on this matter for Sub-Saharan Africa is scarce, even though the region has recorded the most conflicts since World War II.

This article investigates the impact of conflicts on tax revenue in Sub-Saharan countries. I use data on violent conflicts and non-resource tax revenue for 42 countries for the period 1980 to 2015. Using Ordinary Least Squares (OLS) and entropy balancing, I find a negative and significant effect of violent conflicts on tax revenue. I establish that an outbreak of violent conflicts leads to an average 1.7 percent loss of tax revenue per capita. I furthermore rely on Synthetic Control Method (SCM) and the Pesaran (2006) Correlated Common Effect (CCE) estimator to measure the effects of actual conflicts on five countries (Central African Republic, Cote d’Ivoire, Republic of Congo, Guinea and Guinea-Bissau).⁵⁹ Our results suggest that conflicts resulted in loss of tax revenue in Cote d’Ivoire and Guinea-Bissau. I also find negative but not robust effects of violent conflicts in Central African Republic and Congo Republic. The results reveal that Sub-Saharan African countries are having what Centeno (1997, p.1591) called the “wrong kind of war”. Due to the outbreak of violence, government cannot successfully raise revenue and because the conflict negatively affects key macroeconomic variables such as the Gross Domestic Product, the tax base shrink, resulting in a higher overall loss of revenue. This loss of tax revenue can be particularly acute in countries where the tax administration was already poorly performing before the violence erupted. Some specificities of these countries such as ethnic division and natural resource endowment also matter in studying how conflict affects tax revenue.

The analysis presented here has three essential contributions. First, it tackles a subject with mixed results and concludes that the war-making/state-making connection does not work in Sub-Saharan Africa, where most conflicts have their root causes in inequalities, ethnic division along with political instabilities. I estimate the average

⁵⁹ The five countries were selected according to our methodology to have robust synthetic control (see section 4.2).

effects of conflicts on tax revenue and focus on the effects of actual wars on specific states.⁶⁰ Second it identifies another determinant of tax revenue in developing countries. This is particularly important given the crucial role of domestic revenue mobilization for developing countries to finance their development and reduce poverty. Third, I develop an associated web page that allows the user to reproduce the results of the SCM and change elements of the analysis such as the variables, the type of conflict, the length of analysis.⁶¹ This makes the analysis flexible and allow to easily test robustness of the results obtained. It also participates explicitly to the replication principle.

My research is related to three strands of previous work. First, the paper is related to the literature on war-making/state-making connection, most associated with Charles Tilly. This literature provides insights on the relationship between conflicts and the states capacity to raise revenue (see for instance Hintze, 1906, Peacock and Wiseman, 1961, Tilly, 1985). This article is also related to the literature on the cost of wars and conflicts. The cost of wars has been studied extensively but mostly on economic growth (see for instance Abadie and Gardeazabal, 2003; Brück and De Groot, 2013, Collier, 1999, Costalli et al. 2017). Third, the analysis can be linked to the literature on the determinants of the tax revenue in developing countries, in particular research explaining differences in the level of tax revenue (see Burgess and Stern, 1993 and more recently Besley and Persson, 2013; 2014).

The remainder of the paper is organized as follows. Section 4.2 briefly discusses the literature on taxation and conflicts. Section 4.3 introduces conflicts in Sub-Saharan Africa and chronicles the origin of the conflict in the five studied countries. Section 4.4 discusses the empirical strategy and the data. Section 4.5 presents the results and I conclude in Section 4.6.

4.2. Taxation and conflicts: a brief literature review

This section briefly presents some results from the literature on the links between conflicts and taxation and provides some insights on why the relationship may differ by region. For a more discussion on the related literature and the mechanisms by which conflict affects state formation see Rodriguez-Franco (2016) and Taylor and Botea (2008).

⁶⁰ Taylor and Botea (2008) declares that one striking feature of the debate on war-making/state-making connection is that relatively little attention is focused on the effects of actual wars on specific states.

⁶¹ The paper is an ongoing project. I am still building the user interface associated to the paper. The idea of the webpage is to allow the user to select the country to be analysed and then select the length of the pre-treatment and post treatment periods, the predictor and special predictor variables, the predictor options that suit best to its analysis. Of course, changing any of these elements will have an implication on the donor pool.

The literature generally associates wars and conflicts with state formation, in particular its ability to extract/raise revenue. Most studies analysing how war triggered tax reform or shaped the way tax revenue were levied focus on the two world wars and or on the European experiences. Hintze (1906) as well as Tilly (1985, 1990), highlighted the importance of war in building a state's fiscal capacity. Tilly (1985), in particular, explains the increase in countries debt and taxes from seventeenth century onward as a function of increasing cost of war making. Besley and Persson (2014), showed that the share of countries using withholding taxes doubled during WWII. Peacock and Wiseman (1961 and 1979) underlined the role of conflict's crisis, especially those of the two WW in explaining the levy behaviour of authorities. They argued that the increase in taxation caused by wars has a "ratchet effect", so that the post-war levels of taxation do not return to their pre-war levels. Leroy (2007) explains that during peace public interventions are restricted by the reluctance to pay tax, while war increases the tolerance to taxation. This characteristic was noticed in the structure of France public finance throughout world war I, especially in the implementation and collection of new taxes (see Cardoni, 2014). Hill (1894) chronicles the introduction, shaping and evolution of income tax in the United States during the American civil war and said that the country seemed fully prepared to accept this form of taxation as part of the burden made necessary by the war. Of Course, income tax was not the most important element in raising the revenue needed to finance the war effort. But the context of civil war allowed it and other form of direct taxation (interests on bonds for example).

The positive association between war and taxation can be explained through three main mechanisms. The first is the war-making/state making thesis. War is meant to dominate a territory, but since it requires resources, it implies an increase in extraction (mainly taxation). Moreover, the building up of war-making capacity increases the capacity to extract and ultimately leads to an organization with tax-collection agencies, protection services, etc. Second, in an already organized tax system, war periods can be associated to tax reforms because of the sheer necessity and the lower level of resistance from taxpayers. In discussing how war can shape tax system, Hill (1894, p.416) stated: "There were measures which the boldest innovator would hardly have dared propose in time of peace; but under the stress of war they were enacted, sometimes with little opposition and little discussion". War periods can facilitate tax reforms and the introduction of new tax instruments. Some of these measures therefore persist and remain even after the conflict or laid the foundation for sustainable funding of public goods. Finally, War periods can increase taxpayers' willingness to comply with tax obligations. This can be through an increase in patriotism. Feldman and Slemrod (2009) assess the empirical relationship between conflict and tax compliance and show a positive correlation between tax compliance and conflict. They note however that the positive response can be eroded as fatalities grow. This literature

shows that wars were proven to be favourable to reforms, contributed to develop some tax systems as well as governments' sources of income.

However, the applicability of this positive relationship beyond Europe remains controversial. Looking at other regions in particular Sub-Saharan Africa, and/or other types of war the effects are not always positive. Latin America, for instance, did not fund its war expenditures by taxes. (Jones, 1915 and Centeno, 1997). Economies nowadays, have more access to borrowing. Consequently, the financing of wars slowly shifted from taxation to debt. Financing war through debt is particularly appealing as the population does not directly bear the cost of war. Moreover, in a context of high poverty and inequality, the government is expected to resort to a debt financing strategy because they are unable to strike a bargain of fiscal sacrifice (see for example Chan, 2020). In a post-conflict situation, tax issues may just receive less attention as the state may choose to focus on reconstruction, humanitarian services or simply be reluctant to impose new tax burdens on already struggling communities (Van Den Boogaard et al., 2018). It is also possible that the low priority given to tax issues may simply reflect the structure of contemporary international relations, with significant aid flows from partners in the conflict-affected country.

Scholars of internal wars believe these wars to cause state disintegration (see for instance, Centeno, 1997; Fearon and Laitin, 2003). They usually oppose the effects of war depending on the type. Interstate wars are supposed to have a positive effect on taxation, while intrastate/civil wars have negative effect. Internal conflicts cause deterioration of governance and institutional quality – failure of the tax administration, deregulation of tax procedures, thus leading to inefficiency in the mobilization of tax revenues. This deterioration can be particularly acute in countries where institutional quality was already poor before the violence erupted. Violent conflicts also negatively affect key macroeconomic variables such as the GDP and trade (see for instance Abadie and Gardeazabal, 2003; Brück and De Groot, 2013; Glick and Taylor, 2010). These two variables are two main determinants of the tax-to-GDP ratio in developing countries. Most empirical analysis associate them positively to tax revenue.⁶² The erosion of the tax base may lead to a decrease in tax revenue. Some specificities of Sub-Saharan countries, such as ethnic fractionalization, natural

⁶² GDP has a direct relationship with tax revenue: fiscal instruments diversify with economic development, which can lead to a broadening of the tax base (see Musgrave, 1969). GDP is strongly correlated with most of the determinants of tax revenue: increase in administrative capacity with economic development, for example. See (Besley and Persson, 2013, 2014, for more discussion). Importation constitutes the tax base for many taxes. In developing countries tax revenue on international trade still represent a significant share of tax revenue. In addition, collecting tax revenue at the import stage is relatively easier and requires less administrative capacity (see Baunsgaard and Keen, 2010 for more discussion).

resources abundance may also alter the positive effects of war on taxation. In a context of natural resource abundance, the “loot seeking” opportunity can be a motivation for rebellion and violent conflicts (see Collier and Hoeffler, 2004). Tax revenue may decrease because of the resource abundance as a result of the eviction effects (see James, 2015; Jensen, 2011). Government will rely on natural resources because they are easier to tax. Weak institutions may also alter the positive effects of war on taxation. In Tilly's framework, the state making effect on war depend on the ability of the state to dominate a territory and be the unique supplier of protection as it extracts revenue. The evidence in Sub-Saharan Africa rather points to a different direction as most conflicts lead to more insecurities (remote violence, attacks by bandits, control of some territories by rebel groups). The current insecurity in Mali is an illustration. Although the government, backed by French army (re)gained control over most territories, remote violence and isolated attacks against the army still occur. Another channel through which the weak institutions may prevent government from raising tax revenue to finance war is the perceived corruption. When populations become increasingly fatigued by and disgruntled with a predator state, they are less willing to share the sacrifice of the conflict by raising revenue for the government. This may even explain their logics behind joining armed groups /Jihadists (see Benjaminsen et Ba, 2018). Ethnic fractionalization also stands as an important trait of Sub-Saharan African countries. It has helped fuel many political instabilities leading to violent conflicts (see examples below). Post-war situation in weak states also gives rises to ethnic based violence (see Cline, 2021 for the case of the ethnic violence between Fulani and Dogon in Mali following the outbreak of the conflict).

Three main mechanisms appear as a possible explanation to the negative effects of internal violent conflicts on tax revenue. First, the inability to successfully extract revenue due to the violence, associated to the shrink in the tax base resulting from the decrease in economic variables. Second, the specificities of Sub-Saharan African countries (ethnic division, natural resources abundance, weak institutions) may alter the positive effects of conflicts on taxation. Third, the existence of alternative sources of income such as the increasing access to borrowing and international aid may shift the funding of wars away from taxation.

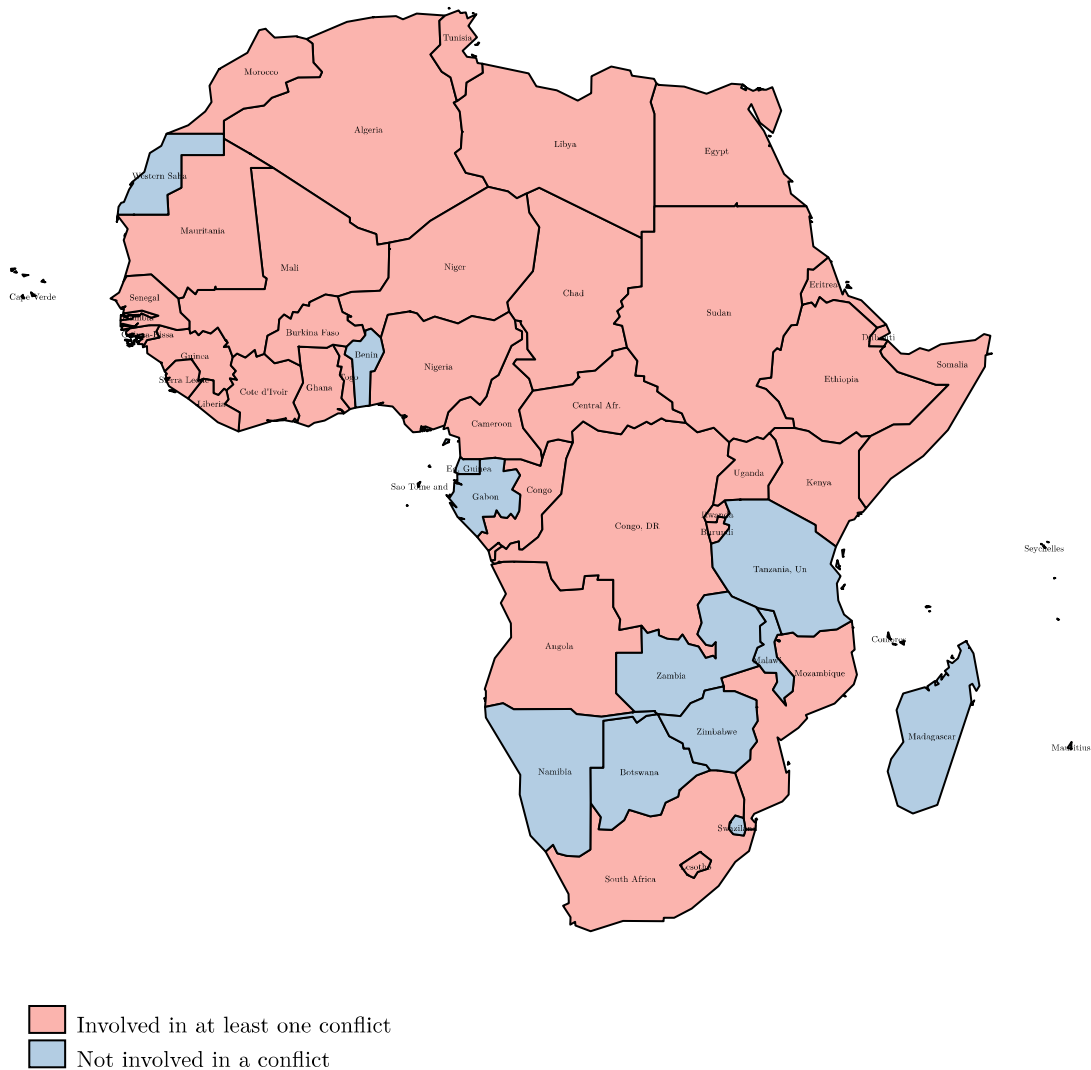
4.3. Conflicts in Sub-Saharan Africa

One striking feature of the African continent is that almost every country has dealt with a conflict since their independence.⁶³ The number of active conflicts increased substantially in this region during the 1980s and 1990s: looking at the conflicts

⁶³ All the recorded conflicts (from 1980 to 2015) but four were internal (internal or internationalized internal). The four exceptions were interstate conflicts: Chad and Nigeria in 1983; Burkina Faso and Mali in 1985; Chad and Libya in 1987; and Cameroon and Nigeria in 1996.

recorded by UCPD/PRIO 60% of countries analysed in this study were involved at least once in a conflict during the period 1980 to 2015. This number reaches 70% when considering all countries of the African continent. Figure 3.1 presents the conflict-ridden countries in Africa over the period 1980-2015. The number of years in active conflicts as well as the strength of those conflicts is different from one country to another. Ethiopia, Uganda and Sudan are among the countries that had the most year in active conflicts (see Figure D.1.1). On average, the strength of conflict increased from the 1960s until the 1990s and decreased since then (Marshall, 2005). Panel A and Panel B in Figure D.1.2 show the average intensity level of conflict in the 1980s and 2000s.

Figure 4.1: Conflict-ridden countries in Africa, 1980-2015



Source: UCPD/PRIO and authors' own calculations.

Number of scholars have studied the determinants of conflicts in Africa (see Blattman and Miguel, 2010 for a complete literature review). Income inequality, natural resource abundance, weak institutions and ethnic division/polarization are among the main and

most studied causes. The existence of large resources is associated with a higher probability of conflicts. Primary commodities generate a “loot seeking” opportunity which can be a motivation for rebellion (Collier and Hoeffler, 2004) and reduce the accountability of government to the population (Collier and Rohner, 2008). Fearon and Laitin (2003) argue that the conflict in poor countries can be seen as an illustration of weak states’ limited capacity to control rebellions. Besley and Persson (2010) links low state capacity and higher probability of civil war to high resources rents. Ethnic division increases the probability of conflicts. Montalvo and Reynal-Querol (2005) and later Esteban et al. (2012) provide empirical evidence of the relationship. The civil wars in the five countries studied are perfect illustrations. Conflicts in the Central African Republic and in Cote d’Ivoire are results of ethnical based political instabilities. Guinea-Bissau and Congo were never able to organize successful transfer of power in a context where income inequalities were growing. The conflict in Guinea stands as the only exception as it was mainly imported and exacerbated by tension between the country and its neighbours, Liberia and Sierra Leone. In the following subsections, I present some backgrounds on the conflicts in these five countries. I complement the description with a detailed chronology of the conflicts in Table D.1.1.

4.3.1. The Central African Republic (2001)

The Central African Republic experienced its first outbreak of conflict in 2001 after a military faction attempted a coup against President Ange-Félix Patassé. The conflict is the result of years of ethnic division (see to Kłosowicz, 2016; United Nations Security Council, 2002 for further details). The country has more than eighty ethnic groups, and not only the largest of them, Gbaja, Banda, Mandija and Sara, compete for power (Kłosowicz, 2016). In 1981, General André Kolinga, a member of the Yakoma tribe, came to power after a coup d’état. The selection of collaborators for state and military offices was based on patronage as well as ethnic and tribal affiliation. The Yakoma tribe, originally from the south of the country, with a population of no more than 5 percent, took over most key positions in the state and army (Kłosowicz, 2016). When Kolinga was replaced by Patassé, from the north of the country, the latter could not trust the army dominated by the Yakoma tribe. He created a well-paid presidential guard as well as a militia both made up of members of the northern tribes. During the attempted coup in 2001, Patassé received help from the Libyans and engaged the notorious bloodthirsty rebels from the *Mouvement pour la Libération du Congo* (MLC). The latter patrolled the south of the country massacred, raped and robbed the population, resulting in hundreds of deaths in 2001 (see Pettersson et al., 2019’s UCDP/PRIODATASET) and thousands of displaced (Kłosowicz, 2016). The conflict still continues, alternating calm and turmoil. The highest number of fatalities was recorded in 2013 (see Pettersson et al., 2019’s UCDP/PRIODATASET).

4.3.2. Cote d'Ivoire (2002)

The conflict in Côte d'Ivoire began in 2002 when soldiers mutinied and took control of the northern part of the country. As in the Central African Republic, the conflict in Côte d'Ivoire is the result of deep-rooted cleavages around ethnicity (for further insights, see Crook, 1997; Ogwang, 2011; Reuters, 2007; Turner, 2014a). In the aftermath of independence, the country recorded remarkable growth rates, mainly driven by the export of cocoa and coffee, whose plantations relied on immigrant workers. President Félix Houphouët-Boigny initiated policies favouring immigration from neighbouring countries and improved the rights of immigrant workers. As a result, immigrants and their descendants counted for almost a quarter of the population in 1998 (Ogwang, 2011). In 1990, in the country's first multiparty elections, the two main candidates were Houphouët-Boigny and Laurent Gbagbo. Gbagbo's *Front Populaire* accused the *Parti Democratique* and Houphouët-Boigny of promoting the interests of the Baoulé – one of the largest ethnic groups and the tribe of Houphouët-Boigny. From that time on, ethnicity became a major political factor. But it was not until five years later, as the presidential elections approached, that an identity politics would emerge. Houphouët-Boigny won the 1990 elections and died 3 years later. He was succeeded by Henri Konan Bédié, candidate for his own re-election in 1995. Bédié seeing the rise of Alassane Ouattara, from the *Rassemblement des Républicains*, who drew support from people with northern or Muslim background, will initiate steps to block Ouattara from running for President. On December 8, 1994, a new electoral code, that would require eligible candidates to have both their parents to be Ivorian nationals in order to run for president, was adopted. In 1995, Bédié also initiated a policy of Ivorian nationalism, called "Ivoirité". The policy was another manoeuvre to make Ouattara candidacy difficult, if not impossible. Bédié was subsequently elected president in 1997, running against Francis Wodié alone, candidate from the *Parti Ivoirien des Travailleurs* (PIT). The campaign for the 2000 presidential election once again announced an ethnic dimension to political life. The division of the political elite, identity politics, inequalities between north and south, and diversity, not only ethnic but also cultural and religious, led to a coup headed by General Robert Gueï in December 1999. Once in power, Gueï had a new constitution adopted by referendum in 2000, which emphasized that presidential candidates “must be Ivorian by origin, born to father and mother who are themselves Ivorian by origin; and must have never availed himself of another nationality”,⁶⁴ thus eliminating Ouattara.⁶⁵ Gueï lost the presidential elections in 2000 to Gbagbo. The hard-line stance of Gbagbo

⁶⁴ Article 35 of *Loi n°2000-513 du 1er Août 2000 portant constitution de la Côte d'Ivoire*. Available at <http://www.unesco.org/education/edurights/media/docs/ea778cb20fbdd7a77fe62ae0c85bbd87c0757abd.pdf>

⁶⁵ Note however that on December 18, 2001, a national reconciliation forum bringing together all political leaders recognized Ouattara's Ivorian nationality.

against northerners prompted disgruntled elements of the army, mainly from the north, to attempt an unsuccessful coup in Abidjan in 2002. Following this failed coup, Gbagbo attempted to demobilize two contingents of the army that were recruited during Gueï's short transition. This led to a mutiny which ended in civil war. More than six hundred casualties were recorded in 2002 (see Pettersson et al., 2019's UCDP/PRIO dataset). The conflict lasted until 2004 and another episode erupted in 2011 following the 2010 elections between Gbagbo and Ouattara.

4.3.3. The Republic of Congo (1993)

The 1993 civil war in the Republic of Congo began following the opposition contesting the results of the parliamentary elections. Even though ethnicity was not at the root of the conflict, politicians overtly stimulated ethnic consciousness to mobilize political supporters (For more details, see Clark, 1998; United Nations Office for the Coordination of Humanitarian Affairs, 2000). After 30 years of one-party political system, the country experimented for the first time a multiparty government in 1991. At the demand of the opposition, President Sassou-Nguesso allowed a sovereign national conference of important political and social figures. A multiparty constitution followed, which was adopted in March 1992. A transitional government was formed with the mandate of organizing the elections (parliamentary and presidential). Pascal Lissouba, candidate of the *Union Panafricaine pour la Démocratie Sociale* (UPADS) is elected president in 1992. UPADS had formed a coalition with the *Parti Congolais du Travail* (PCT) to gain a majority in parliament. But, a month after his installation as president, the coalition broke down with the withdrawal of the PCT. The PCT joined forces with Bernard Kolélas, who had finished second in the presidential elections and whose party, the *Mouvement Congolais pour le développement et la démocratie Intégrale* (MCDDI), held the second most seats in the parliament. Lissouba proceeded to dissolve the parliament (against constitutional procedure) and scheduled new parliamentary elections for the following year. After the new elections, UPADS and its minor allies gained a majority. The opposition demanded that many seats be rerun and boycotted the second round of the elections. As the situation became intense, the three main politicians formed private militias to control access to various areas of the capital and the country slipped into civil war. Very quickly the country found itself in a tripartite division along ethno-regional lines. The constituency of Lissouba was made up of the three southern regions of Niari, Bouenza and Lekoumou. Kolélas gained votes in Brazzaville and in the surrounding area of Pool region. Sassou led in four of the northern regions, Likouala, Sangha, Cuvette and Cuvette-Ouest. Clashes between the militias later gave way to mob action by alienated youth. The recorded number of deaths from UCDP/PRIO is 53, but Clark (1998) reported two thousand deaths. The war continued and 1997 was one of the most devastating episodes. Another episode happened in 2016.

4.3.4. Guinea (2000)

The 2000 civil war in Guinea is the result of a long-lasting civil war that engulfed Liberia then Sierra Leone (two border countries) in 1990s. It was mainly imported and was exacerbated by tension between Guinean president Lassana Conté and his regional nemesis Charles Taylor, president of Liberia (See Arieff, 2009; Turner, 2014c for additional details). Conté Backed rebel movements opposed to Taylor. The support for anti-Taylor rebels played a role in inciting armed attacks on Guinean soil in regions bordering Liberia and Sierra Leone. In September 2000, Guinean dissidents, backed by the Liberian government, militia from ULIMO and rebels from the Revolutionary United Front (RUF) attacked Guinea. Attacks started in the southern part of Guinea (the border areas with Liberia and Sierra Leone) and gradually spread north. More than two hundred deaths were recorded in 2000 (see Pettersson et al., 2019's UCDP/PRIO dataset), and a quarter million people were internally displaced. Clashed continued in 2001, the year that marked the end of the conflict. The Guinean conflict is different from most civil wars in Sub-Saharan Africa, as it resulted from neighbouring government retaliation – by financing an insurgency across border. It was also shorter and concerned mostly bordering areas with neighbours Liberia and Sierra Leone.

4.3.5. Guinea-Bissau (1998)

The Guinea-Bissau civil war was triggered by an attempted coup d'état led by General Ansumane Mané against the President Joao Bernardo Vieira. The civil war is a result political instability in a country that failed to organize successful transfer of power since the independence (see Peace Direct, 2015; Turner, 2014b). In 1980, Vieira, then Prime minister, toppled the government of Luis Cabral and remained president since. In January 1998, Viera suspended Mané, an army General and former chief of staff. Mané was accused of negligence in regard to controlling the illegal sale of Guinean arms to the *Mouvement des Forces Démocratiques de la Casamance* (MFDC), in neighbouring Senegal. Mané, who was very popular among soldiers, was later home-arrested. As a reaction, he and a group of allies from the armed forces took over the main military bases and arms depots. That was the beginning of the civil war. Neighbouring Senegal and Guinea intervened as they sent troops in to aid the government. In 1999, Vieira was ousted by Mané and the military junta. Mané briefly headed the junta before National Assembly speaker Malam Bacai Sanha took power as acting president. In the following presidential elections of 2000, Kumba Iala gained the presidency. Iala rejected a demand from the junta to have a special consultative status. He was overthrown in a coup three years later. Vieira returned from exile and won the 2005 election. He was murdered in 2009 by a group of soldiers. The country has been experiencing a series of political instabilities that still continues.

4.4. Methodology and data

4.4.1. Data

Here I present the data and the empirical strategy to measure the causal effects of conflicts on tax revenue. Data on conflicts are from the UCPD/PRIO armed conflict dataset, version 19.1 (see Gleditsch et al., 2002; Pettersson et al., 2019). The dataset records armed conflicts concerning States and characterized by the use of force between the two parties, and which result in a death toll of at least 25 deaths during a calendar year. Our analysis covers the period 1980-2015. In this timeframe, all the recorded conflicts but four were internal (internal or internationalized internal). The four exceptions were interstate conflicts: Chad and Nigeria in 1983; Burkina Faso and Mali in 1985; Chad and Libya in 1987; and Cameroon and Nigeria in 1996. I use data on non-resource tax revenue from Caldeira et al. (2019). The authors provide annual country-level panel data for the period of 1980-2015 for 42 countries of Sub-Saharan Africa. Along with GDP per capita (in 2010 constant US dollar), Trade openness (sum of total import and export as percentage of GDP), the structure of the economy (measured by the added value of agriculture in share of GDP) are the control variables. I collected them from World Bank, World Development Indicators. To explore the role of the specificities of Sub-Saharan African countries, I use ethnic fractionalization, natural resources endowment, the institutional quality. The ethnic fractionalization index is from Alesina et al. (2003). I use natural resources rent as percentage of GDP from World Bank World Development Indicators to measure countries resource endowment. Institutional quality is measured using the International Country Risk Guide (ICRG) database. Following Frankel et al. (2013), I compute an index of institutional quality based on an average of four normalized variables: investment profile, corruption, law and order, and bureaucratic quality. Higher values of the index indicate strong economic and political institutions. I also use alternative source of revenue in developing countries as further controls. I use net development assistance and official aid as a share of GDP and public and publicly guaranteed external debt stocks as share of GDP. The first is obtained from World Bank, World Development Indicators and the second is from World Bank, International Debt Statistics.

For the SCM framework, I use ethnic fractionalization as special predictor to capture the effect of ethnic division.

Table 4.1 presents the descriptive statistics of the variables included in the analysis.

Table 4.1: Descriptive statistics

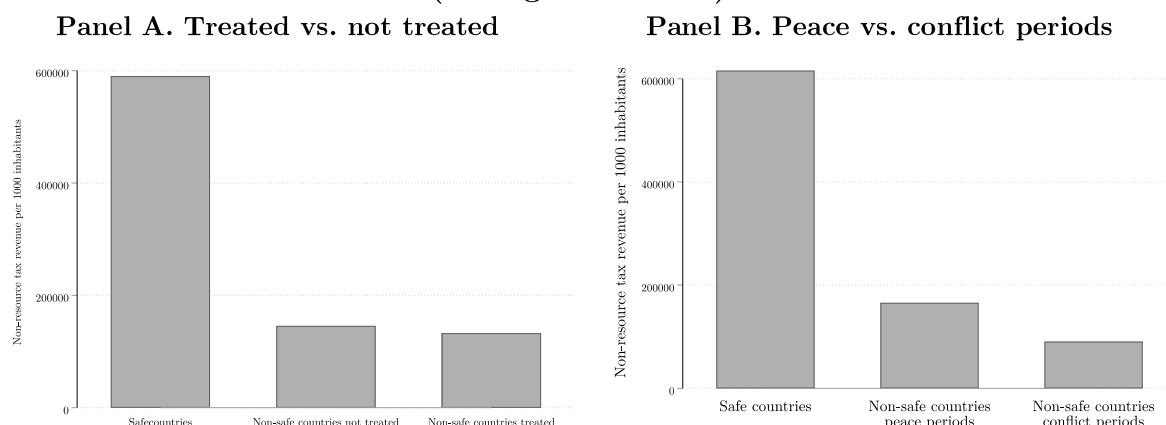
Variables	Obs.	Mean	Std. Dev.	Min	Max
Non-resource tax	1435	312546.40	553222.40	1582.75	4000083.00
Conflict	1512	0.18	0.39	0.	1
GDP per capita	1474	1892.50	2780.36	131.65	20333.94
Agriculture added value	1345	27.42	15.70	0.89	72.03
Total trade	1334	73.97	47.07	6.32	531.74
Ethnic fractionalization	41	0.65	0.24	0.00	0.93
Resource endowment	1431	11.61	11.92	0.00	89.17
ICRG Index	878	0.45	0.11	0.11	0.78
Net development assistance and official aid	1448	10.79	10.49	-0.25	94.44
Public and publicly guaranteed external debt	1357	56.66	50.92	0.00	424.98

Note: Non-resource tax revenue is expressed in 2010 constant US\$ per thousand inhabitants. Conflict is a dummy variable that takes 1 if there is a conflict in the country in a given year. GDP per capita is also expressed in constant 2010 US\$. Agriculture added value and total trade are in percentage of GDP. Ethnic fractionalization is measured by an index ranging from 0 to 1 see Alesina et al. (2003). Resource endowment is measure by natural resource rent as percentage of GDP. Net development assistance and official aid as well as Public and publicly guaranteed external debt are expressed as percentage of GDP.

Table D.1.2 presents the relationships between the variables used in the analysis and statistical significance at the critical level of 5%. Conflicts are negatively associated with most of the variables. The negative association of conflicts and economic growth has been well documented (see e.g., Abadie and Gardeazabal, 2003; Brück and De Groot, 2013). Glick and Taylor (2010) present evidence of the negative effects of war on international trade. By shrinking economic activities, conflicts contribute to increasing the share of agricultural activities in the economy. Highly divided societies are breeding grounds for conflicts (see e.g., Montalvo and Reynal-Querol, 2005; Esteban et al., 2012 for discussion on the matter).

Figure 4.2 and Figure 4.3 present further stylized facts on the relationship between conflicts and the main predictors. Non-resource tax revenue is higher, on average, in countries that have never faced conflicts (Panels A and B in Figure 4.2). Countries where conflicts occurred at least once have higher non-resource tax revenue during peace period than during conflicts periods (Panel B in Figure 4.2). Panel A in Figure 4.2 shows that the five countries studied have similar tax revenue with countries that I do not study in the SCM framework.

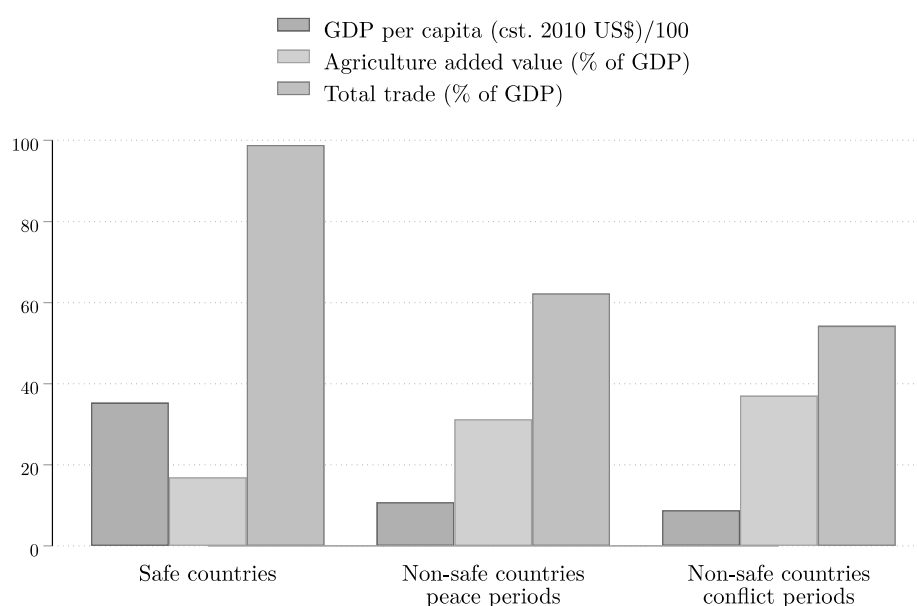
Figure 4.2: Non-resource tax revenue in safe and conflict-ridden countries (average 1980-2015)



Sources: Tax revenue Dataset for SSA, UCDP/PRIO and authors' own calculations. Non-resource tax revenue is expressed in constant 2010 US\$ per thousand inhabitants. Non-safe countries treated included Central African Republic, Cote d'Ivoire, republic of Congo, Guinea, Guinea-Bissau

Figure 4.3 presents the predictors variables according to exposure to conflicts. On average, the GDP per capita is lesser during conflict periods than during peace periods and safe countries have the highest level. The added value of agriculture in the share of GDP becomes more important during conflict periods. This is because of the contraction of activities, which in turn, may negatively affects tax collection. Indeed, tax collection is more complicated in the primary sector see (Caldeira et al. 2019). Additionally, in developing countries, this sector largely evades taxes due to exemptions policies, the means of administration and to the liability of tax thresholds. Total trade variable has similar trends with GDP per capita.

Figure 4.3: Predictors according to exposure to conflict (average 1980-2015)



Sources: Tax revenue Dataset for SSA, UCDP/PRIO and authors' own calculations. To manage scales, the GDP per capita was divided by 100.

Figure D.2.1 presents the evolution of non-resource tax revenue in the five countries studied and compare them to the evolution in safe countries and non-safe countries which do not fit the condition to be treated. Non-tax revenue in Central African Republic is amongst the lowest in the sample and is decreasing over the period. The characteristics of predictors are complicated as well. The lower level of tax revenue is associated to a higher, (almost the highest) level of agriculture added value, lower GDP per capita and international trade. Republic of Congo stands at a direct contrast to Central African Republic. Non-resource tax revenue per thousand inhabitants is high.⁶⁶ The country relies a lot on natural resources. International trade is high and mostly about primary resources. Agriculture has a small share of the economy. The GDP per capita is also very high.⁶⁷ As public revenue in the country is strongly related to resource tax revenue, it is unsteady and replicates a lot of variations. This may make hard the construction of the counterfactual. Non-resource tax revenue is decreasing in Cote d'Ivoire. Primary activities are an important part of the economic activities. The GDP per capita is above the average level of GDP per capita in conflict-ridden countries. Non-resource tax revenue in Guinea is low compared to the average level of the sample. Guinea-Bissau presents the same characteristics both in outcomes variables and predictors as the Central African Republic.

4.4.2. Empirical strategy

As a first step to our analysis, I estimate the effects of wars on non-resource tax revenue for an unbalanced panel of 42 countries over the period 1980-2015. I estimate the following equation:

$$y_{i,t} = \beta c_{i,t} + \delta y_{t-1} + \gamma x_{i,t} + \alpha_i + \theta_t + u_{i,t}, \quad (\text{eq. 4.1})$$

$c_{i,t}$ is a dummy indicator for whether country i experience conflict at time t . $u_{i,t}$ represents the error term α_i and θ_t are respectively country and time fixed effects. The first accounts for unobservable country-specific factors and the second for time specific factors. $y_{i,t}$ and $y_{i,t-1}$ represents the non-resource tax revenue in country i respectively at time t and $t - 1$. Finally, x is a vector of control variables.

At first, I use Ordinary Least Square (OLS) to estimate (4.1). This provides an average effect of conflict, assuming that the effects are homogeneous over time and across country. To test the sensibility of the OLS estimates from (4.1), I rely on the entropy balancing method proposed by Hainmueller (2012). Entropy balancing is a

⁶⁶ Bear in mind that the population is very low, and the country is very rich in natural resources.

⁶⁷ We do not address the true distribution of wealth in the country and issues of inequality are beyond the scope of our analysis.

generalization of conventional matching methods that use a re-weighting scheme to incorporate covariate balance into a weight function that is applied to the sample.⁶⁸

Since equation (4.1) includes the lagged dependent variable in the right-hand side, the fixed effect estimator is inconsistent because of the correlation between the lagged dependent variable and the error term (see Nickell, 1981). I use the Generalized Methods of Moments (GMM) System estimator, which allows controlling for both unobserved country-specific effects and potential endogeneity of the explanatory variables. Basically, Blundell and Bond (1998) show that this extended GMM estimator is preferable to that of Arellano and Bond (1991) when the dependent variable, the independent variables, or both are persistent. I rely on the two-steps system GMM estimator of Blundell and Bond (1998), which is considered to produce more robust estimates toward heteroscedasticity and other disturbances.

I furthermore estimate the average medium-term effect of conflicts episodes using the local projection method from Jordà (2005). Local projection requires estimation of a series of regressions for each horizon h . I apply a more general specification of (4.1) to our panel data. In the identification strategy, I consider the conflict as an external shock. The equations to be estimated are:

$$y_{i,t+h} = \beta_h c_{i,t} + \delta_h y_{t+h-1} + \gamma x_{i,t+h} + a_i + u_{i,t+h}, \quad h = 0, 1, \dots, 10 \quad (\text{eq. 4.2})$$

After, I turn to exploring the effects of some of the specificities of sub-Saharan countries, with the aim of discovering the main channels through which the negative effects work. I will systematically test how the inclusion of ethnic fractionalization, natural resources abundance, corruption affect the relationship between conflicts and tax revenue. I will also evaluate how access to alternative sources of revenue such as borrowing, or aid affects the relationship. I use entropy balancing as it allows to weight the sample. I also present the results from the GMM-system.⁶⁹

The second stage of our analysis is to estimate the effects of actual conflicts on specific countries. Our methodology is inspired by Abadie et al. (2015) and Bove et al. (2014). I use SCM to estimate the effect of conflict. Not only does the synthetic control method provide an effective way to define the counterfactual but it provides a way to bridge the quantitative/qualitative divide in comparative politics (Abadie et al., 2015). The SCM framework seems particularly suited to the analysis of conflicts in Africa. Given the heterogeneous nature of conflicts in Sub-Saharan Africa, comparative case studies are likely to provide a better understanding of the effects of conflicts. Another reason

⁶⁸ See Balima (2020) for an application of this method to estimate the effects of political instability.

⁶⁹ One potential limitation to these results may be the fact that most of these variables have been used as determinant of conflicts.

why case study is great is that the intensity of conflict varies, and countries resilience are not the same. The gap between the conflict-ridden country and its artificial counterfactual and the cumulative stream of gaps can identify the yearly effect as well as the cumulative effects of conflicts on subsequent collection of the tax resources over extended periods of time.

I investigate the impact of the conflict for five countries, selected according to the following conditions:

- The treated unit and the control group must not have missing data on the outcome in the 23-year sample period. This is because, I require 13-year pre-conflict to calibrate the synthetic control and 10-year post-war observations to forecast the effect of the civil war.
- In case of multiple conflicts, I select the first one in the chronological order.
- Accordingly, the treated country must have experienced its first conflict in 1993 or later, so as the pre-intervention period can be 13 years. In a similar manner, the treated unit must have experienced a conflict at the latest in 2005, to have 10 years of post-conflict window.

The potential donor pool of a treated unit contains countries which did not experience any conflict in that particular 23-year-long time frame. Finally, I construct the donor pool by restricting the size of the potential donor pool to consider only units similar to the treated units (see Abadie et al. 2015 for discussion related to the construction of the donor pool). For that matter, I rely on a simple arithmetic approach.

Let us say the potential donor pool of country i is made up of n countries, $country_1, country_2, \dots, country_n$. For each year in the pre-intervention period, I calculate the percentage difference of the dependent variable between country i with respect to each country in the potential donor pool as follows:

$$p.diff = (y_{i,t} - y_{n,t})/y_{i,t}$$

I subsequently select countries where the standard deviation of $p.diff$ is less than or equal to the unit.⁷⁰ To evaluate the statistical significance of our estimates, I conducted placebo studies following the paper of Abadie et al. (2010), which addressed methodological shortcomings of case study analysis using SCM. I apply the synthetic control method to countries in the donor pool of each treated country. From the placebo test analysis, I calculate the associated p-value of the treated unit post/pre MSPE ratio. It is the proportion of units (placebos and treated) that have a ratio equal

⁷⁰ We alternatively selected 1.5 and 2 as cut-off. We also used a scenario with no restriction, selection all the countries in the potential donor pool. The synthetic control weights did not change except for Cote d'Ivoire.

or higher than that of the treated unit.⁷¹ The hard-to-overcome difficulty regarding our SCM framework is the presence of missing values in our dataset. The computation of the synthetic version does not allow missing values of the dependent neither for the treated unit nor for the donor pool. This leads to the inability to estimate the effects for Democratic Republic of Congo and Lesotho. Missing values also lead to shortening the countries in the donor pool.

In addition to our SCM framework, I look at individual separate effect using Pesaran (2006) Correlated Common Effect (CCE) estimator for the five treated countries. As the sample used is large, $T = 36$, I can apply the CCE estimator and estimate individual separate effect for the five treated countries (see Pesaran, 2006).

4.5. Empirical results

4.5.1. Average effects of conflicts on tax revenue

I now turn to our benchmark results. Table 4.2 presents the OLS estimates of the impacts of conflicts on tax revenue. In all specification, conflict is estimated to have a highly significant negative impact on tax revenue. Column 1 does not include any effects. I successively add fixed effects (column 2), and both fixed and time effects (column 3). Columns 4 and 5 include control variables. The coefficient in column 5, which include all the variables and both fixed and time effects, is -13.4. It means that conflicts induce a drop in non-resource tax revenue per capita of about 13 US\$, which represents a loss of 4.3%. Estimates using entropy balancing depict smaller loss of revenue (c.f. Table 4.3). The coefficient in column 5 suggests that conflicts induce a 5.4 loss in non-resource tax revenue, which represents 1.7%. Using the GMM-system estimator, I obtain similar results with a drop of about 1.5% in non-resource tax revenue (c.f. Table 4.4). The average negative effect of conflicts hovers around 10 US\$ per capita in the medium term, representing a loss of 3.2% (c.f. Figure D.3.1).

An insightful result is that the coefficients associated with conflict is higher in column 5 than in column 3 for both Table 4.2 and Table 4.3. This suggests that due to the outbreak of violence government cannot successfully raise revenue and because the conflict also negatively affects key macroeconomic variables, the tax base shrink and the overall loss is higher.

⁷¹ See the associated R-Package <https://cran.r-project.org/web/packages/SCtools/SCtools.pdf>.

Table 4.2: Impact of conflict on tax revenue (OLS)

Non-resource tax Per capita (Constant 2010 US\$)	(1)	(2)	(3)	(4)	(5)
Conflicts Dummy	-4.156*	-5.733**	-5.940*	-12.285*	-13.411*
	(2.316)	(2.535)	(3.240)	(6.951)	(7.507)
Non-resource tax Per capita (Constant 2010 US\$) _(t-1)	1.014***	0.938***	0.919***	0.707***	0.704***
	(0.012)	(0.027)	(0.026)	(0.063)	(0.062)
GDP per capita (constant 2010 US\$)				0.078***	0.075***
				(0.017)	(0.017)
Agriculture, value added (% of GDP)				-0.021	0.281
				(0.292)	(0.332)
Total trade (% of GDP)				-0.270	-0.376
				(0.312)	(0.285)
Constant	3.948	27.353***	28.664***	-23.353	-18.151
	(2.729)	(8.527)	(10.363)	(19.615)	(14.921)
Country FE	No	Yes	Yes	Yes	Yes
Time FE	No	No	Yes	No	Yes
Observations	1393	1393	1393	1199	1199
Number of countries		42	42	40	40
R-squared	0.9819	0.8328	0.8407	0.8659	0.8706
Adjusted R-squared	0.9819	0.8326	0.8365	0.8654	0.8662

Note: Robust standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). The table reports the OLS estimates of the regression of non-resource tax revenue per capita in constant US\$ on the conflict dummy and a set of control variables.

Table 4.3: Impact of conflict on tax revenue (entropy balancing)

Non-resource tax Per capita (Constant 2010 US\$)	(1)	(2)	(3)	(4)	(5)
Conflicts Dummy	-2.171*	-4.123**	-4.918***	-4.184***	-5.350***
	(1.276)	(1.643)	(1.538)	(1.521)	(1.525)
Non-resource tax Per capita (Constant 2010 US\$) _(t-1)	1.018***	0.930***	0.908***	0.757***	0.759***
	(0.012)	(0.032)	(0.033)	(0.055)	(0.055)
GDP per capita (constant 2010 US\$)				0.045**	0.045**
				(0.018)	(0.019)
Agriculture, value added (% of GDP)				0.041	0.061
				(0.099)	(0.088)
Total trade (% of GDP)				0.089	0.063
				(0.080)	(0.087)
Country FE	No	Yes	Yes	Yes	Yes
Time FE	No	No	Yes	No	Yes
Observations	1393	1393	1393	1199	1199
Number of countries	42	42	42	40	40
R-squared	0.976	0.978	0.979	0.981	0.982
Adjusted R-squared	0.976	0.977	0.978	0.981	0.981

Note: Robust standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). The table reports the estimates of the second step of the entropy balancing methods. I regress non-resource tax revenue per capita in 2010 constant US\$ on the conflict dummy and a set of control variables.

Table 4.4: Impact of conflict on tax revenue (GMM-system)

Variables	(1)	(2)
Conflicts Dummy	-5.377** (2.124)	-4.737*** (1.584)
Non-resource tax Per capita (Constant 2010 US\$) _(t-1)	0.992*** (0.012)	0.941*** (0.014)
GDP per capita (constant 2010 US\$)		0.014** (0.007)
Agriculture, value added (% of GDP)		-0.260 (0.354)
Total trade (% of GDP)		0.070 (0.077)
Observations	1393	1199
Number of countries	42	40
Instruments	6	9
AR1 P-value	0.02	0.03
AR2 P-value	0.67	0.68
Hansen P-value	0.29	0.94
Long Run conflict effects	-703.543	-80.200**
Standard error	1109.67	33.562

Note: Robust standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). The table reports the GMM-system estimates of a regression of non-resource tax revenue per capita in 2010 constant US\$ on the conflict dummy and a set of control variables. The computed long run estimates and its standard error is displayed in the table.

4.5.2. Exploring the specificities

In this section, I will explore the effects of some of the specificities of Sub-Saharan countries. As discussed earlier, Sub-Saharan African countries present some particularities. It is therefore interesting to investigate how those particularities affect the relationship between conflicts and taxation. In Table 4.5, I successively include ethnic fractionalization, the endowment in natural resources, and the quality of the institutions. The negative impact of conflict on tax revenue is robust to the inclusion of these additional variables. Moreover, coefficients of the variable of interest in columns 2, and 4 are not only higher than that in column 3 of Table 4.3, but they are also higher than the coefficient in column 5 of Table 4.3. The results show that these specificities discussed, ethnic division and resource endowment do matter in studying the impact of conflict on tax revenue. Internal division makes it tougher for government to secure support for the conflict. Resource endowment has an eviction effect on tax revenue as the government rely more on them in financing the conflict, resulting in less tax revenue mobilisation. Results in columns 1 and 2 of Table 4.6 points to the same direction. A counterintuitive result arises from the inclusion of quality of institutions in Table 4.5. The absolute value of the magnitude increases. However, it is lower in Table 4.6.

Table 4.7 and Table 4.8 include control for alternative source of funding. Again, the negative impact of conflict on tax revenue is robust. The relationship between the alternative source of funding and the tax revenue is negative. However, the magnitude of the coefficient of the conflict variable becomes smaller when I control for aid and debt.

Table 4.5: Impact of conflict on tax revenue (entropy balancing) – Controlling for specificities

Non-resource tax Per capita (Constant 2010 US\$)	(1)	(2)	(3)	(4)	(5)	(6)
Conflicts Dummy	-4.489*** (1.576)	-5.670*** (1.584)	-5.287** (2.085)	-6.308*** (2.004)	-6.940*** (2.538)	-8.272*** (2.557)
Non-resource tax Per capita (Constant 2010 US\$) _(t-1)	0.773*** (0.050)	0.775*** (0.049)	0.798*** (0.032)	0.803*** (0.032)	0.747*** (0.058)	0.758*** (0.053)
GDP per capita (constant 2010 US\$)	0.042*** (0.016)	0.042** (0.017)	0.037*** (0.008)	0.035*** (0.008)	0.040*** (0.012)	0.037*** (0.012)
Agriculture, value added (% of GDP)	0.055 (0.095)	0.075 (0.088)	0.076 (0.082)	0.127 (0.085)	0.240 (0.149)	0.339** (0.152)
Total trade (% of GDP)	0.096 (0.081)	0.065 (0.087)	0.072 (0.132)	0.048 (0.131)	0.189 (0.136)	0.151 (0.139)
Ethnic Fractionalization	-111.391* (65.970)	-106.942 (67.528)				
Total natural resources rents (% of GDP)			-0.089 (0.200)	-0.155 (0.193)		
ICRG index					4.979 (10.691)	-0.930 (13.125)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	Yes	No	Yes	No	Yes
Observations	1,199	1,199	1,199	1,199	771	771
Number of countries	40	40	40	40	28	28
R-squared	0.983	0.982	0.986	0.986	0.982	0.984
Adjusted R-squared	0.982	0.982	0.985	0.985	0.982	0.982

Note: Robust standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). The table reports the estimates of the second step of the entropy balancing methods. I regress non-resource tax revenue per capita in 2010 constant US\$ on the conflict dummy and a set of control variables.

Table 4.6: Impact of conflict on tax revenue (GMM-system) – Controlling for specificities

Variables	(1)	(2)	(3)
Conflicts Dummy	-4.897*** (1.439)	-6.257*** (2.185)	-4.700 (3.109)
Non-resource tax Per capita (Constant 2010 US\$) _(t-1)	0.937*** (0.015)	0.922*** (0.012)	0.881*** (0.076)
GDP per capita (constant 2010 US\$)	0.014** (0.007)	0.018*** (0.006)	0.021* (0.013)
Agriculture, value added (% of GDP)	-0.296 (0.361)	-0.052 (0.362)	0.187 (0.286)
Total trade (% of GDP)	0.017 (0.080)	0.170** (0.076)	0.270** (0.105)
Ethnic Fractionalization	-30.837** (15.583)		
Total natural resources rents (% of GDP)		-1.675*** (0.625)	
ICRG index			71.490** (29.381)
Observations	1,199	1,199	771
Number of countries	40	40	28
Instruments	10	10	10
AR1 P-value	0.03	0.03	0.04
AR2 P-value	0.69	0.65	0.12
Hansen P-value	0.95	0.83	0.74
Long Run conflict effects	-77.646***	-80.246**	-39.496
Standard error	29.553	31.166	35.564

Note: Robust standard errors in parentheses (***) $p < 0.01$, (**) $p < 0.05$, (*) $p < 0.1$). The table reports the GMM-system estimates of a regression of non-resource tax revenue per capita in 2010 constant US\$ on the conflict dummy and a set of control variables. The computed long run estimates and its standard error is displayed in the table.

Table 4.7: Impact of conflict on tax revenue (entropy balancing) – Controlling for alternative sources of funding

Non-resource tax Per capita (Constant 2010 US\$)	(1)	(2)	(3)	(4)
Conflicts Dummy	-1.989 (1.235)	-2.760** (1.252)	-1.860 (1.188)	-2.669** (1.163)
Non-resource tax Per capita (Constant 2010 US\$) _(t-1)	0.597*** (0.088)	0.610*** (0.084)	0.641*** (0.087)	0.651*** (0.084)
GDP per capita (constant 2010 US\$)	0.048*** (0.015)	0.047*** (0.016)	0.038*** (0.011)	0.036*** (0.011)
Agriculture, value added (% of GDP)	-0.048 (0.078)	-0.032 (0.079)	-0.059 (0.064)	-0.029 (0.070)
Total trade (% of GDP)	0.178** (0.087)	0.172* (0.089)	0.161* (0.086)	0.138 (0.089)
Aid	-0.178** (0.082)	-0.202** (0.083)		
Public debt			-0.016 (0.016)	-0.018 (0.026)
Country FE	No	Yes	Yes	Yes
Time FE	No	No	Yes	No
Observations	1,175	1,175	1,099	1,099
Number of countries	40	40	37	37
R-squared	0.922	0.926	0.930	0.934
Adjusted R-squared	0.919	0.920	0.927	0.929

Note: Robust standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). The table reports the estimates of the second step of the entropy balancing methods. I regress non-resource tax revenue per capita in 2010 constant US\$ on the conflict dummy and a set of control variables.

Table 4.8: Impact of conflict on tax revenue (GMM-system) – Controlling for alternative sources of funding

Variables	(1)	(2)
Conflicts Dummy	0.942*** (0.014)	0.797*** (0.066)
Non-resource tax Per capita (Constant 2010 US\$) _(t-1)	-4.379** (1.764)	-4.891*** (1.664)
GDP per capita (constant 2010 US\$)	0.014** (0.007)	0.036*** (0.013)
Agriculture, value added (% of GDP)	-0.314 (0.327)	-0.099 (0.239)
Total trade (% of GDP)	0.060 (0.084)	0.130* (0.072)
Aid	0.064 (0.202)	
Public debt		-0.091* (0.047)
Observations	1,175	1,111
Number of countries	40	37
Instruments	10	10
AR1 P-value	0.03	0.02
AR2 P-value	0.69	0.58
Hansen P-value	0.76	0.92
Long Run conflict effects	-74.975**	-24.092*
Standard error	33.884	12.561

Note: Robust standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). The table reports the GMM-system estimates of a regression of non-resource tax revenue per capita in 2010 constant US\$ on the conflict dummy and a set of control variables. The computed long run estimates and its standard error is displayed in the table.

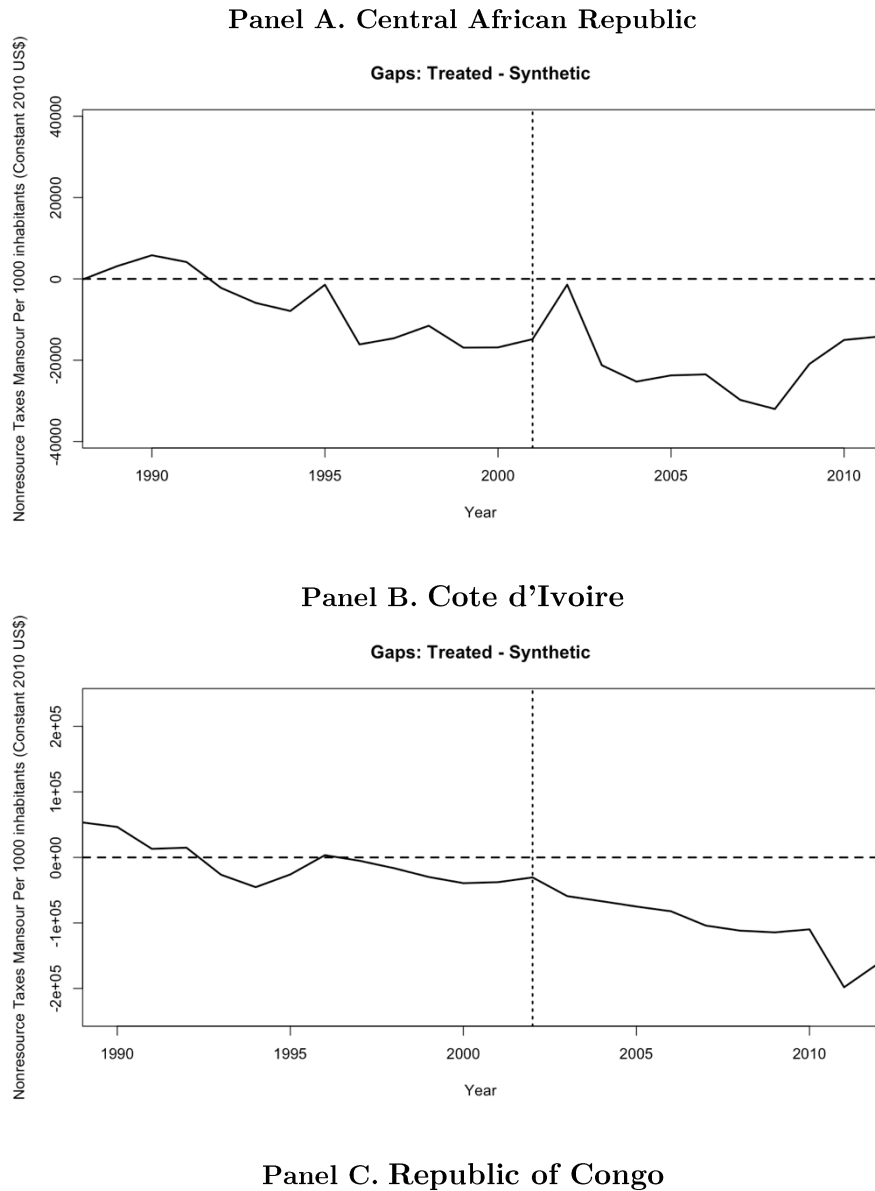
4.5.3. Effects of conflicts on tax revenue in specific countries

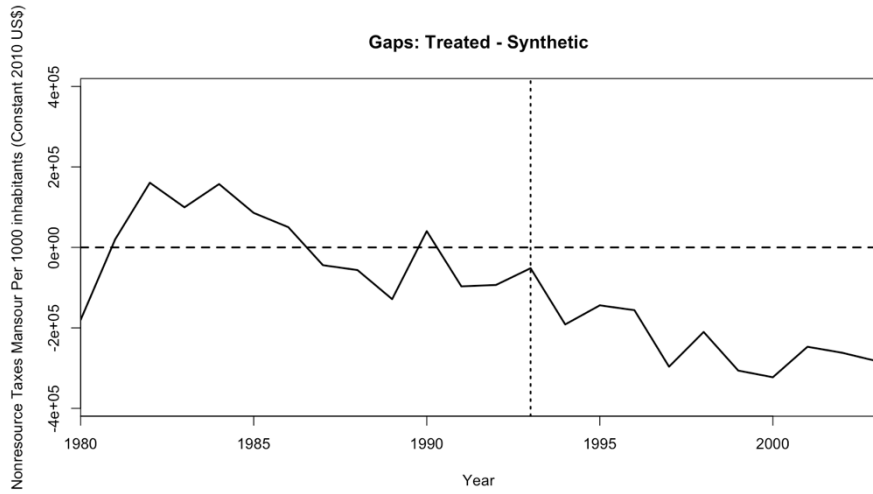
4.5.3.1. Results using synthetic control method

Here I present the effects of conflicts using SCM. For each country, I present the estimated unit weight for donor pool (Table D.4.1), describing countries used according to SCM algorithm to build the synthetic control of each treated country; the trends in outcome variables of the treated country versus its synthetic control (Figure D.4.1), measuring the effect of conflict for each year; the gap between the true value of the outcome variable and its synthetic control (Figure 4.4); the placebo analysis (Figure D.4.2), where I randomly assign the treatment to countries that did not experience conflicts; and the associated p-value of the treated unit post/pre MSPE ratio (Table D.4.2).

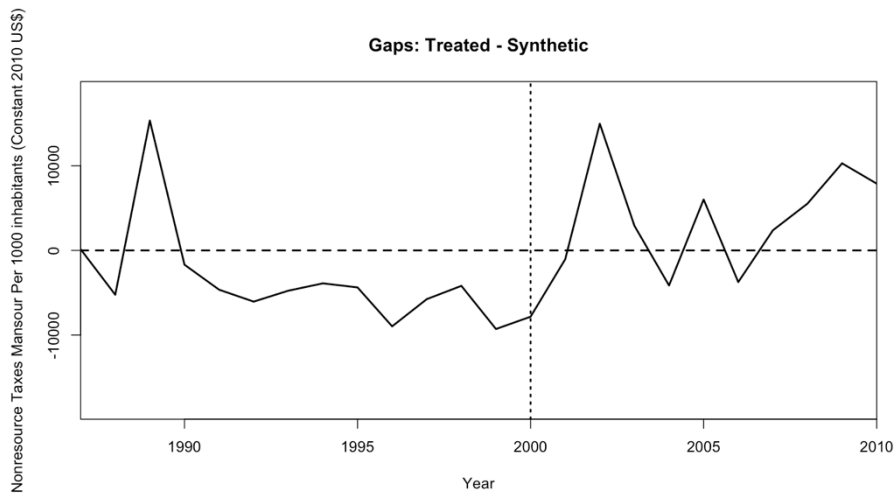
The estimated effect of conflict on non-resource tax revenue is the difference between non-resource tax and its synthetic version. The divergence between the non-resource tax revenue and its synthetic control after the outbreak of conflict in Cote d'Ivoire and Guinea-Bissau indicates that conflicts have had significant negative impact on non-resource tax revenue.

Figure 4.4: Gap between tax revenue and the synthetic tax revenue

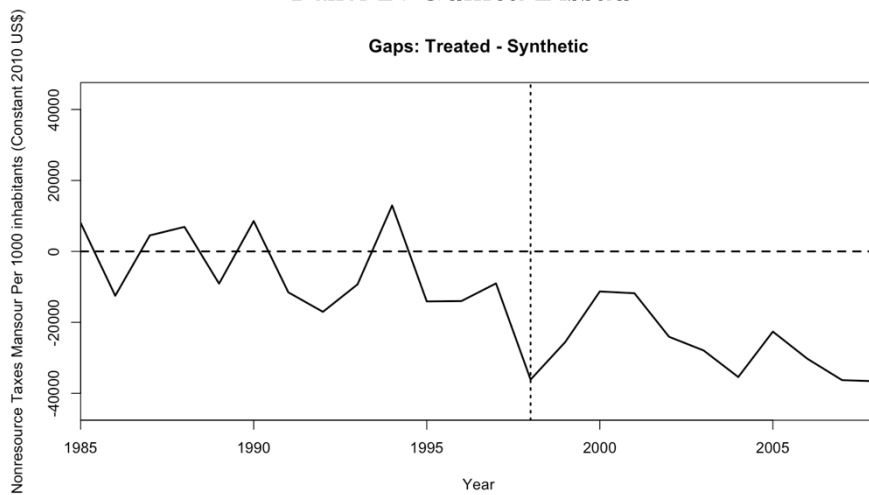




Panel D. Guinea



Panel B. Guinea-Bissau



Note: The figure presents the yearly gap between the non-resource tax revenue in 2010 constant US\$ for 1000 inhabitants and its synthetic control for Central African Republic, Cote d'Ivoire, The Republic of Congo, Guinea and Guinea-Bissau.

In Cote d'Ivoire, the average yearly estimated gap is 90000⁷² (90 US\$ per capita). The p-value of the treated unit post/pre MSPE ratio is 0.18, which means that only 18% of the 17 countries (Cote d'Ivoire and its 16 control countries) have a ratio of post/pre MSPE equal of higher than that of Cote d'Ivoire. Two countries have a higher post/pre MSPE ratio than Cote d'Ivoire: Swaziland and Zimbabwe. In Figure D.5.1, I provide additional insight on the post/pre MSPE ratio. I present the gap between the non-resource tax revenue and its synthetic control in Cote d'Ivoire Swaziland and Zimbabwe. The figure shows that the high MSPE in Swaziland and Zimbabwe – which resulted in a higher unit post/pre MSPE ratio than Côte d'Ivoire – can hardly be interpreted as an effect of a treatment in 2002. I then present the trends in outcome variables of the treated country versus its synthetic control (Figure D.5.2) as well as the yearly gap (Figure D.5.3) excluding Swaziland and Zimbabwe. The results barely changed.

The average yearly estimated gap in Guinea-Bissau is 26000 (26 US\$). The p-value of the treated unit post/pre MSPE ratio is 0.25, with Guinea-Bissau having the highest post/pre MSPE ratio.

The divergence between the non-resource tax revenue and its synthetic control after the outbreak of conflict in the remaining countries are not statistically significant. The p-value of the treated unit post/pre MSPE ratio is relatively high. The Central African Republic, the Republic of Congo and Guinea-Bissau all experienced an important loss of tax revenue after the outbreak of the violent conflict. However, our estimates are not statistically significant. Guinea stands in the analysis as the only country, where there was no drop in tax revenue after the conflict. The average gap between the non-resource tax revenue and its synthetic control is positive, about 4000 (4 US\$ per capita).

4.5.3.2. Robustness checks

As alternative method, I estimated individual separate effects of conflicts on treated countries using the Pesaran (2006) CCE estimator.

⁷² I considered the gap up to 2010 as the financial crisis started right after.

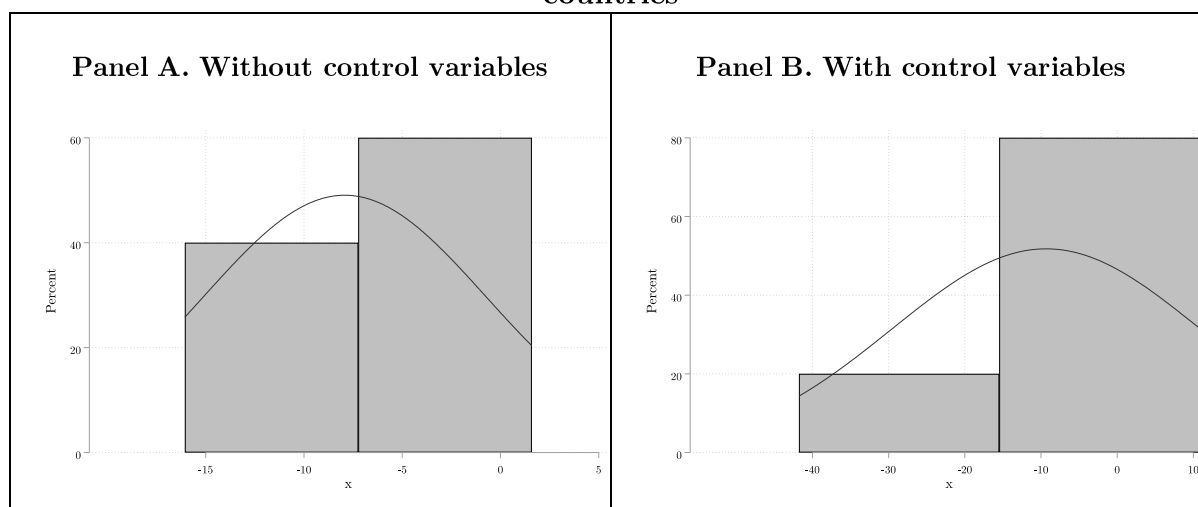
Table 4.9: Impact of conflict on tax revenue using Pessaran (2006)

Panel A. Averages across groups		
	(1)	(2)
<hr/>		
Variables		
Conflicts Dummy	-7.954** (3.461)	-5.854 (10.424)
Non-resource tax Per capita (Constant 2010 US\$) _(t-1)	0.621*** (0.182)	0.074 (0.101)
GDP per capita (constant 2010 US\$)		0.202** (0.079)
Agriculture, value added (% of GDP)		1.609** (0.759)
Total trade (% of GDP)		0.278 (0.245)
Constant	15.135 (12.974)	-74.050 (96.433)
<hr/>		
Observations	169	169
Number of countries	5	5

Note: Robust standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). The table reports the Pesaran (2006) CCE coefficients of the regression of non-resource tax revenue per capita in constant US\$ on the conflict dummy.

Panel B. Country-specific coefficients						
		CAR	CIV	Congo	Guinea	Guinea-Bissau
<hr/>						
Variables						
(1)	Conflicts Dummy	1.596 (3.852)	-16.065 (13.818)	-6.983 (18.793)	-4.299 (6.419)	-13.868* (7.905)
(2)	Conflicts Dummy	3.184 (2.468)	-13.022 (10.059)	10.804 (17.853)	-5.820 (5.372)	-41.759*** (8.119)

Panel A in Table 4.9 presents the average effects of conflicts across the five treated countries over the period 1980-2015. The coefficient becomes non-significant when I include the control variables. Panel B in Table 4.9 shows the individual separate effects of conflicts. The results are line with those from the SCM framework. Conflict is estimated to have a highly significant negative impact on tax revenue in Guinea-Bissau. However, in Cote d'Ivoire, the coefficients are not statistically significant. The distribution of estimated coefficients of conflict is presented in Figure 4.5.

Figure 4.5: Gap Distribution of individual effects of conflicts for the five treated countries

Note: The figure is the histogram of the individual coefficients obtained for the dummy conflict using Pesaran (2006) CCE.

4.6. Conclusion

Starting from the reference work of Tilly (1985), who has stressed the importance of war in building a state's fiscal capacity, this paper estimates the impact of conflicts in Sub-Saharan Africa. The results show that while wars in Western Europe and US were favourable to reforming tax structure and increasing taxes, conflicts, in this case, internal conflicts rather led to a decrease of tax revenue in Sub-Saharan Africa. Internal conflicts not only alter government capacity to collect revenue, but they also reduce economic variables that constitutes the base of many taxes. Specificities such as ethnic division and natural resource endowment associated with the limited capacity to control rebellions hamper the mechanisms through which wars, especially internal wars lead to state building (see Rodriguez-Franco, 2016). Our results show the importance of stability and peace in developing Sub-Saharan Africa for a steady improvement of domestic revenue mobilization.

4.7. References

- Abadie, A., and Gardeazabal, J. (2003). The economic costs of conflict: A case study of the Basque Country. *American economic review*, 93(1), 113-132.
- Abadie, A., Diamond, A., and Hainmueller, J. (2010). Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program. *Journal of the American statistical Association*, 105(490), 493-505.
- Abadie, A., Diamond, A., and Hainmueller, J. (2015). Comparative politics and the synthetic control method. *American Journal of Political Science*, 59(2), 495-510.
- Acemoglu, D. (2003). Why not a political Coase theorem? Social conflict, commitment, and politics. *Journal of comparative economics*, 31(4), 620-652.
- Alesina, A., Devleeschauwer, A., Easterly, W., Kurlat, S., and Wacziarg, R. (2003). Fractionalization. *Journal of Economic growth*, 8(2), 155-194.
- Arellano, M., and Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The review of economic studies*, 58(2), 277-297.
- Arieff, A. (2009). Still standing neighbourhood wars and political stability in Guinea. *The Journal of Modern African Studies*, 331-348.
- Balima, H. W. (2020). Coups d'état and the cost of debt. *Journal of Comparative Economics*, 48(3), 509-528.
- Baunsgaard, T., and Keen, M. (2010). Tax revenue and (or?) trade liberalization. *Journal of Public Economics*, 94(9-10), 563-577.
- Besley, T. and T. Persson (2013). Chapter 2 - Taxation and development. In A. J. Auerbach, R. Chetty, M. Feldstein, and E. Saez (Eds.), *Handbook of Public Economics*, Volume 5, pp. 51-110. Elsevier.
- Besley, T., and Persson, T. (2009). The origins of state capacity: Property rights, taxation, and politics. *American economic review*, 99(4), 1218-44.
- Besley, T., and Persson, T. (2010). State capacity, conflict, and development. *Econometrica*, 78(1), 1-34.
- Besley, T., and Persson, T. (2014). Why do developing countries tax so little?. *Journal of Economic Perspectives*, 28(4), 99-120.

- Blattman, C., and Miguel, E. (2010). Civil war. *Journal of Economic literature*, 48(1), 3-57.
- Blundell, R., and Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of econometrics*, 87(1), 115-143.
- Bove, V., Elia, L., and Smith, R. P. (2014). The relationship between panel and synthetic control estimators of the effect of civil war. *Birkbeck Centre for Applied Macroeconomics BCAM Working Papers*, Oct.
- Brück, T., and De Groot, O. J. (2013). The economic impact of violent conflict. *Defence and Peace Economics*, 24(6), 497-501.
- Burgess, R., and Stern, N. (1993). Taxation and development. *Journal of economic literature*, 31(2), 762-830.
- Caldeira, É., Compaore, A., Dama, A. A., Mansour, M., and Rota-Graziosi, G. (2019). Effort fiscal en Afrique subsaharienne : les résultats d'une nouvelle base de données. *Revue d'economie du développement*, 27(4), 5-51.
- Cardoni, F. (2014). The 'science' of French public finances in the first World War. *Accounting History Review*, 24(2-3), 119-138.
- Centeno, M. A. (1997). Blood and debt: War and taxation in nineteenth-century Latin America. *American Journal of sociology*, 102(6), 1565-1605.
- Chambas, G., and Laporte, B. (2005). La transition fiscale à travers la fiscalité indirecte interne. Chambas,, ed., *Afrique au sud du Sahara: mobiliser des ressources fiscales pour le développement*, *Economica*.
- Clark, J. F. (1998). Foreign intervention in the civil war of the Congo Republic. *Issue: A Journal of Opinion*, 26(1), 31-36.
- Collier, P. (1999). On the economic consequences of civil war. *Oxford economic papers*, 51(1), 168-183.
- Collier, P., and Hoeffler, A. (2002). On the incidence of civil war in Africa. *Journal of conflict resolution*, 46(1), 13-28.
- Collier, P., and Hoeffler, A. (2004). Greed and grievance in civil war. *Oxford economic papers*, 56(4), 563-595.
- Collier, P., and Rohner, D. (2008). Democracy, development, and conflict. *Journal of the European Economic Association*, 6(2-3), 531-540.

- Costalli, S., Moretti, L., and Pischedda, C. (2017). The economic costs of civil war: Synthetic counterfactual evidence and the effects of ethnic fractionalization. *Journal of Peace Research*, 54(1), 80-98.
- Crook, R. C. (1997). Winning coalitions and ethno-regional politics: the failure of the opposition in the 1990 and 1995 elections in Côte d'Ivoire. *African Affairs*, 96(383), 215-242.
- Esman, M. J. (1997). Public administration, ethnic conflict, and economic development. *Public Administration Review*, 527-533.
- Esteban, J., Mayoral, L., and Ray, D. (2012). Ethnicity and conflict: An empirical study. *American Economic Review*, 102(4), 1310-42.
- Fearon, J. D., and Laitin, D. D. (2003). Ethnicity, insurgency, and civil war. *American political science review*, 75-90.
- Feldman, N., and Slemrod, J. (2009). War and taxation: When does patriotism overcome the free-rider impulse?. In *The new fiscal sociology: Taxation in comparative and historical perspective*, p. 138-154. Cambridge: Cambridge University Press.
- Frankel, J. A., Vegh, C. A., and Vuletin, G. (2013). On graduation from fiscal procyclicality. *Journal of Development Economics*, 100(1), 32-47.
- Gardeazabal, J. (2010). Methods for measuring aggregate costs of conflict. *The oxford handbook of the economics of peace and conflict*, 227-251.
- Gleditsch, N. P., Wallensteen, P., Eriksson, M., Sollenberg, M., and Strand, H. (2002). Armed conflict 1946-2001: A new dataset. *Journal of peace research*, 39(5), 615-637.
- Glick, R., and Taylor, A. (2010). Collateral damage: trade disruption and the economic impact of war. *The Review of Economics and Statistics*, 92(1), 102-127
- Hainmueller, J. (2012). Entropy balancing for causal effects: A multivariate reweighting method to produce balanced samples in observational studies. *Political analysis*, 25-46.
- Hill, J. A. (1894). The civil war income tax. *The Quarterly Journal of Economics*, 8(4), 416-452.
- Hintze, O. (1906). Military Organization and the Organization of the State. In *The Historical Essays of Otto Hintze (New York: Oxford University Press, 1975)*.

- Horiuchi, Y., and Mayerson, A. (2015). The opportunity cost of conflict: statistically comparing Israel and synthetic Israel. *Political Science Research and Methods*, 3(3), 609-618.
- James, A. (2015). US state fiscal policy and natural resources. *American Economic Journal: Economic Policy*, 7(3), 238-57.
- Jensen, A. D. (2011). State-building in resource-rich economies. *Atlantic Economic Journal*, 39(2), 171-193.
- Jones, C. L. (1915). War and Public Finance in South America. *Journal of Political Economy*, 23(8), 791-806.
- Kłosowicz, R. (2016). Central African Republic: Portrait of A Collapsed State After the Last Rebellion. *Politeja*, (42), 33-52.
- Lacina, B., and Gleditsch, N. P. (2005). Monitoring trends in global combat: A new dataset of battle deaths. *European Journal of Population/Revue Européenne de Démographie*, 21(2), 145-166.
- Leeson, P. T. (2007). Better off stateless: Somalia before and after government collapse. *Journal of comparative economics*, 35(4), 689-710.
- Leroy, M. (2007). Sociologie des finances publiques. *Paris, La Découverte Repères*.
- Marshall, M. G. (2005). Conflict Trends in Africa, 1946–2004: A Macro–Comparative Perspective: Report Prepared for Africa Conflict Prevention Poll (ACPP). *Government of the United Kingdom, October, 14*.
- Montalvo, J. G., and Reynal-Querol, M. (2005). Ethnic polarization, potential conflict, and civil wars. *American economic review*, 95(3), 796-816.
- Nickell, S. (1981). Biases in dynamic models with fixed effects. *Econometrica: Journal of the econometric society*, 1417-1426.
- Ogwang, T. (2011). The root causes of the conflict in Ivory Coast. *Africa Portal Backgrounder n° 5*.
- Peace Direct (2015). A short history of peacebuilding in Guinea-Bissau. Retrieved from reliefweb.int.
- Peacock, A. T., and Wiseman, J. (1979). Approaches to the analysis of government expenditure growth. *Public Finance Quarterly*, 7(1), 3-23.

Peacock, A.T and Wiseman, J. (1961). The growth of public expenditure in the United Kingdom. *Princeton University Press*.

Pesaran, M. H. (2006). Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica*, 74(4), 967-1012.

Pettersson, T., Högladh, S., and Öberg, M. (2019). Organized violence, 1989–2018 and peace agreements. *Journal of Peace Research*, 56(4), 589-603.

Rasler, K. A., & Thompson, W. R. (1985). War making and state making: governmental expenditures, tax revenues, and global wars. *The American Political Science Review*, 491-507.

Reuters (2007). Key events in Ivory Coast's conflict. Retrieved from reliefweb.int.

Rodriguez-Franco, D. (2016). Internal wars, taxation, and state building. *American sociological review*, 81(1), 190-213.

Taylor, B. D., & Botea, R. (2008). Tilly tally: War-making and state-making in the contemporary third world. *International Studies Review*, 10(1), 27-56.

Tilly, C. (1985). Warmaking and State Making as Organized Crime. In *Bringing the State Back in*, ed. by Evans, P. B., Rueschemeyer, D., & Skocpol, T. *Cambridge University Press*.

Tilly, C. (1990). Capital, Coercion and European States. *Cambridge, MA: Basil Blackwell*.

Turner, B. (2014a). Côte D'Ivoire. In *The Statesman's Yearbook* (pp. 364-368). Palgrave Macmillan, London.

Turner, B. (2014b). Guinea-Bissau. In *The Statesman's Yearbook* (pp. 567-570). Palgrave Macmillan, London.

Turner, B. (2014c). Guinea. In *The Statesman's Yearbook* (pp. 563-566). Palgrave Macmillan, London.

United nations Office for the Coordination of Humanitarian Affairs (2000). UN Consolidated Inter-Agency Appeal for the Republic of the Congo - Transition Appeal. Retrieved from reliefweb.int.

United nations Security Council (2002). Report of the Secretary-General on the situation in the Central African Republic. Retrieved from reliefweb.int.

Van Den Boogaard, V., Prichard, W., Benson, M. S., & Milicic, N. (2018). Tax Revenue Mobilization in Conflict-affected Developing Countries. *Journal of International Development*, 30(2), 345-364.

West Africa Network for Peacebuilding (2000). Policy Brief: Guinea-Conakry - Causes and responses to possible conflict. Retrieved from reliefweb.int.

D. Appendix to chapter IV

D.1. Appendix:

Figure D.1.1: Number of years in active conflicts over the period 1980-2015

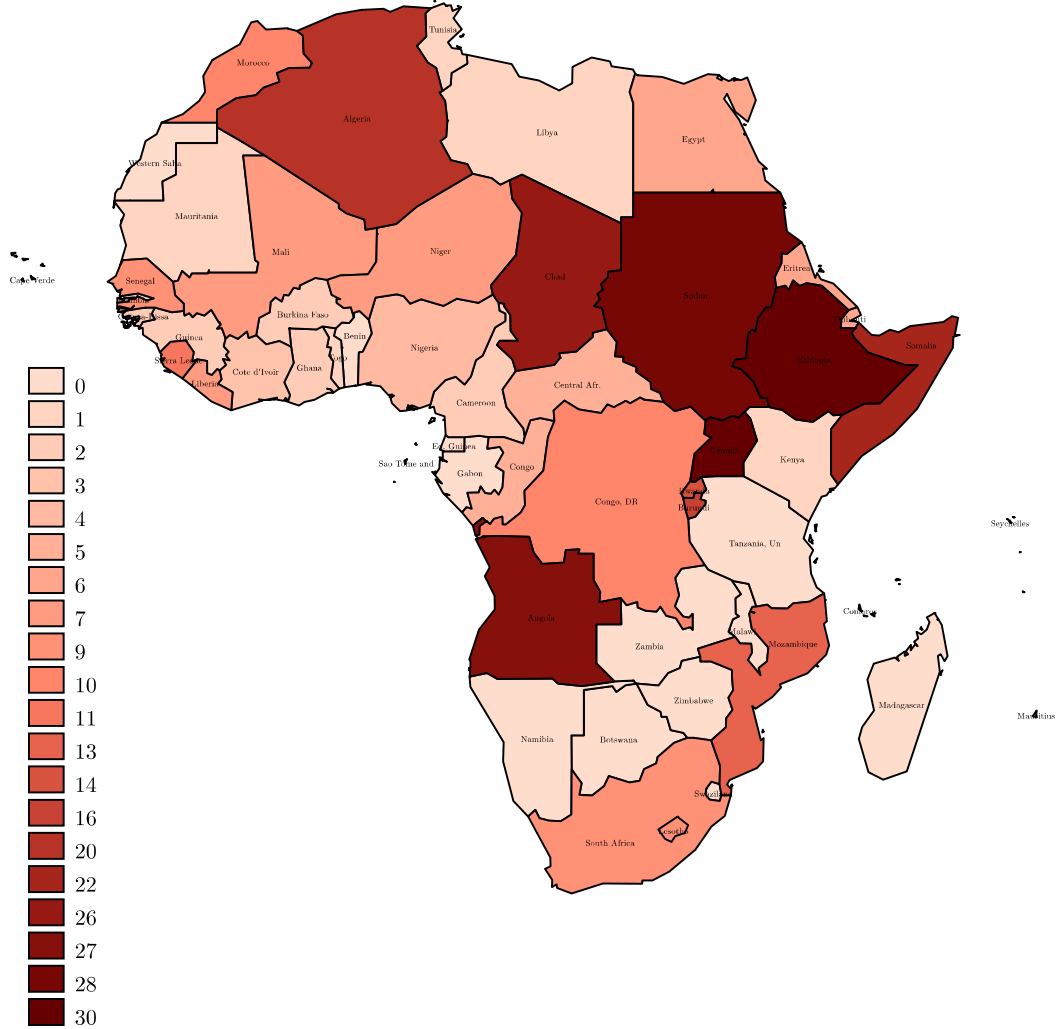
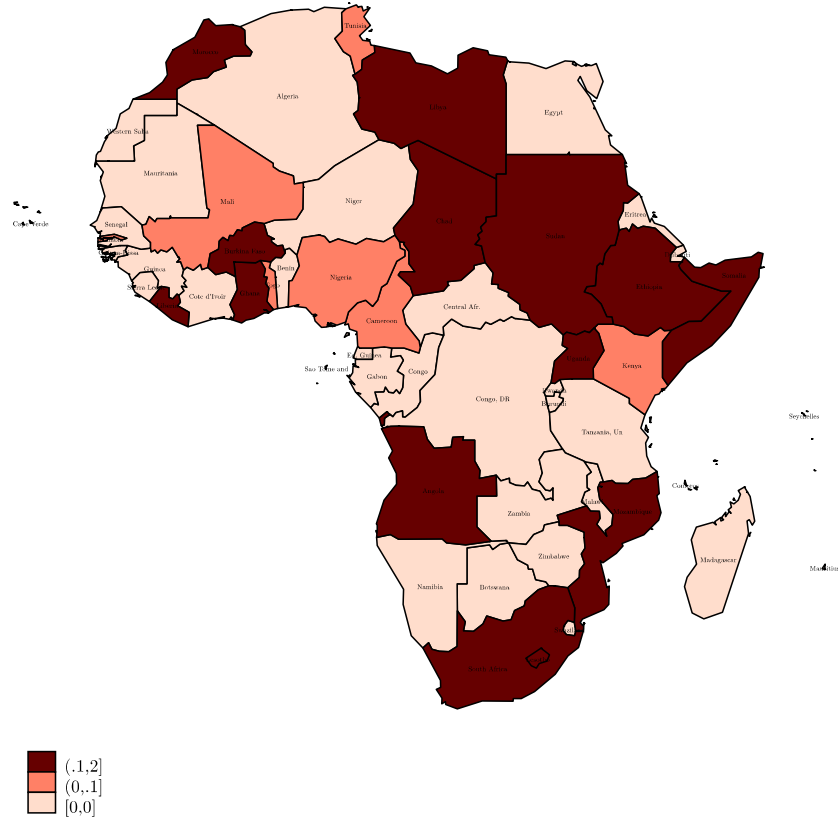


Figure D.1.2: Average intensity level of active conflicts in the 1980s and 2000s

Panel A: Average intensity level over the period 1980-1989



Panel A: Average intensity level over the period 2000-2010

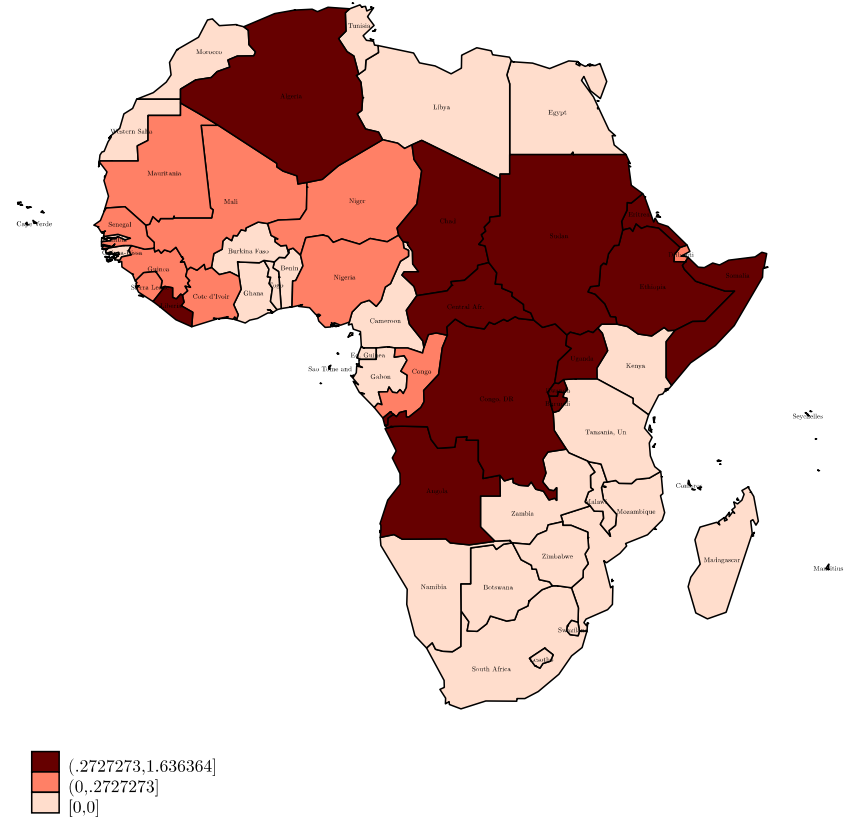


Table D.1.1: Detailed chronology of conflicts

Start date	Country	Country2	Opposition actor(s)	Opposition2	year	Int.	Start date2
27/05/01	Gov. of CAR*	Gov. of Libya	Military faction (forces of André Kolingba)		2001	1	01/06/01
			Forces of Francois Bozize		2002	1	01/06/01
		Gov. of France	Seleka		2006	1	28/11/06
			CPJP		2009	1	26/11/09
			CPJP		2010	1	26/11/09
			CPJP		2011	1	26/11/09
			Seleka anti-Balaka, Seleka		2012 2013	1 1	26/11/09 26/11/09
19/09/02	Gov. of CI		MPCI, MPIGO		2002	1	20/09/02
			MJP, MPIGO		2003	1	20/09/02
			FRCI		2004	1	20/09/02
			FDSI-CI, FRCI		2011	1	25/02/11
03/11/93	Gov. of Congo*		Ninjas		1993	1	11/11/93
		Gov. of Angola, Gov. of Chad	Cobras, Cocoyes	Gov. of Angola, Gov. of Chad	1997	2	06/06/97
		Gov. of Angola, Gov. of Chad	Cocoyes, Ninjas, Ntsiloulous		1998	2	06/06/97
		Gov. of Angola, Gov. of Chad	Cocoyes, Ninjas, Ntsiloulous		1999	1	06/06/97
		Gov. of Angola	Ntsiloulous		2002	1	10/04/02
01/09/00	Gov. of Guinea		RFDG		2000	1	17/09/00
			RFDG		2001	1	17/09/00
07/06/98	Gov. of GB	Gov. of Guinea, Gov. of Senegal	Military Junta for the Consolidation of Democracy, Peace and Justice		1998	1	07/06/98
		Gov. of Guinea, Gov. of Senegal	Military Junta for the Consolidation of Democracy, Peace and Justice		1999	1	07/06/98

Notes: * denotes countries with an episode that started after 2015. All conflicts are internal. Conflicts where there is country2/opposition2 actors are internationalized internal. Country2: lists countries that enter the conflict with troops to actively support the country in conflict. Opposition2: actors on the opposition side. Int: is the intensity; 1 means less than 1000 deaths in a given year, 2 more than 1000 deaths in a given year. Start date2: date when a given episode of conflict activity reached 25 battle related deaths in a year. CAR is Central African Republic, CI is Cote d'Ivoire, Congo is Republic of Congo, GB is Guinea-Bissau.

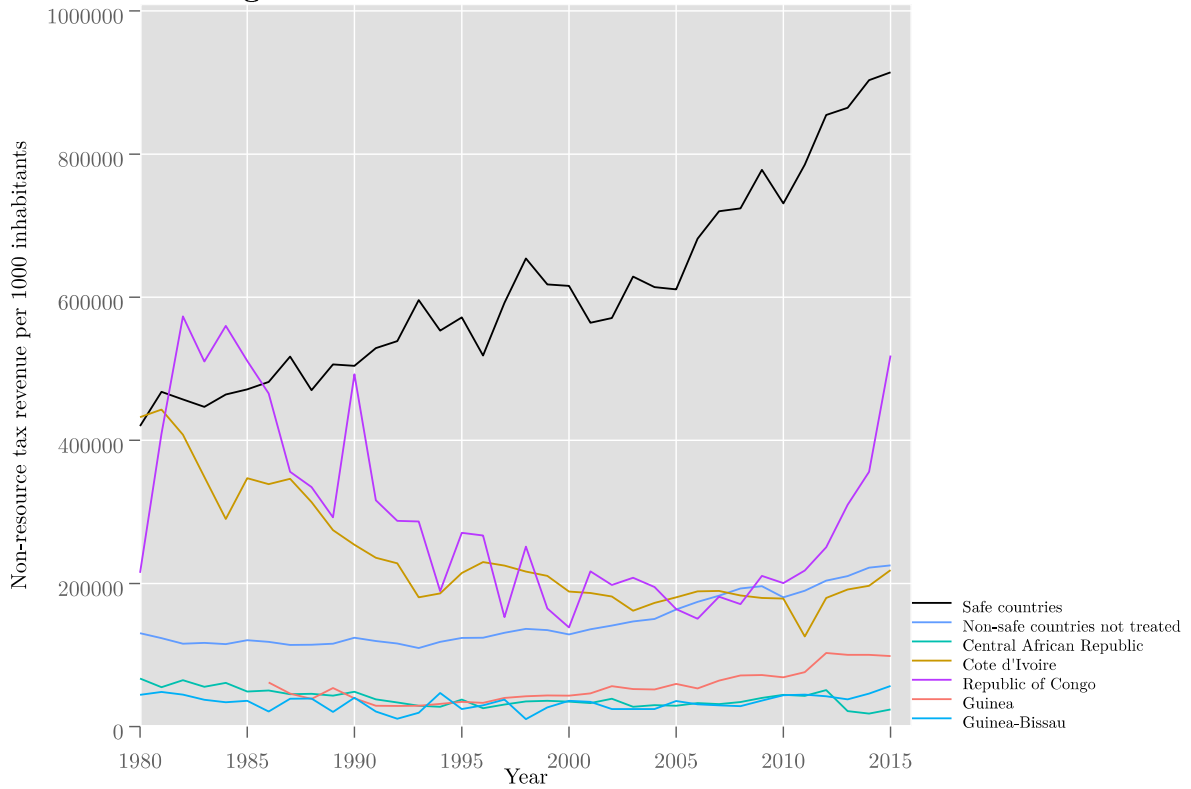
Table D.1.2: Correlation between variables

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Non-resource tax [1]	1									
Conflict [2]	-0.1843*	1								
GDP per capita [3]	0.7735*	-0.1733*	1							
Agriculture added value [4]	-0.5977*	0.2936*	-0.6384*	1						
Total trade [5]	0.3022*	-0.1885*	0.3717*	-0.6133*	1					
Ethnic fractionalization [6]	-0.3246*	0.1725*	-0.2293*	0.2678*	-0.3251*	1				
Resource endowment [7]	-0.1520*	0.1783*	0.1417*	0.1016*	0.3065*	0.2705*	1			
ICRG Index [8]	0.4016*	-0.1669*	0.2996*	-0.4228*	0.048	-0.1907*	-0.2925*	1		
Net assistance & aid [9]	-0.3214*	0.0335	-0.3746*	0.3790*	-0.0743*	-0.0524*	-0.0366	-0.2161*	1	
Public external debt [10]	-0.2568*	0.034	-0.2165*	0.2334*	-0.0591*	0.1930*	0.2029*	-0.2784*	0.5268*	1

Note: * significant at 5%

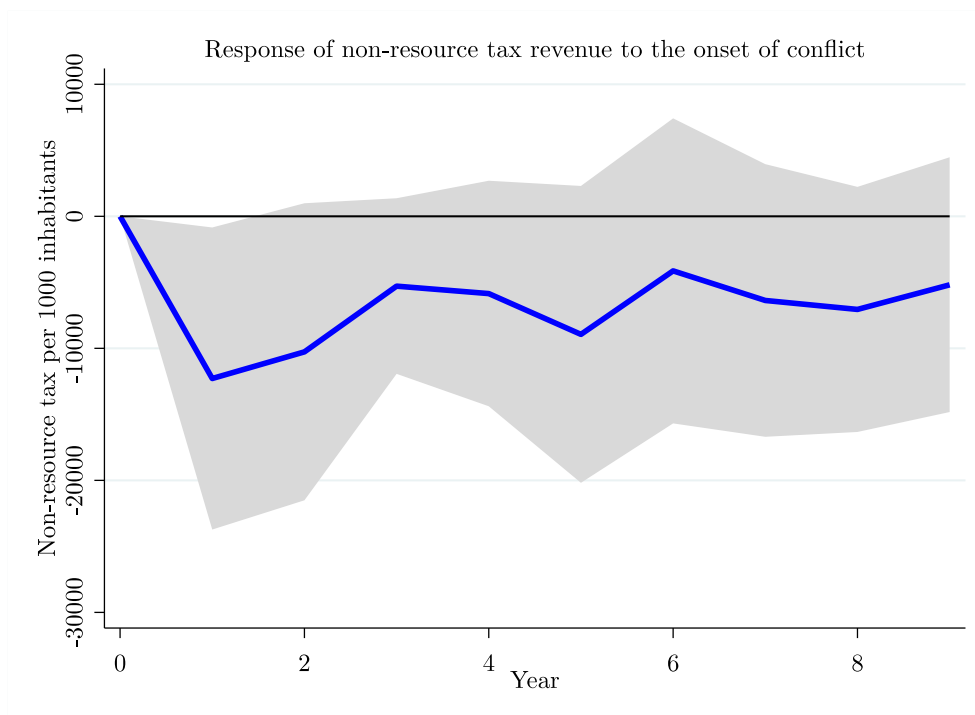
D.2. Appendix: Trends in non-resource tax revenue

Figure D.2.1: Evolution of non-resource tax revenue



D.3. Appendix: Impact of conflict on tax revenue over 10 years (OLS).

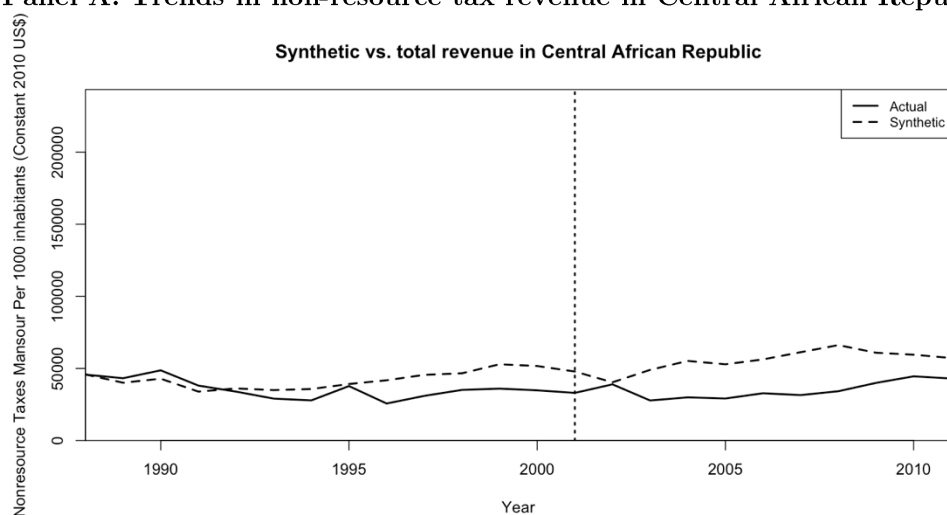
Figure D.3.1: Impact of conflict on tax revenue over 10 years (OLS).



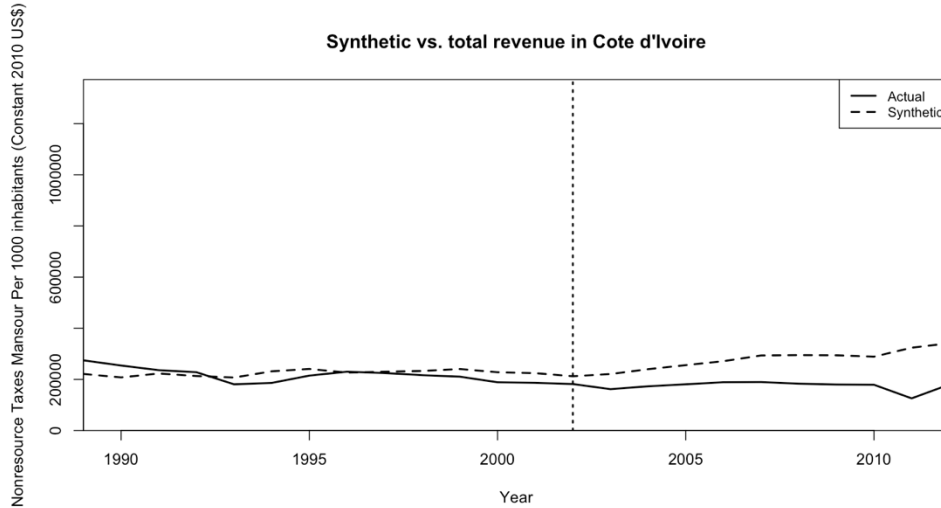
D.4. Appendix: Results from the synthetic control estimation.

Table D.4.1: Estimated synthetic control weights

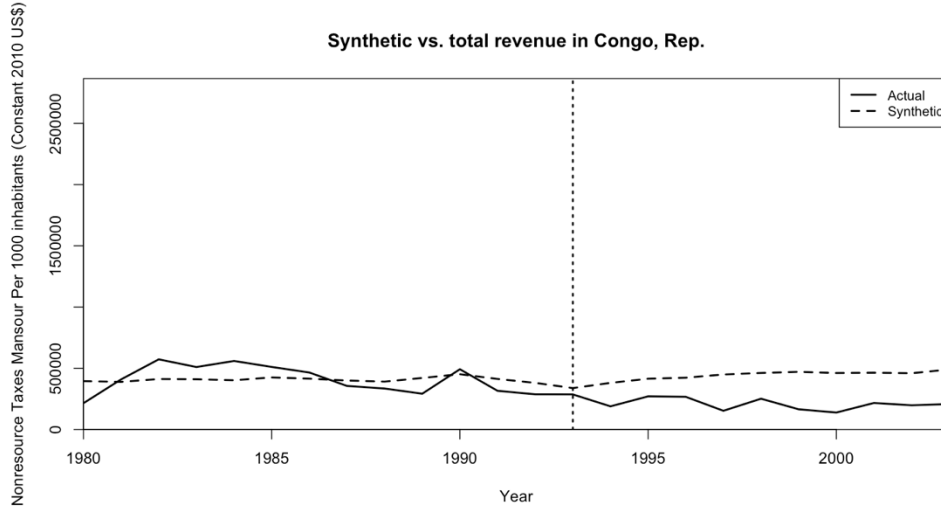
Country	Central Afr. Rep.	Cote d'Ivoire	Congo Rep.	Guinea	Guinea-Bissau
Benin	0	0.004	0	0	-
Burkina Faso	0.457	0.002	0	0.534	0.958
Botswana	-	0.003	0	-	-
Cabo Verde	-	0.002	0	-	-
Ghana	0	0.003	0	0	-
Kenya	0	0.789	0	0	-
Madagascar	0.543	0	0	0.466	0.042
Mauritius	-	0.005	0	-	-
Malawi	0	0.003	0	0	0
Namibia	-	0.096	-	-	-
Swaziland	-	0.002	0	-	-
Togo	0	0.004	0.655	0	-
Tanzania	0	0.003	-	-	-
South Africa	-	0.013	0.345	-	-
Zambia	0	0.068	-	0	-
Zimbabwe	-	0.002	0	-	-

Figure D.4.1: Non-resource tax revenue treated and synthetic control
Panel A. Trends in non-resource tax revenue in Central African Republic


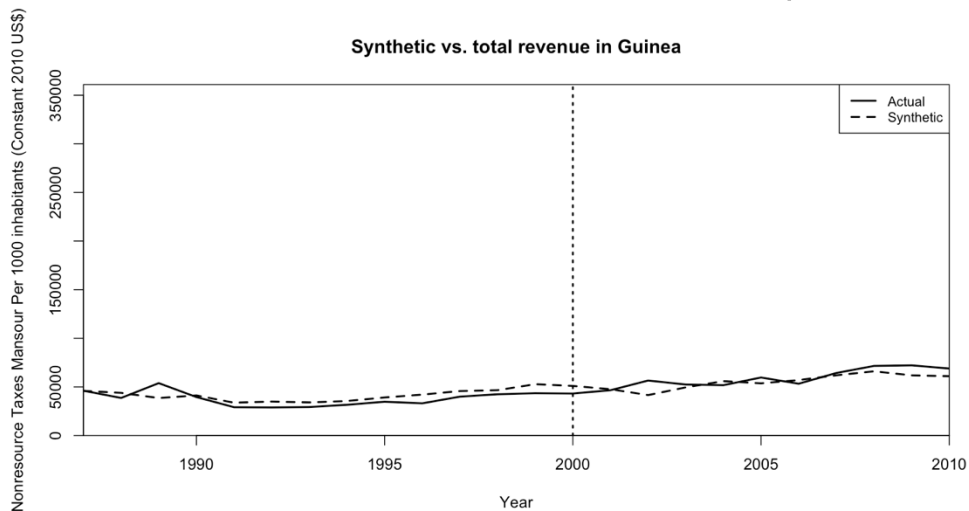
Panel B. Trends in non-resource tax revenue in Cote d'Ivoire



Panel C. Trends in non-resource tax revenue in Republic of Congo



Panel D. Trends in non-resource tax revenue in Guinea



Panel E. Trends in non-resource tax revenue in Guinea-Bissau

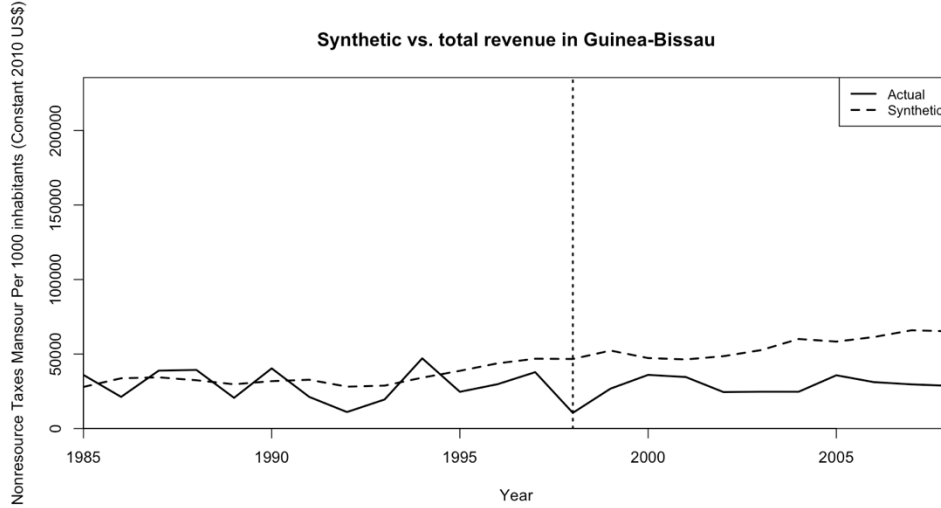
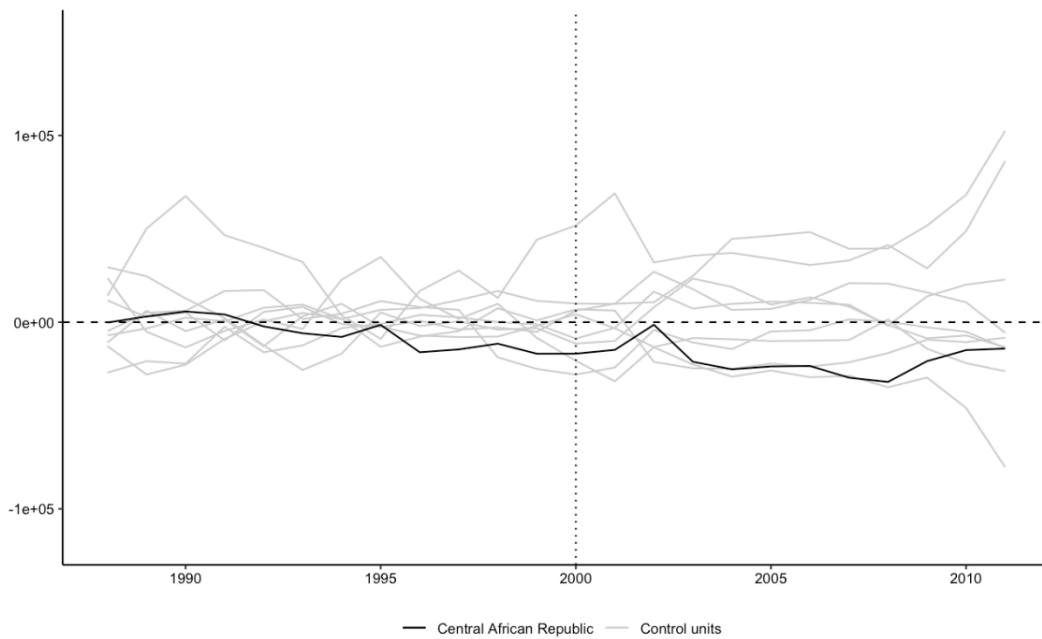
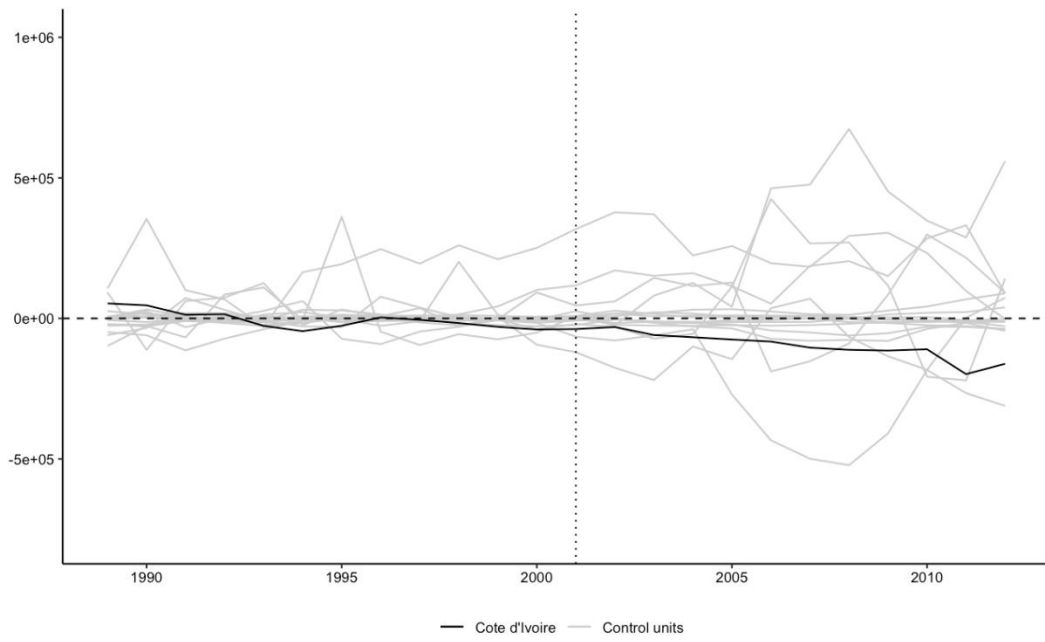


Figure D.4.2: Non-resource tax revenue gaps in the treated countries and Placebo gaps in all their respective control countries

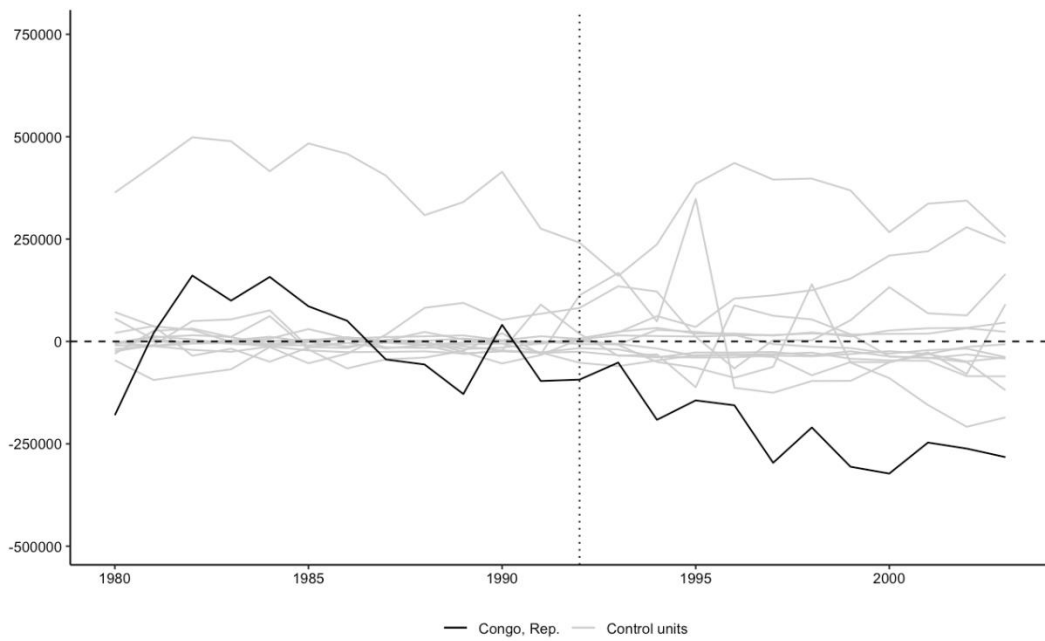
Panel A. Central African Republic



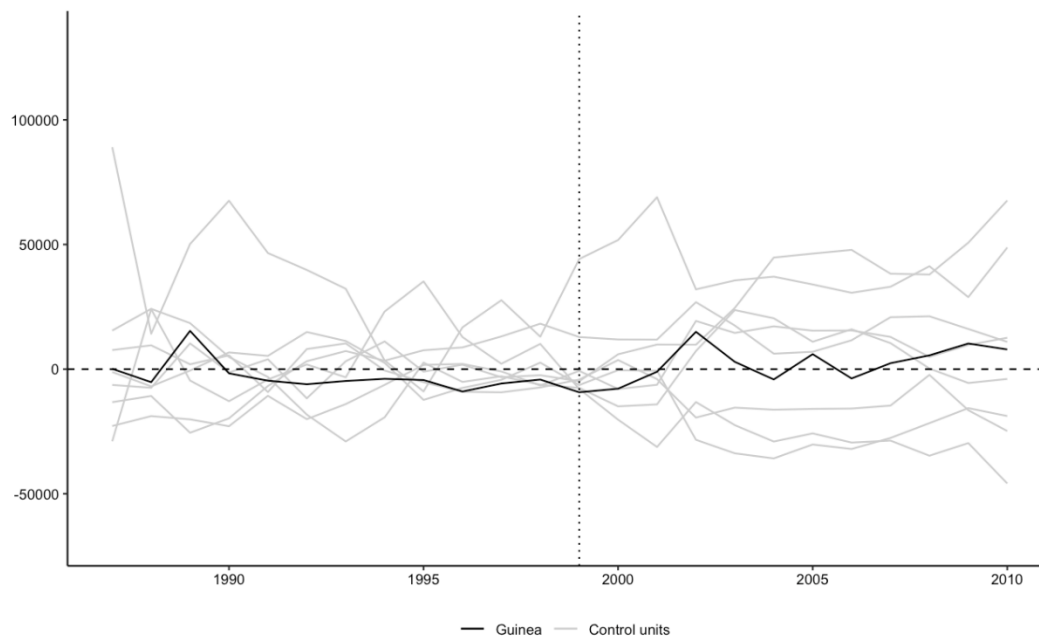
Panel B. Cote d'Ivoire



Panel C. Republic of Congo



Panel D. Guinea



Panel E. Guinea-Bissau

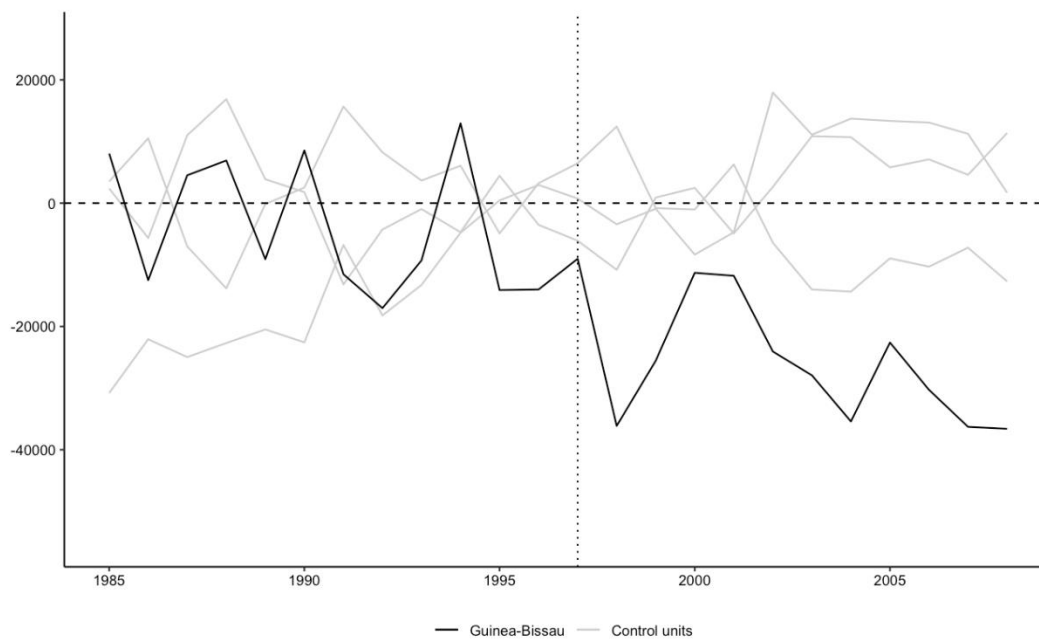


Table D.4.2: P values of the treated unit post/pre MSPE ratio.

Country	Central Afr. Rep.	Cote d'Ivoire	Congo Rep.	Guinea	Guinea-Bissau
Mspe Test value	0.5	0.18	0.43	0.67	0.25

D.5. Appendix: Additional robustness for Cote d'Ivoire

Figure D.5.1: Non-resource tax revenue gaps in Cote d'Ivoire and Placebo gaps in control countries with a post/pre MSPE ratio higher

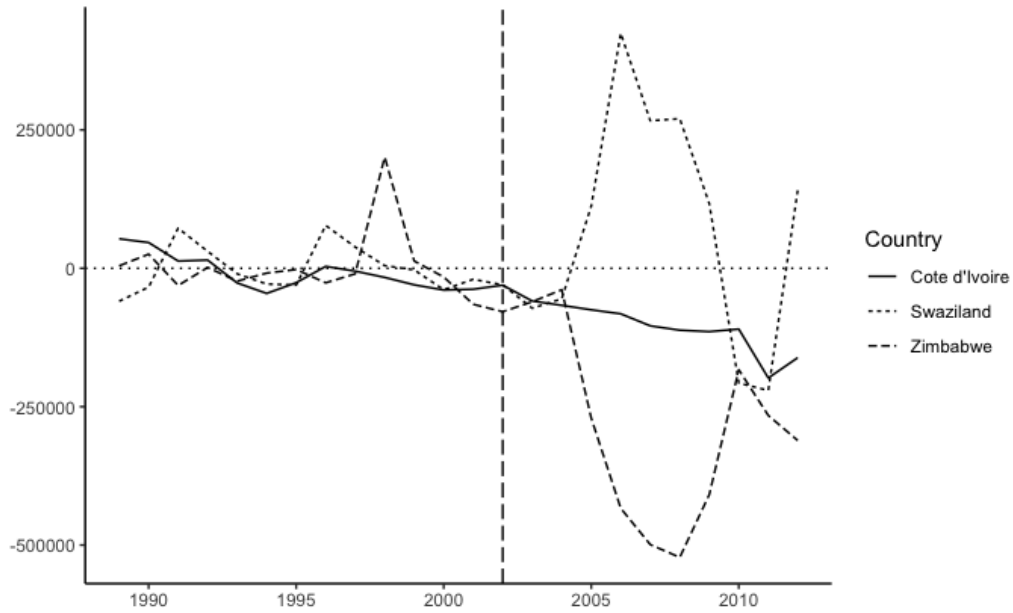


Figure D.5.2: Non-resource tax revenue treated and synthetic control in Cote d'Ivoire excluding Swaziland and Zimbabwe

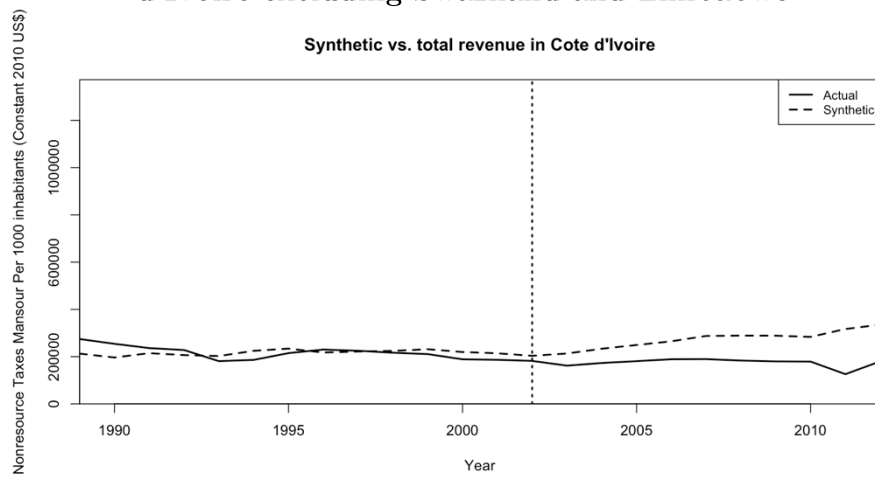
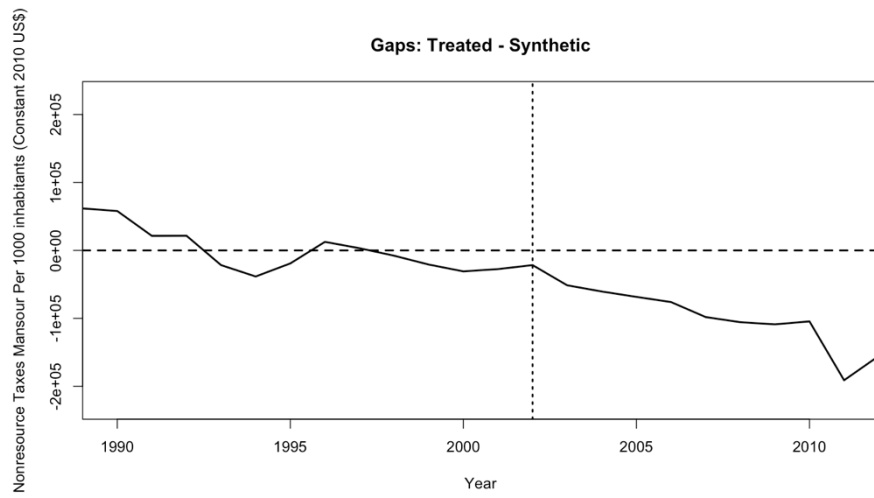


Figure D.5.3: Gap between tax revenue and the synthetic tax revenue in Cote d'Ivoire excluding Swaziland and Zimbabwe



Part III: Spend better

“One does not give without a motive.” ~ A Malian proverb

5. Chapter V: The quality of public expenditure in developing countries

This chapter is a joint work with Emilie Caldeira (CERDI-CNRS), H el ene Djoufelkit (AFD), H el ene Ehrhart (AFD) and Gr egoire Rota-Graziosi (CERDI-CNRS). It is part of a report intended to French Agency of Development (AFD) on quality of public expenditure.

The associated webpage to replicate the results is available at <https://data.cerdi.uca.fr/afd-pubexp/>

Abstract

Using a database covering 192 countries from 1990 to 2015, we measure the quality of public expenditure in developing countries and identify some factors explaining its variations. We construct a unique outcomes indicator of public expenditure for three sectors (education, health and public infrastructure). The resulting indicator is then used as output to estimate the efficiency of public expenditure using the stochastic frontier approach. The quality of public spending is estimated for 146 countries. The average efficiency score is 0.71. Sub-Saharan Africa and South Asia have the lowest efficiency scores on average with 0.55 and 0.66 respectively. Eastern Asia and Pacifica, Middle East and North Africa, and Latin America and Caribbean are at the same level, while the ranking is dominated by European and North American countries. Analysis by income level shows an improvement in efficiency as a country's income level increases: low-income countries have the lowest efficiency level. The dispersion of the efficiency scores among OECD countries is low meaning similar level of efficiency. Non-OECD high-income countries have decent scores on average, but the heterogeneity is important, in particular for Middle East and North Africa and Latin America and Carribean. In all regions and at all income levels, the performance indicator has improved since 1990.

An online application was developed for the analysis and is available at: <https://data.cerdi.uca.fr/afd-pubexp/>. It allows the user to download the data, replicate the results or carry out extensions of the results.

Keywords: Public spending, Macroeconomics, Fiscal policies, Developing countries, efficiency.

JEL Codes: H5, O11, O23, O5

5.1. Introduction

In a context of debt vulnerability and where official development assistance is stagnant or even decreasing, the improvement of public expenditure efficiency appears just as essential to financing economic development as Domestic Revenue Mobilization. An efficient use of public revenue can result in additional financing capacity by freeing up fiscal space. Moreover, it is likely to improve fiscal citizenship, further strengthening the capacity to collect taxes, hence creating a virtuous circle between efficiency, accountability and revenue mobilization.

Analysing public expenditure provides a better understanding of the role of the State in the economy and allow to appreciate the type of social contract. The quality of public expenditure remains a subject little studied by the academic world. Indeed, while a relatively old and well-developed literature exists on the effect of the size and composition of public expenditure, very few scientific articles focusing explicitly on the quality of public expenditure were produced⁷³ and their methodology sometimes seems unsuitable.⁷⁴ One possible explanation for this relative scarcity of studies on the quality of public expenditure is the difficulty in defining the very notion of quality of expenditure, which occupies a large part of this chapter. The definition of the quality of public expenditure varies according to the objectives of the latter. These objectives refer to the role of the State in the economy and can be associated with the notion of efficiency or fairness. Public expenditure can be assessed according to whether it contributes to economic growth, macroeconomic stabilization or sustainable development. It may also aim to alleviate poverty or reduce inequalities. In this study, we measure the efficiency of public expenditure by estimating the capacity of sectoral spending to achieve the targeted objectives.

We cover 192 countries⁷⁵ from 1990 to 2015 and measure the quality of public expenditure and identify the factors contributing to its effectiveness. The approach adopted is mainly macroeconomic, however we will rely on some results from microeconomic analysis of sectoral public expenditure. We consider public spending as a whole through a simultaneous analysis of the quality of spending in several sectors: education, health and infrastructure. Beyond the availability of variables and

⁷³ For instance, a simple search on google scholar for articles or research documents relating to “quality of public expenditure(s)” or “quality of public spending” returns respectively 603, 258 and 786 documents, while the same search relating to “composition of public expenditure(s)” or “composition of public spending” yield 701,000,804,000 and 444,000 documents.

⁷⁴ In particular, many of these studies are based on non-parametric models whose results are highly sensitive to variations in the sample and the presence of outliers.

⁷⁵ The database includes 192 countries. Depending on the section, the final number of countries may differ due to missing observations.

indicators measuring the outcomes of these sectors,⁷⁶ their choice is based on endogenous growth theories. Dissatisfied with common accounts of exogenous factors determining long-run growth, some growth theorists – such as Aschauer (1989); Barro (1990, 1991, 2001); Lucas Jr (1988) - highlighted the preponderant role of capital expenditure and human capital formation as a factor of economic growth and development. Public infrastructure promotes and supports private investment while the formation of human capital improves worker productivity. Health spending is positively associated with economic growth, along with education spending, they represent the so-called social spending. Spending in the two sectors are complementary: health expenses reduce the risk of mortality which affects the return on investments in education (Mushkin, 1962).

Our empirical strategy is as follows: We construct a unique outcomes indicator of public spending for the three sectors identified (education, health and public infrastructure). The resulting indicator is then used as output to estimate the efficiency of public expenditure using the stochastic frontier approach.

One major contribution of the study is the simultaneous analysis of three main sectors identified by endogenous growth literature, hence allowing to take into account the main sectors through which public expenditure may affect economic development. Previous studies were narrowed to sectoral analyses or a simultaneous analysis of two sectors at most.

The methodology used to build our sectoral indices and the outcomes indicator represents another contribution of the study. The computation scheme of sectoral indices allows for the integration of several variables (hence different dimensions of outcomes). Moreover, it allows us to simultaneously capture the effects of these variables as well as potential complementary effects between sectors. A common limit to most studies of the efficiency of social spending is the implicit assumption that these spending has independent effects on the indicators of each sector (see for instance ...). However, there may be substitutability or complementary effects between the two different types of spending. The composition of public expenditure has an important impact on its efficiency: The effectiveness of some health programs may depend on the level of education of the people targeted by these programs. An illustration is the case of the treatment of some diseases, for example advanced malaria or meningitis, which may manifest through high fevers and convulsions. The manifestation of these diseases, although very serious and highly deadly have long been viewed by the parents of the

⁷⁶ A database was built from different sources for the study. Appendix E.5 presents all the data used in the analysis.

suffering children as “bird disease” in Burkina Faso, Cote d’Ivoire and Mali.⁷⁷ The effectiveness of programs aiming to fight these diseases requires prior education of targeted population. Another example is the interaction between spending on education and health in the reducing child labor (see Grigoriou and Rota-Graziosi, 2008).

Another contribution of this study, a technical one, is the development of a user interface allowing modification of elements of the analysis such as the variables introduced in the calculation of the indices and their weights. This makes the analysis flexible and allow to easily test robustness of the results obtained. A detailed guide to using the application is available in French at the address of the website at at: <https://data.cerdi.uca.fr/afd-pubexp/>. Its purpose is to guide the user in rigorous replication and modification of the study.

After a brief introduction to the analysis of the quality of public expenditure (section 5.2), section 5.3 presents the calculation of the outcomes indicator of public expenditure. Section 5.4 is devoted to estimating efficiency. Section 5.5 concludes.

5.2. The quality of public expenditure: an overview of the existing literature

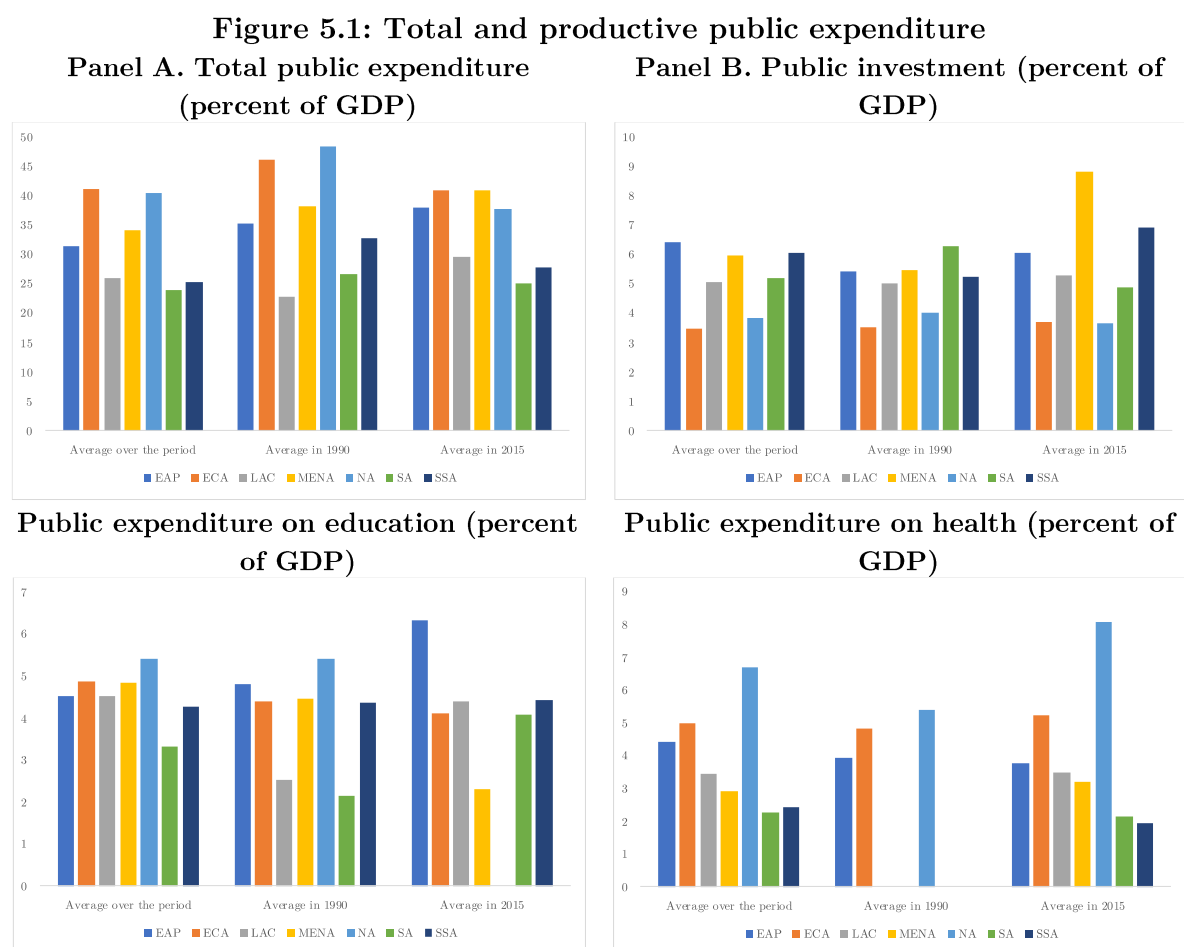
Cross-country analysis on public expenditure considered mainly three elements: the level, the composition, and the effectiveness/efficiency of public expenditure. The choice of the approach depends on the goal variable (economic growth, poverty reduction, equity etc.) and on the country or group of countries considered, in particular their initial endowment. In addition to these main elements of the analysis of the quality of public expenditure, recent developments relating to budget transparency, institutional organization, public sector management and even the budget procedure appear, generally in the form of case studies. Starting from this literature, we adopt the public expenditure efficiency approach to measure the quality of public expenditure. The approach identifies to what extent the expenditure incurred by the government allows the achievement of the objectives set. Furthermore, the analysis makes it possible to associate both the government’ size (measured by the level of public expenditure) and the composition of public expenditure in the achieving the set results.

⁷⁷ An expression in Bambara/Dioula “*Kônô yé a ta*” meaning that the child was carried away by the bird was used to denote the state of convulsion of the child in several villages in Burkina Faso, Cote d’Ivoire and Mali. Similar beliefs are detailed by Gazin et al. (1988), p.2: “*La maladie de l’oiseau implique que l’enfant n’a plus été, à un moment donné, symboliquement protégé contre cet oiseau maléfique et omniprésent. Cette atteinte peut correspondre à un accès pernicieux, à une crise convulsive hyperthermique, à une crise d’épilepsie*”.

5.2.1. The size of the government: classical approach of the role of the state.

Most traditional economists consider that the State should not interfere in the general activity. Consequently, the classical growth framework identifies a negative relationship between the size of the government and economic growth (see Zagler and Durnecker, 2003, for a review of the literature). This conception is based on the classical theory according to which any intervention of the state introduces economic distortions (through taxation, for example). Public spending is considered to be less efficient than market spending and may crowd out the private sector. Afonso and Furceri (2010) show a negative relationship between the size of the public sector and growth for European countries. This view of the role of the government is opposed to that of the Keynesian on the effect of fiscal expansion on economic growth.

Another strand of the literature on the size of the government introduces the consideration of initial growth. The relationship between the size of the government and economic development then appears non-linear. It follows the shape of a bell curve: the marginal efficiency of public expenditure is decreasing so that there is a point beyond which its effect is negative. Data on the size of government tends to illustrate the latter effect. On average over the period 1990-2015, total public expenditure represents 31.6 percent of Gross Domestic Product - GDP (Panel A in Figure 5.1). There is great heterogeneity between countries, particularly according to their income level and geographic area. Europe and Central Asia (ECA) and North America, which are predominantly high-income countries, have the highest public expenditure-to-GDP ratios, respectively 41 percent and 40 percent of GDP. In contrast, South Asia, Latin America and the Caribbean (LAC) and Sub-Saharan Africa (SSA) have the lowest ratios. However, we can see that the ratio of public expenditure to GDP has fallen in the ECA region and in North America. The other regions - which are mostly made up of emerging and developing economies - are experiencing the opposite phenomenon with slight increases in public expenditure as a percentage of GDP. The LAC region experienced the largest increase in public expenditure, 1 percent on average each year over the period 1990-2015.



Sources: TCdata360, World Development Indicators (WDI), World Health Organization, International Capital Stock Dataset (ICSD), and authors' own calculations.

5.2.1. The composition of public expenditure: productive versus unproductive spending

The analysis of the composition of public expenditure - of which Aschauer (1989) is one of the pioneering works - contrasts investment expenditure with consumption. However, the mere distinction between consumption and capital expenditure is not sufficient to understand the effect of the structure of public expenditure on economic growth Zagler and Durnecker (2003, p.405). Indeed, the literature also identifies spending on education, health, and research and development as contributing to promoting economic growth (Barro, 1990; Lucas Jr, 1988; Mushkin, 1962; Romer, 1990). The main limitation of this approach opposing two categories of public expenditure is the failure to take into account the existence of complementarity between them. unproductive expenditure can be essential for productive one. They can have a supporting role (investment in education and increase in the number of teachers) or an amplifying effect. In addition, the effect of the composition of public expenditure on growth could be conditioned on the initial proportion of the different components of public expenditure as identified in Devarajan *et al.* (1996).

We consider expenditure on education, health and public infrastructure to be the most productive. Expenditure on education include all expenditure allocated to education: current expenditure, capital and transfers. Public investment⁷⁸ covers all capital expenditures made by governments. Finally, expenditure on health is made up of current and capital expenditure from the government budget, loans or donations to the health sector. Public expenditure on education and health represents 4.5 percent and 3.7 percent of GDP respectively, while investment amounts to 5.1 percent of GDP (Panels B, C, and D in Figure 5.1). The components of public expenditure considered here as productive – education, health and public investment – decline with respect to the income level of the considered group of countries. It should be noted that middle income countries regardless of the region are the ones that invest the most. These countries have generally high growth rate which requires significant investments to sustain it.

5.2.2. The Analysis of the effectiveness or efficiency of public expenditure

A third strand of the literature focuses on the effectiveness or efficiency of public expenditure. Effectiveness is the achievement of fixed objectives while efficiency corresponds to an optimization of the resources in achieving the fixed objectives. Papers related to the efficiency of public expenditure have focused on either the efficiency of total public expenditure, or the efficiency of expenditure in one sector or at most two sectors. Studies related to effectiveness are mainly on developing countries and to a lesser extent emerging country. Effectiveness is to ensure that the objectives for which public resources are mobilized and committed are achieved. Public expenditure efficiency analyses, which cover all countries, estimate how to increase results for the same level of expenditure (maximization approach) or how to reduce expenditure for an unchanged level of results (minimization approach). The idea behind efficiency analyses is that there is an ideal frontier that no economic agent can cross. Thus, the analysis allows to estimate the gain in term of resource that a government could benefit by comparing it to its peers.

5.2.3. Some recent initiatives aiming to improve budget management and the quality of public expenditure

Budget transparency is a prerequisite for assessing the quality of public spending. The Global Initiative of Fiscal Transparency (GIFT) addresses this issue and involves the International Monetary Fund (IMF), the World Bank, the International Budget

⁷⁸ Following International Monetary Fund (2015, 2014), we use public investment data which may contain non-public infrastructure investments, as data on infrastructure spending is not widely available.

Partnership (IBP), the International Federation of Accountants (IFAC) and Public Expenditure and Financial Accountability (PEFA).

Assessing the quality of public expenditure requires studying the budget process (or model) which determines the allocation of public resources. Public finance management has evolved through the introduction in many countries of performance-based management. This mainly consists in controlling the results of public policies more than the expenditure circuit itself. A prerequisite for performance-based management requires identification and strengthening of responsibilities, which may require a simplification of the budget model by the elimination or consolidation of accounts or special funds. The adoption of budgetary rules can also modify the quality of public expenditure by constraining public decision-makers. Several instruments - such as the PEFA or the Public Investment Management Assessment (PIMA) - produced by the OECD, the IMF or the World Bank make it possible to assess the strengths and weaknesses of the budget model.

Cross-country analyses using these instruments are limited by the availability of widely comparable data as well as their temporal depth.

Beyond transparency, the institutional organization of public spending also impacts its quality. This organization varies in particular according to the degree of (de)centralization of public expenditure, the nature of public expenditure devolved to local authorities and the financial resources allocated to them. Indeed, by bringing political decision-makers closer to citizens (principle of proximity), decentralization aims to improve knowledge of the needs and preferences of populations by decision-makers (Hayek, 1948) on the one hand, and on the other hand, it should increase the responsibility and the effectiveness of local governments (Seabright, 1996). At the same time, the inter-jurisdictional competition that decentralization could induce (principle of competition), should improve the adequacy of the supply of public goods and services to the preferences of the inhabitants (Oates, 1972; Tiebout, 1956) and stimulate the search for efficiency by local governments (Besley and Case, 1995; Salmon, 1987).

Considering the expected benefits of greater proximity between policy makers and the population, several empirical studies assess the effectiveness of decentralized provision of public goods or services. Most of these analyses establish a positive impact. Faguet (2004) reveals that the composition of the public goods provided changed in Bolivia after decentralization, responding better to the needs of the populations concerned. Likewise, Bird and Rodriguez (1999) found a favorable effect of decentralization on access to health, primary education, housing and infrastructure in the Philippines. Galiani et al. (2008) have similar educational results in Argentina between 1994 and 1999. At the macroeconomic level, Robalino et al. (2001) establish a negative

correlation between the degree of decentralization and mortality rates, while Enikolopov and Zhuravskaya (2007) obtain a positive impact of decentralization on health and education indicators in 95 developed and developing countries between 1975 and 2000. Other empirical analyses nonetheless have more mixed results: Azfar and Livingston (2002) find little evidence of better local provision of public services in Uganda in 2000; Winkler and Rounds (1996) show that the decentralization of education in Chile has dramatically reduced the number of jobs in education affecting performance on knowledge assessment tests.

5.3. The outcomes indicator of public expenditure

5.3.1. Methodology of construction of the sectoral indices and the outcomes indicator of public expenditure

This section describes the methodology adopted for the construction of the public expenditure outcomes indicator; this indicator is then used as output in estimating efficiency frontier. The outcomes indicator is a composite index calculated from a weighted geometric mean⁷⁹ – the weights can be easily modified using the online application⁸⁰ – of indices standardized by sector. Figure E.1.1 summarizes the approach and presents all the variables used in the calculation. We closely followed the principles laid down in the OECD guidelines in the construction of the composite indicator and the choice of quality criteria (see OECD, 2008, for more details). More specifically, we relied on economic theories for the selection of variables and the final choice of inclusion in the analysis depends on the availability of data given the objective of cross-country comparison.

Each sectoral index – education, health, infrastructure – is calculated using a Principal Component Analysis (PCA). The PCA allows the combination of collinear variables in order to generate a composite indicator that captures the maximum information common to these variables. The weights allocation allows to correct for the information overlap between the correlated variables. In addition, the contribution of each variable in the sector index is determined statistically, reducing subjectivity in the analysis.

Before performing the PCA, a Cronbach coefficient Alpha is calculated for each sectoral index to determine the direction and degree of correlation between the different variables. Cronbach's alpha gives an estimate of the internal consistency of a set of indicators and indicates how relevant that set of individual indicators is for

⁷⁹ The computation method is inspired by that of the Human Development Index (HDI). We calculate sectoral indices and then aggregate them into a single indicator.

⁸⁰ A Shiny web application was created as part of the study. This application accompanies the study and allows, among other things, to make the calculation dynamic.

estimating a single one-dimensional indicator (OECD, 2008). The values of Cronbach's alphas are 0.5 for education and 0.8 for both health and infrastructure. The results of the respective PCAs show that the first component explain a large part of the total variability of the variables, confirming the relevance of the proposed approach. The first component represents 0.7, 0.9 and 0.8 respectively for the education, health and infrastructure indices. In addition to these three indices, an income index is calculated using the per capita GDP. This index is obtained with a z score calculated as follows:

$$Z_{it} = \frac{(x_{it} - \mu_{t0})}{\sigma_{t0}}, \quad (\text{eq. 5.1})$$

μ_{t0} and σ_{t0} represent respectively the mean and the standard deviation of the variable of the starting period, here 1990. This standardization prevents a variable from having too much influence on the components, and therefore on the sector index. In addition, standardization with respect to the central values of the starting period allows better consideration of improvements over time, especially those of countries lagging behind.

The outcomes indicator, denoted by OI , is as follows:

$$OI = \sqrt{\sum w_s \prod I_s^{w_s}}, \quad (\text{eq. 5.2})$$

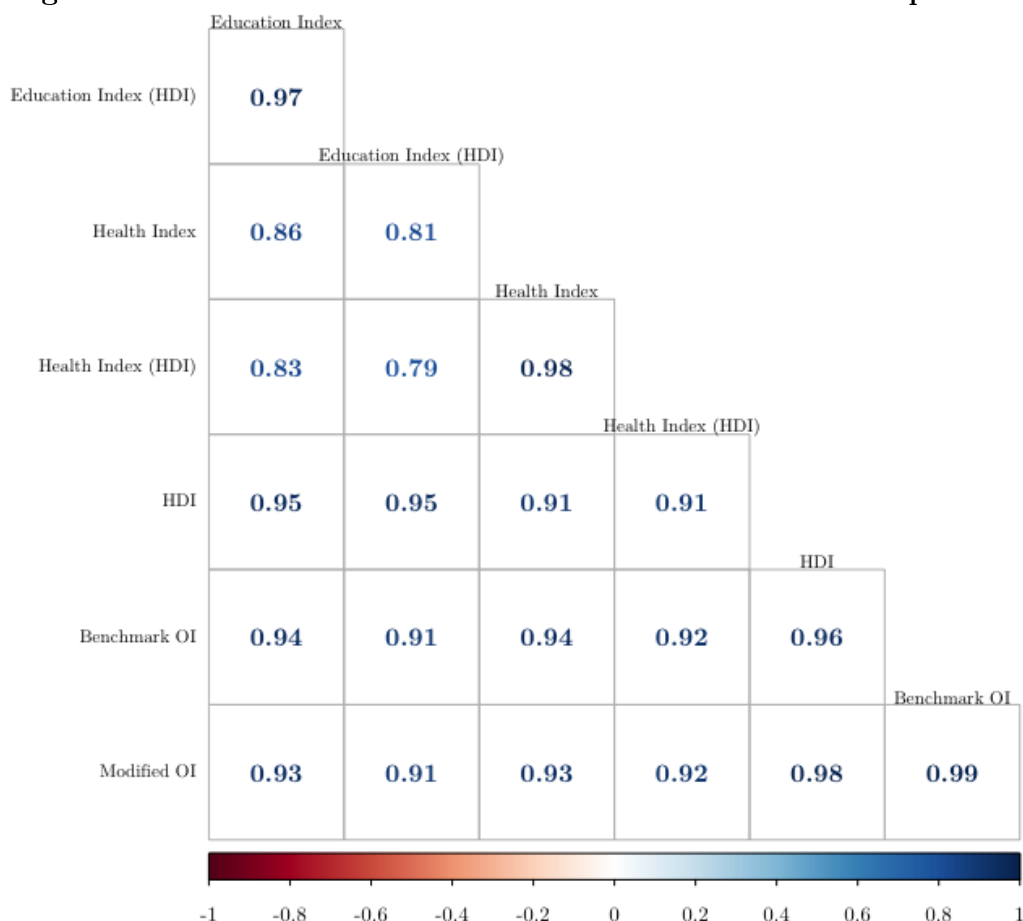
I_s represents the index of sector s and w_s the weight allocated to sector s .

The method has several advantages. First, low results in one dimension (sector) are not linearly compensated by good results in another one. Hence, the poor performance of a sectoral index is reflected in the final composite indicator since the level of substitutability between dimensions is reduced. The second advantage is that the user can easily adjust the weights allocated to the different indices, as in the Budget allocation process, and put emphasis on one particular sector. Finally, the method allows to make maximum use of all the available data and variables in the calculation of indices at the PCA step without overweighting the sector in the final calculation. Indeed, the calculation of a composite indicator often involves a trade-off between the number of variables used and the number of observations (in time and space) maintained in the analysis. As the availability varies from one sector to another, it is here possible to use a different number of variables per sector, since the calculation method relaxes the constraint of having the same number of variables per sector to equitably weight them in the final indicator.

The sectoral indices and the outcomes indicator provide a wide coverage of elements affected by public expenditure. To exhibit the relevance of our method, we compare the resulting indices and the indicator to the ones developed using the Human Development Index (HDI) approach developed by the United Nations Development Program (UNDP). Figure 5.2 presents the correlations between sectors' indices

obtained using separately our method and HDI's method as well as the relationship between our outcomes indicators and the HDI. The education and health indices are strongly correlated with those obtained by the HDI method. Similarly, a strong correlation exists between outcome indicators and the HDI itself.

Figure 5.2: Correlation of our indices with the HDI and components



Source: World Bank's Edstat, UNDP, and authors' own calculations.

Note: Education Index and health Index are the indices of education and health sectors respectively. Education Index (HDI) and Health Index (HDI) are the sectors' indices using the HDI method. Benchmark OI is the benchmark outcomes indicator and is the combination of the indices of education, health, and infrastructure using (5.2) with identical weights. Modified OI is the combination of the indices of education, health, infrastructure, and income using (5.2) with identical weights.

5.3.2. Measure of the outcomes of public expenditures

Public expenditure is meant to finance collective wants in order to maximize social and economic welfare. Given that objective, we measure its effectiveness by the government achievements in health, education, and infrastructure which public expenditure is supposed to finance. We use outcomes variables related to education, health and infrastructure in order to calculate an index for each sector.

In the remainder of this section, we present descriptive statistics of the variables used to calculate each sectoral index (presented in Figure E.1.1), which are then included in the calculation of the outcomes indicator.

5.3.2.1. Education

Education contributes to the formation and accumulation of human capital and implicitly favors growth and support economic development. Human capital is the basis of the majority of endogenous growth models (Barro, 1991) and not taking it into account can alter the results when one wants to understand the differences in growth between countries (Mankiw *et al.*, 1992).

We use four outcome variables⁸¹ to compute education index. The gross enrolment ratio indicates the extent to which the authorities of a country have succeeded in implementing mass education and literacy. In some countries (majority of African countries), the official language is a legacy of colonization. Access to employment – in particular qualified jobs – is therefore conditioned on a minimum level of literacy.⁸²The pupil-teacher ratio, particularly high in poor countries, can be an important indicator of the quality of education. It may provide an insight into the difference in resource allocated to education. The average number of years of schooling indicates the average level of education received by a person. The expected number of years of schooling provides information on the level of education that an individual can expect to achieve.

The selected outcome variables for the sector of education have improved in all regions of the world (see Figure 5.3). ECA and North America remain the best performers while SSA and South Asia lag significantly behind on all education variables. The mean years of schooling and the expected years of schooling are the most improved variables. The mean years of schooling has increased by 1.36% on average every year between 1990 and 2015. Countries in MENA, SSA, and South Asia recorded the highest average annual growth rates. South Asia and MENA regions are gradually narrowing the gap between them and the more developed regions. The pupil-teacher ratio remains very high in some regions (South Asia and SSA). Indeed, these countries have initiated incentive measures aimed at increasing school attendance however the number of schools and that of teachers remain insufficient.

The education index is calculated for 179 countries (see column I of Table E.2.1).⁸³ Most countries have good scores for this index: the average score is 0.65. About twenty

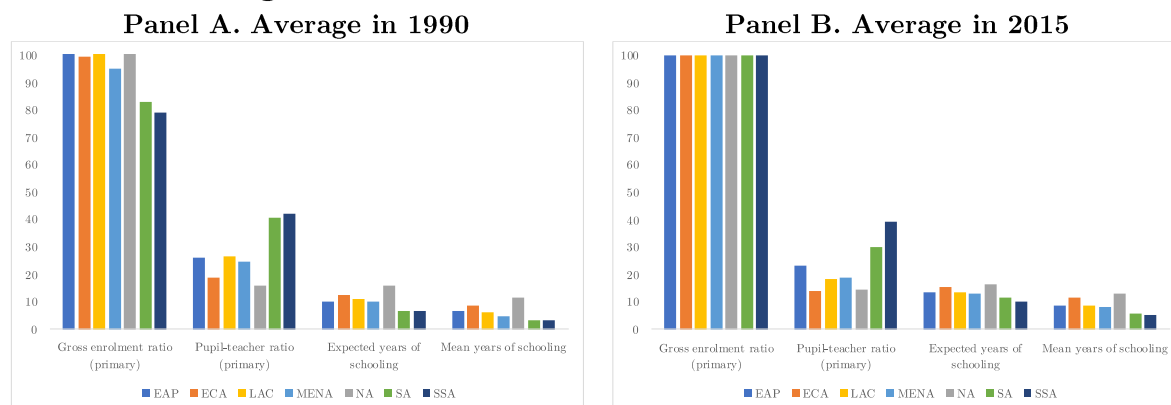
⁸¹ See Human Development Report (2010) for further discussion on the role of education outcome variables in improving human capital.

⁸² In addition, school is not compulsory in all countries of the world. There are still denominational schools in some countries (Catholic, Koranic or Evangelical). The existence of these “unconventional” education services may impact measures of human capital quality improvement, in particular because of issues relating to the recognition of these diplomas, job openings at the end of the cycle and the equivalence established with the conventional education curriculum.

⁸³ The ranking provides an overview of where countries stand and should be interpreted with caution since the panel is unbalanced. Some countries have data available only for recent years (e.g., Malta). Thus, the average

countries have on average scores below 0.4, these countries are essentially African countries. It should be noted that the education index improves over time in all regions of the world. However, South Asia and SSA are still lagging far behind.

Figure 5.3: Outcome variables of education sector



Source: World Bank's Edstat, UNDP, and authors' own calculations

5.3.2.2. Health

Along with expenditure on education, health spending is an investment in the human capital. Expenditure on health may increase the supply of labor force through a volume effect (reduction of mortality for instance). In addition, improving health allows a gain in labor productivity by reducing, for example, the number of sick leaves. Improving the health of the population reduces the risk that accompanies investments in education (Grigoriou and Rota-Graziosi, 2008) and reduces the rate of depreciation of the investment in human capital (Mushkin, 1962). It thus increases the return on investment in education.

Four outcome variables were included in the calculation of the health sector: the infants mortality rate, the mortality rate among children under five years, the female adult's mortality rate and the life expectancy at birth.

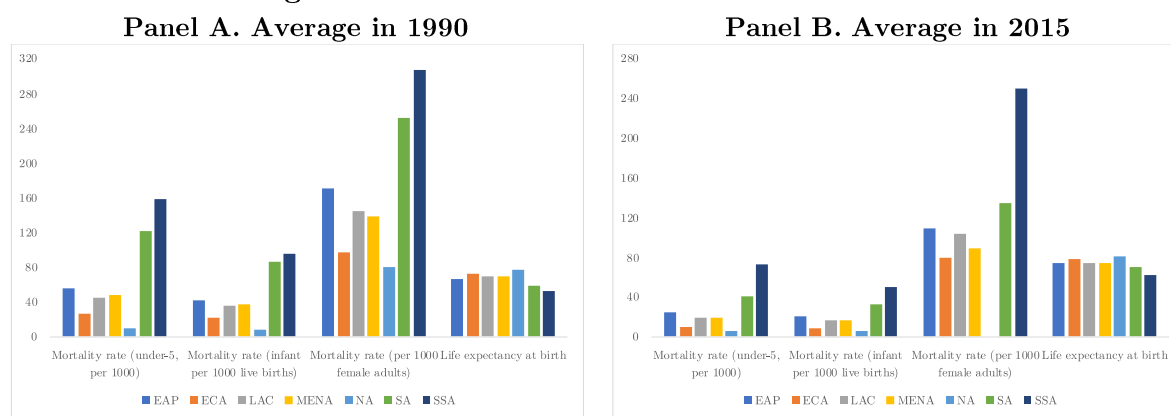
The outcome variables for the health sector have shown marked improvements (see Figure 5.4). Advances in medicine in high-income countries and better access to healthcare in developing countries explain the sustained decline in infant and maternal mortality. In particular, access to medicines and vaccines has improved in developing countries. The decline in mortality translates into an improvement in life expectancy, gradually changing the demographic structure of countries. High-income countries face

presented better reflects the current situation of the country, which is undoubtedly better than the situation over the entire period (1990-2015). Countries in this situation would of course be in the lead when considering the average. On the contrary, countries like Finland, which have data over relatively longer periods, may have lower averages. This remark applies to all classifications using average values.

an aging population while low-income countries are accelerating or even completing their demographic transition.

The health index is calculated for 187 countries. On average, scores of the health index are better than those of the education index, the average score being 0.75. The trend as well as the evolution over time by region are broadly the same as for education, with the African countries showing the worst results in particular (see column II of Table E.2.1). South Asian countries lag less behind in the health index compared to the education index.

Figure 5.4: Outcome variables of health sector



Source: World Bank's Edstat, WDI, and authors' own calculations

5.3.2.3. Public infrastructure

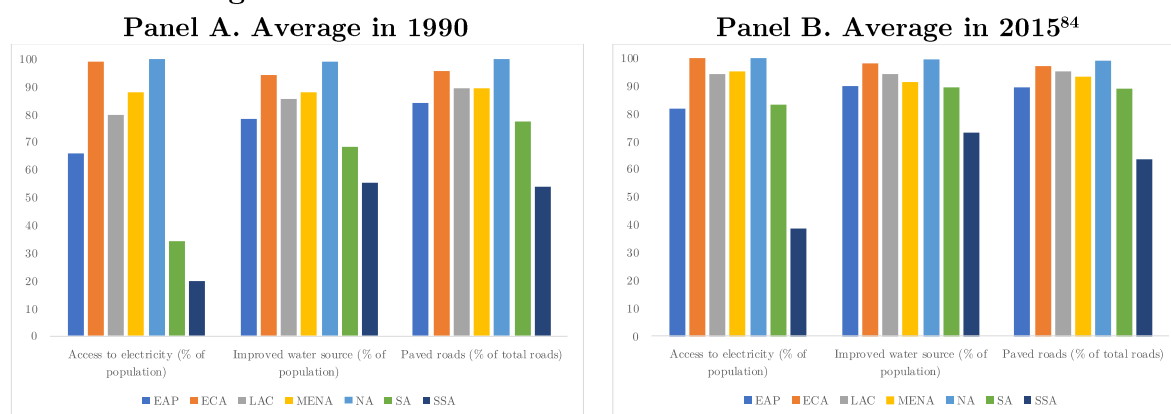
The differences in infrastructure endowments provide a partial explanation of the pronounced differences in development between countries. Public investments finance the provision of public goods, which generate positive externalities. Since Aschauer (1989), several papers have highlighted the crucial role of capital expenditure in economic growth (see Munnell, 1992, for a discussion). By increasing the capital stock and improving the productivity of allocated resources of States, public investments increase the productive capacity and the return on investment (Munnell and Cook, 1990). Public investments can increase private investments by making an economic region/area more competitive and more appealing to private capital (Martin and Rogers, 1995), hence, promoting employment and growth (Easterly and Rebelo, 1993). Finally, it is worth mentioning the key role of public infrastructure in reducing transaction costs (Roller and Waverman, 2001) and production costs. We use three variables to calculate the infrastructure index: The percentage of the population with access to electricity, the percentage of the population with access to an improved water source, and the proportion of paved roads in percentage of total roads.

For the selected variables, LAC, East Asia and MENA regions were able to considerably reduce the gap with North America and then ECA region. Countries in

these regions widely ensure access to basic services such as access to water (see Figure 5.5). Sub-Saharan Africa remains the only continent to have less than 50% of the population with access to electricity. Access to water is improving, although there are still disparities between countries and depending on whether one considers urban or rural areas.

The infrastructure index is calculated for 144 countries, with an average score of 0.7. This score is high in particular because in the majority of the countries with available data, access to electricity and water is fully (or almost) guaranteed for the whole population, these countries therefore have scores very close to 1, or even of 1. However, it is the index that shows the most dispersion (see column III of Table E.2.1). Like the two previous indices, the infrastructure index has improved over time. SSA and South Asia are the two worst performing regions. It should be noted, however, that infrastructure variables have improved considerably in South Asia, which is gradually catching up with countries in East Asia and the Pacific.

Figure 5.5: Outcome variables of infrastructure sector



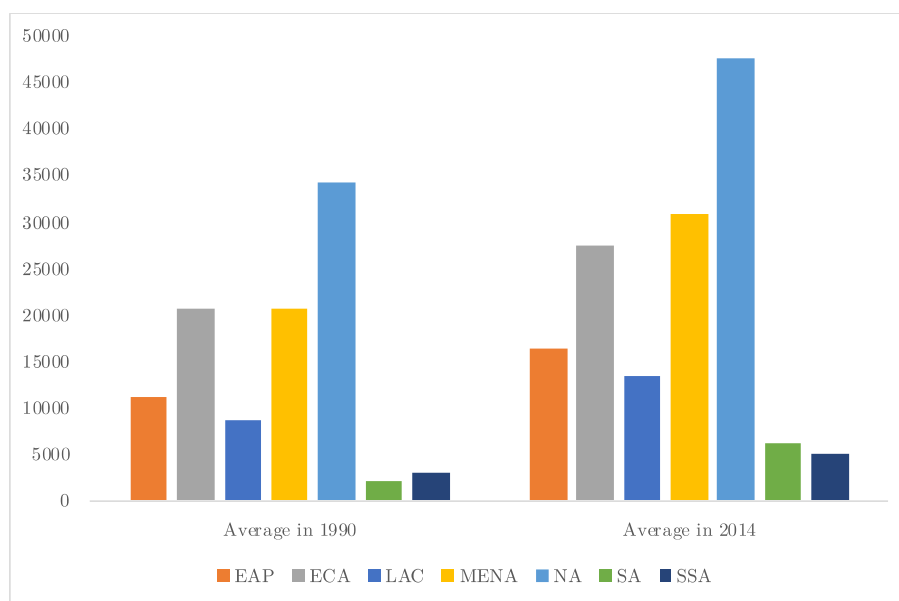
Source: WDI, International Road Federation, and authors' own calculations

5.3.2.4. Income

In addition to the three previous indices, we calculate an income index using the natural logarithm of the GDP per capita (PPP, 2011) based on (5.1). Per capita GDP is increasing in all regions of the world. South Asia is particularly dynamic with an annual average growth rate around 7%. Column IV of Table E.2.1 presents the scores of the income index for 186 countries.

Figure 5.6: GDP per capita (PPP, 2011 international USD)

⁸⁴ Data on electricity and road are respectively limited to 2014 and 2013.



Source: World Bank's Edstat and authors' own calculations

5.3.3. Results of the outcomes indicator of public expenditure

The indices presented above are used in the calculation of the outcomes indicator of public expenditure, which will itself be used as an output in the efficiency analysis based on a stochastic frontier approach. The outcomes indicator is a geometric mean of the sectoral indices with a weight allocated to each sector.

While the literature on public expenditure provides information on important sectors, the level of weighting of the different sectors can only be arbitrary. Thus, the tool developed as part of this analysis will allow experts to identify, depending on the sample, the sectors with the greatest impact and to weight them accordingly. This outcomes indicator of public expenditure will allow to assess the results achieved simultaneously in these sectors.

As indicated in the introduction, the definition of the quality of public expenditure depends on the objectives assigned to it. Public expenditure can be considered as a means of supporting and promoting economic growth: it affects positively human capital through a volume effect (increase in labor supply) and a quality effect (improvement in quality and productivity of workers). Public expenditure also impacts physical capital by encouraging private investments and increasing their net returns. Under this approach, productive public expenditure has a positive indirect effect on growth because it represents an investment in both human and physical capital. However, in a context of cross-country comparison, it is often difficult to separate the effect of public expenditure from the effect of other variables. For example, it is difficult to distinguish the effects on the health status of a population attributable to health programs from those attributable to better nutrition, better housing, better working conditions and higher incomes as noted by Mushkin (1962).

Public expenditure can also be seen as a direct source of economic growth. In this case, it is difficult to distinguish or isolate the simultaneous effect between public expenditure and economic growth (see Roller and Waverman, 2001, for a discussion) Is public expenditure increasing because the country is in a growth dynamic period (Wagner's law) or is it the increase in public expenditure that drives growth? The inability to process this simultaneity may result in biased estimates. Moreover, it will be particularly difficult to isolate the effect of public expenditure on growth from the effect of the multitude of variables identified as determinant of growth.⁸⁵

Considering the first approach (indirect channel), the benchmark outcomes indicator (BOI) is calculated using education, health and infrastructure indices with identical weights. We also use a modified outcomes indicator (MOI), obtained using education, health, infrastructure, and income indices in order to assess the robustness of our results.⁸⁶

The income level, that reflects the level of development, is positively associated with the outcomes indicator, with high income countries having the highest scores. High-income OECD countries are the best performers followed by non-OECD high-income countries. Results are mixed for middle-income countries, with some lower-middle income countries showing better results than their peers in the upper-middle category. The ranking by region shows that ECA and those of North America present the best scores. The bottom of the ranking is occupied by the SSA and South Asia. The outcomes indicator improves over time in all regions regardless of income level. In addition to having high scores, high-income countries present low heterogeneity. Despite having the worst performance, low-income countries are improving over time: the outcomes indicator is increasing by 2.4% on average each year. The annual average growth rate is 1.06% for lower-middle income countries while it stands at 0.69% for upper-middle income countries. The by-region analysis presents similar results: North America and ECA regions perform the best, but SSA and South Asia are experiencing the strongest growth rate on average each year.

⁸⁵ Facchini (2014), for instance, identified that 73 variables have been used as determinant of economic growth.

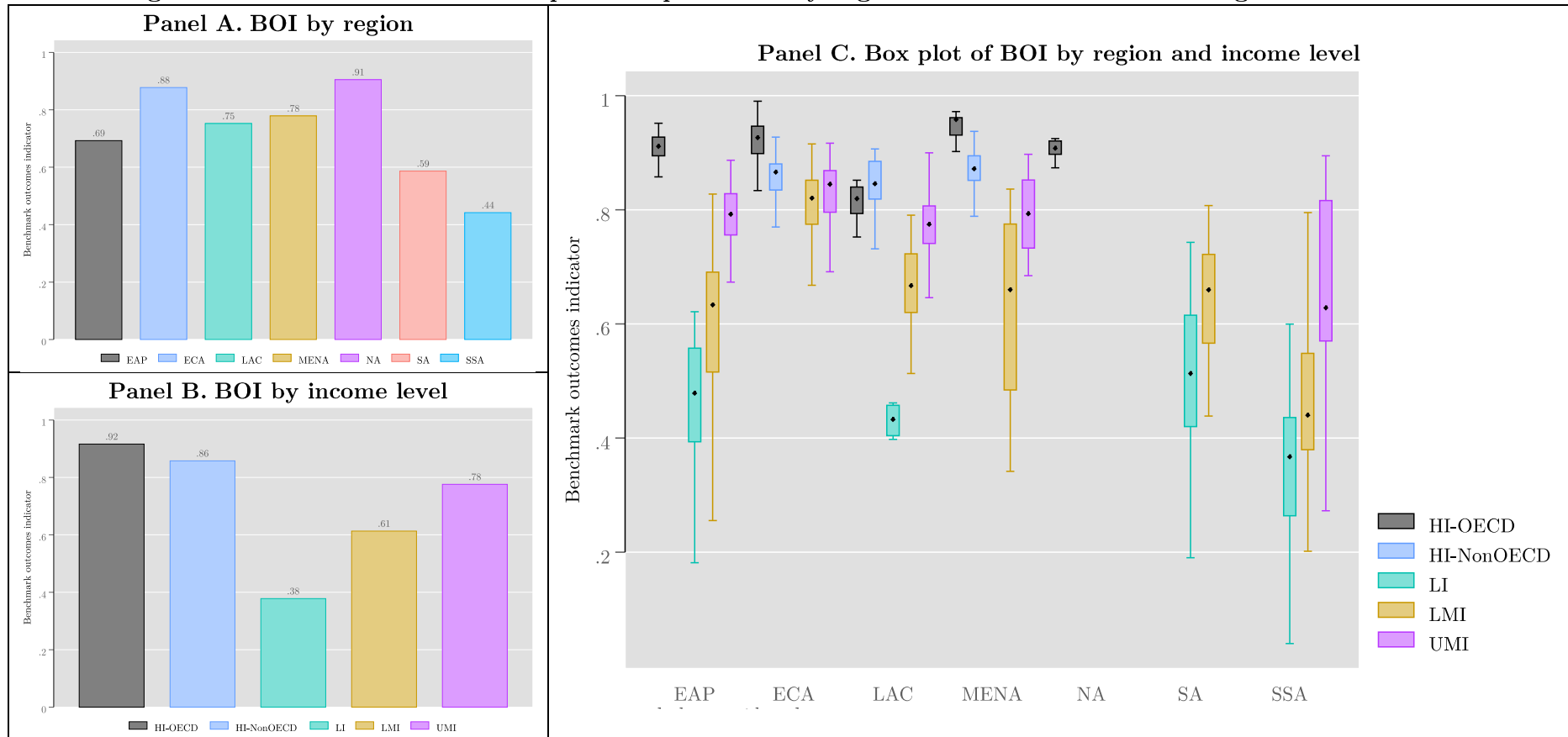
⁸⁶ The correlation coefficient between the two indicators is 0.99

Table 5.1: Outcomes indicator of public expenditure – country average over 1990-2015

Country	Scores		Country	Scores		Country	Scores		Country	Scores		Country	Scores				
	BOI	MOI		BOI	MOI		BOI	MOI		BOI	MOI		BOI	MOI			
Afghanistan	0.381	0.418	Central African Rep.	0.228	0.216	Gambia, The	0.478	0.422	Kyrgyz Republic	0.790	0.651	Nigeria	0.420	0.426	Sudan	0.441	0.427
Albania	0.809	0.733	Chad	0.221	0.236	Georgia	0.865	0.746	Lao PDR	0.478	0.452	Norway	0.961	0.941	Suriname	0.774	0.736
Algeria	0.765	0.723	Chile	0.815	0.778	Germany	0.946	0.907	Latvia	0.853	0.793	Pakistan	0.549	0.518	Swaziland	0.421	0.444
Angola	0.350	0.375	China	0.757	0.671	Ghana	0.532	0.486	Lebanon	0.882	0.814	Panama	0.768	0.728	Sweden	0.909	0.881
Argentina	0.822	0.776	Colombia	0.733	0.691	Greece	0.914	0.866	Lesotho	0.435	0.409	Papua New Guinea	0.311	0.330	Switzerland	0.978	0.950
Armenia	0.838	0.707	Comoros	0.588	0.491	Grenada	0.842	0.778	Liberia	0.441	0.343	Paraguay	0.714	0.661	Tajikistan	0.666	0.541
Australia	0.903	0.868	Congo, Dem. Rep.	0.330	0.261	Guatemala	0.637	0.603	Lithuania	0.828	0.781	Peru	0.706	0.662	Tanzania	0.390	0.374
Austria	0.932	0.899	Congo, Rep.	0.466	0.467	Guinea	0.333	0.319	Luxembourg	0.922	0.923	Philippines	0.674	0.613	Thailand	0.795	0.741
Azerbaijan	0.780	0.713	Costa Rica	0.794	0.741	Guinea-Bissau	0.378	0.348	Macedonia, FYR	0.833	0.766	Poland	0.902	0.847	Togo	0.438	0.382
Bahamas, The	0.838	0.811	Cote d'Ivoire	0.406	0.402	Guyana	0.664	0.610	Madagascar	0.407	0.369	Portugal	0.901	0.856	Tonga	0.793	0.693
Bahrain	0.899	0.879	Croatia	0.887	0.832	Haiti	0.431	0.412	Malawi	0.419	0.355	Qatar	0.879	0.913	Trinidad and Tobago	0.776	0.754
Bangladesh	0.508	0.455	Cuba	0.853	-	Honduras	0.653	0.587	Malaysia	0.833	0.791	Romania	0.803	0.758	Tunisia	0.801	0.731
Barbados	0.888	0.826	Cyprus	0.873	0.844	Hungary	0.852	0.810	Mali	0.237	0.243	Russian Federation	0.854	0.810	Turkey	0.752	0.728
Belarus	0.878	0.795	Czech Republic	0.925	0.871	Iceland	0.930	0.900	Malta	0.894	0.850	Rwanda	0.339	0.304	Uganda	0.267	0.246
Belgium	0.928	0.894	Denmark	0.946	0.911	India	0.618	0.557	Mauritania	0.366	0.372	Samoa	0.767	0.678	Ukraine	0.876	0.772
Belize	0.762	0.700	Djibouti	0.419	0.405	Indonesia	0.705	0.656	Mauritius	0.842	0.779	Sao Tome and Principe	0.652	0.573	United Arab Emirates	0.870	0.886
Benin	0.411	0.382	Dominica	0.802	0.731	Iran, Islamic Rep.	0.778	0.743	Mexico	0.758	0.730	Saudi Arabia	0.824	0.826	United Kingdom	0.940	0.898
Bhutan	0.684	0.638	Dominican Republic	0.751	0.704	Iraq	0.726	0.686	Moldova	0.804	0.676	Senegal	0.434	0.405	United States	0.910	0.890
Bolivia	0.668	0.616	Ecuador	0.728	0.683	Ireland	0.926	0.893	Mongolia	0.594	0.571	Serbia	0.874	0.805	Uruguay	0.864	0.801
Botswana	0.582	0.586	Egypt, Arab Rep.	0.757	0.699	Israel	0.948	0.893	Morocco	0.652	0.605	Seychelles	0.848	0.808	Uzbekistan	0.799	0.678
Brazil	0.781	0.741	El Salvador	0.740	0.684	Italy	0.930	0.893	Mozambique	0.262	0.228	Sierra Leone	0.238	0.236	Vanuatu	0.653	0.573
Bulgaria	0.881	0.803	Eritrea	0.398	0.369	Jamaica	0.766	0.707	Myanmar	0.516	0.455	Slovak Republic	0.896	0.838	Vietnam	0.713	0.617
Burkina Faso	0.362	0.337	Estonia	0.853	0.807	Japan	0.911	0.879	Namibia	0.544	0.539	Slovenia	0.925	0.872	West Bank and Gaza	0.788	-
Burundi	0.337	0.286	Ethiopia	0.305	0.277	Jordan	0.846	0.758	Nepal	0.576	0.490	Solomon Islands	0.559	0.489	Yemen, Rep.	0.484	0.472
Cabo Verde	0.734	0.655	Fiji	0.771	0.702	Kazakhstan	0.831	0.779	Netherlands	0.941	0.905	South Africa	0.638	0.628	Zambia	0.348	0.351
Cambodia	0.387	0.364	Finland	0.911	0.882	Kenya	0.445	0.421	New Zealand	0.922	0.879	Spain	0.928	0.883	Zimbabwe	0.493	0.453
Cameroon	0.415	0.407	France	0.931	0.893	Korea, Rep.	0.888	0.842	Nicaragua	0.623	0.564	Sri Lanka	0.754	0.685			
Canada	0.877	0.854	Gabon	0.627	0.641	Kuwait	0.845	0.863	Niger	0.247	0.229	St. Vincent & the Grenadines	0.814	0.746			

Source: Authors' calculations

Figure 5.7: Outcomes indicator of public expenditure by region and income level – Average over 1990-2015



Source: Authors' calculations

5.4. Estimation of public expenditure efficiency

5.4.1. Estimation strategy

Several approaches are adopted in the economic literature to estimate the efficiency frontier. Some papers – (see for instance, Afonso and St. Aubyn, 2006; Clements, 2002; Gupta and Verhoeven, 2001; International Monetary Fund, 2015; Yohou, 2015) – used non-parametric or semi-parametric methods (Data Envelopment Analysis – DEA or Free Disposal Hull – FDH). These methods rely on linear optimization programs to compute the efficiency frontier. They have the particularity of estimating the frontier without any restriction on the functional form between the inputs and the outputs. However, they remain sensitive to random variations in data and measurement errors. Thus, any variation between production units is likely to be interpreted as inefficiency. Moreover, the inefficiencies estimated by these models are very sensitive to variations in the sample, to heterogeneity between units and to the presence of outliers.⁸⁷

Parametric methods, in particular stochastic frontier approach (SFA), impose specific functional form on the production technology. However, their major advantages are that they deal with stochastic noise and allow richer specifications, especially with panel data (Hjalmarsson *et al.*, 1996; Odeck, 2007). The stochastic frontier models assume that no economic agent can go beyond an ideal frontier. Deviations from this ideal frontier represent inefficiencies.⁸⁸ From a statistical point of view, this is equivalent to considering a model characterized by an error term with two components: the first represents the idiosyncratic error term which captures the measurement errors and all the other classical noises while the second measures inefficiency. These models are estimated using a maximum likelihood with the objective of inferring the parameters associated with the frontier and the inefficiency (or efficiency) term.

As mentioned in Hjalmarsson *et al.* (1996), the choice of the stochastic model is the result of compromise. These trade-offs relate, among other things, to the purpose of the study, the type of data and the characteristics of the production technology. Our analysis relies on the SFA. This choice is based on the type of data and the flexibility offered by the SFA in the specification of the production technology. In particular, we use large panel data, and our production units are heterogeneous. Furthermore, random shocks are likely to affect the way our inputs affect output in some countries, so it is important to be able to take these shocks into account in the estimation of the efficiency score. The use of SFA also prevents potential measurement errors in public

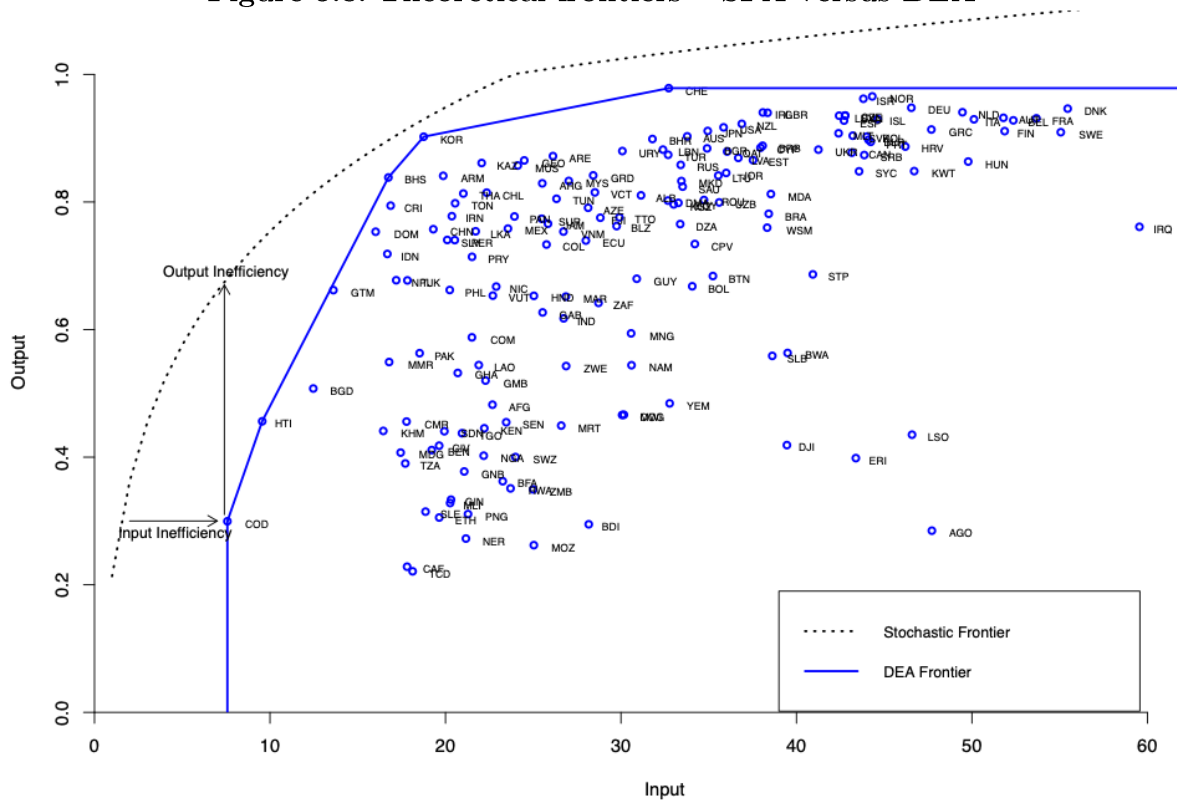
⁸⁷ See Hjalmarsson *et al.* (1996) and Odeck (2007) for more discussions.

⁸⁸ Introduced initially to model production and technical efficiency of firms (Aigner *et al.*, 1977; Meeusen and van Den Broeck, 1977), the production function predicts the maximum output that a firm can produce given its level of inputs.

expenditure data from affecting the efficiency scores by modelling them in the error term.⁸⁹

Figure 5.8 presents the theoretical frontiers using DEA and SFA. For a given point, inefficiency is measured by the distance between the point and the theoretical frontier. The points on the blue curve would all have an efficiency score of 1 (meaning 0 inefficiency) using DEA, while they would have inefficiency (admittedly close to zero) with SFA. Another difference between the two approaches will emerge in the aggregation scheme of the inputs when there is more than one. Moreover, our inputs are particular because we use both the level (total public expenditure as percentage of GDP) and the composition (share in total public expenditure of education, health and infrastructure sectors) of public expenditure, hence SFA is the most suitable.

Figure 5.8: Theoretical frontiers – SFA versus DEA



Source: Authors' calculations

Inefficiency, which, measures the degree to which public resources are poorly allocated to outcomes, may refer to input or output inefficiency. The relation that links the outcomes indicator to its optimal value with respect to the level and composition of public expenditure is given by $y = \gamma / (1 + \mu)$, with y the optimal value of the outcomes indicator and μ the inefficiency so that $\mu = 1 - \varepsilon$. Thus, an efficiency score ε means that μ percent of the country's public expenditure is not properly allocated. In other

⁸⁹ Devarajan *et al.* (1996) discuss the problems associated with data from developing countries, in particular GDP.

words, compared to its peer, the country could achieve μ percent more in terms of public expenditure outcomes or achieve the same level of outcomes by dividing its level of public expenditure by $(1 + \mu)$.⁹⁰

While most academic papers have focused on the efficiency of sectoral public expenditure, our objective is to assess the overall efficiency of public expenditure. The model specification is based on the relevant literature (see Afonso and St. Aubyn, 2006; Clements, 2002; Dabla-Norris et al., 2012; Devarajan et al., 1996; Sow and Razafimahefa, 2015). Some notable improvements are nevertheless proposed. We use the outcomes indicator calculated in section 5.3 as output. Moreover, we rely on a model that separates the error term into four components: The Generalized True Random Effects model (GTRE) introduced by Colombi *et al.* (2014); Kumbhakar *et al.* (2014); Tsionas and Kumbhakar (2014). We assess the extent to which countries could increase public expenditure outcomes, given the level and composition of public expenditure. The GTRE allows to take into account random shocks and is robust to the presence of heterogeneity within the panel. The approach was built on the basis of the limitations of previous models (Battese and Coelli, 1988, 1992; Cornwell *et al.*, 1990; Greene, 2005; Kumbhakar, 1990; Lee and Schmidt, 1993; Pitt and Lee, 1981) by separating the error into four components: persistent inefficiency, time-varying inefficiency, country random effect and the noise. Different methods are proposed in the literature to estimate the GTRE model. Colombi *et al.* (2014) use a maximum likelihood estimator (MLE), Kumbhakar *et al.* (2014) propose a multistep procedure, Tsionas and Kumbhakar (2014) rely on a Bayesian approach and finally Filippini and Greene (2016) use a simulated maximum likelihood approach. The model to be estimated is as follows:

$$Y_{it} = \alpha_0 + f(X_i; \beta) + \vartheta_i + v_{it} - \eta_i - \mu_{it} \quad (\text{eq. 5.3})$$

η_i and μ_{it} are persistent and time-varying inefficiencies respectively while ϑ_i and v_{it} represent respectively random effects and the stochastic noise.

The MLE approach from Colombi *et al.* (2014) provide a form of log-likelihood based on assumptions about the distribution of the four error terms. Assuming that v_{it} is independent and identically distributed (iid) with a normal distribution and μ_{it} is iid with a half-normal distribution the error term $\psi_{it} = v_{it} - \mu_{it}$ follows an asymmetric normal distribution with parameters $\lambda = \sigma_v/\sigma_\mu$ and $\sigma = \sigma_v^2 + \sigma_\mu^2$. Similarly, the error term $\gamma_i = \vartheta_i - \eta_i$ follows an asymmetric normal distribution of parameter $\sigma = \sigma_\vartheta/\sigma_\eta$ and $\sigma = \sigma_\vartheta^2 + \sigma_\eta^2$. The two-term error $\varepsilon_{it} = \psi_{it} + \gamma_i$ is the sum of two asymmetric normal

⁹⁰ While we are able to control for the differences in the composition of public expenditure, the inability to separate inefficiency due solely to the level of public expenditure from inefficiency due to an inadequate allocation between unproductive and productive expenditure remains an important limitation of our analysis.

distributions and then admits a known density. It is therefore possible to define the function of the log-likelihood and to deduce from it the MLE of the parameters. However, the complexity of the likelihood function, which, in his form, involves T_i integrations, makes very hard the implementation in practice.⁹¹ Filippini and Greene (2016) proposes a computation method based on Butler and Moffitt (1982) formulation to simplify the log-likelihood function and subsequently estimates the MLE using a simulation-based optimization. With the same assumptions on the parameters as before, the idea is to obtain the conditional density $f(\varepsilon_i/\gamma_i)$, which is defined on ψ_i . This manipulation involves only one integration instead of T_i integrations. Moreover, the resulting integral is approximated by the Monte Carlo method in optimization of the log-likelihood. In order to simplify the implementation of the estimation, we use the multi-step procedure proposed by Kumbhakar *et al.* (2014).⁹² The model based on (5.3) is estimated in three steps:

In the first step, a standard random-effect regression is used to estimate $\hat{\beta}$ and predict the values of ε_{it} and γ_i . We estimate the following equation:

$$Y_{it} = \alpha^* + f(X_{it}, \beta) + \varepsilon_{it} + \gamma_i, \quad (\text{eq. 5.4})$$

where $\alpha^* = \alpha_0 - E(\eta_i) - E(\mu_{it})$, $\gamma_i = \vartheta_i - \eta_i + E(\eta_i)$, $\varepsilon_{it} = v_{it} - \mu_{it} + E(\mu_{it})$, $E(\eta_i) = \sqrt{\frac{2}{\pi\sigma_\eta}}$, and $E(\mu_{it}) = \sqrt{\frac{2}{\pi\sigma_\mu}}$.

In the second step, we rely on a standard stochastic frontier technique to estimate the time-varying inefficiency component μ_{it} using the predicted values of ε_{it} from the first step. Following Battese and Coelli (1988), this procedure gives the prediction of the time-varying inefficiency $\exp(-\mu_{it}|\varepsilon_{it})$.

Finally, in the first step, we estimate the persistent inefficiency component, denoted by η_i by performing a standard stochastic frontier technique as in the previous step. The persistent inefficiency is then defined by $\exp(-\eta_i)$.

The outcomes indicator of public expenditure represents the output. The inputs are total public expenditure in percent of GDP and the share in total public expenditure of sectors considered productive (education, health and infrastructure). The selected inputs capture simultaneously the level and the composition of public expenditure, allowing to compare between countries the degree of public intervention and the proportion of resources allocated to productive expenditure. Indeed, the size of the government alone is not enough to determine the differences in the quality of public expenditure. As point out by Sheldon (2007), there are many variables that can

⁹¹ For these authors a direct optimization of the log-likelihood of the model appears complex.

⁹² See Kumbhakar *et al.* (2015) for the estimation procedure.

influence a government's public expenditure and therefore its size. The variables identified can be structural or cyclical, cause a change in aggregate demand or measure the extent of political representation.⁹³ Shelton's (2007) results emphasize the importance of considering the structure of governments. The composition of public expenditure can thus reflect the differences in structure or in the social contract (implicit) or not that binds the governors to the governed. The composition of public expenditure alone is not sufficient to explain the differences in quality. Using an extension of Barro (1990), Lee (1992) demonstrates that different sizes of government are associated with different proportions of productive expenditure. Thus, it will be possible to better estimate the quality of expenditure by taking into account both the size of the government and the composition of expenditure.

5.4.2. Results of public expenditure efficiency

5.4.2.1. Benchmark results

Table 5.2: Step-one results of the approach of Kumbhakar *et al.* (2014)

Variables	BOI	MOI	BOI	BOI	MOI
	I	II	III	IV	V
Total public expenditure (% of PIB)	0.003*** (0.0002)	0.003*** (0.0002)		0.003*** (0.0002)	0.003*** (0.0002)
Pub. exp. on edu. (% of total pub. exp.)	0.002*** (0.0003)	0.001*** (0.0003)	0.002*** (0.0003)	0.003*** (0.0003)	0.002*** (0.0003)
Pub. exp. on health (% of total pub. exp.)	0.004*** (0.0004)	0.004*** (0.0004)	0.001*** (0.0004)	0.004*** (0.0004)	0.004*** (0.0004)
Pub. investment (% of total pub. exp.)	0.001*** (0.0001)	0.001*** (0.0001)	0.000*** (0.0001)	0.001*** (0.0001)	0.001*** (0.0001)
Total public expenditure per capita			0.000*** (0.0000)		
Natural resources rents (% of PIB)				0.003*** (0.0002)	0.003*** (0.0002)
Constant	0.531*** (0.0172)	0.512*** (0.0157)	0.598*** (0.0147)	0.500*** (0.0169)	0.484*** (0.0155)
Observations	2488	2488	2488	2446	2446
R-squared	0.278	0.292	0.335	0.054	0.072
Number of countries	146	146	146	145	145

Note: Standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). The table reports the results for the first step of the estimation procedure of public expenditure efficiency.

The results of the first step of the approach of Kumbhakar *et al.* (2014) are presented in Table 5.2 (see column I for the results of the baseline specification). The inputs

⁹³ Shelton (2007) identifies nine variables that can influence public expenditure. It divides these variables in two groups: the "demand shifters" (trade openness, population, GDP per capita, ethnic fragmentation and income inequality) and the manner in which political system operates on a fixed demand (extent of political representation type of electoral system, type of government, federal character or not of the system).

chosen are all significant at the one percent: public expenditure and its composition are good determinants of the outcomes indicator.

Efficiency scores measure the extent to which the expenses incurred achieve results. Table 5.3 contains descriptive statistics of the estimation results: the total, time-varying and persistent efficiency. The average efficiency score over the period is 0.71.

Table 5.3: Summary of public expenditure efficiency – Baseline results

Efficiency	Mean	Standard deviation.	Minimum	Maximum
Time-varying	0.852	0.037	0.639	1.000
Persistent	0.830	0.140	0.519	0.995
Total	0.707	0.123	0.348	0.885

Source: Authors' calculations

We estimated public expenditure efficiency for 146 countries. Table 5.4 presents countries' average efficiency score over the period 1990 to 2015. An efficiency score ε means that $1 - \varepsilon$ percent of country's public expenditure is inefficiently allocated. For example, on average over the period, public expenditure in Côte d'Ivoire stands at 23 percent of GDP and its efficiency score is 0.55, meaning that compared to its peer, Côte d'Ivoire could increase the efficiency of its public expenditure by 45 percent ($= 1 - 0.55$) on average. In other words, a country with an optimal distribution of public expenditure between productive and unproductive expenditure would have achieved 45 percent more in terms of results for the same level of public expenditure as Côte d'Ivoire.

Figure 5.9 presents the average efficiency by region (Panel A) and by income level (Panel B) using the baseline specification. SSA and South Asia lag behind with an average efficiency score of 0.55 and 0.66 respectively. EAC, MENA, and LAC regions are at the same level while the ranking is dominated by EAC and North America. Focusing on efficiency and income level, the results show an improvement in efficiency as the country's income level increases. Low-income countries are those with the highest level of inefficiency on average. OECD countries are characterized by low dispersion in general. High-income non-OECD countries also score well but are characterized by greater heterogeneity, especially for MENA and LAC countries. The greatest heterogeneities in efficiency scores are observed for middle-income countries.

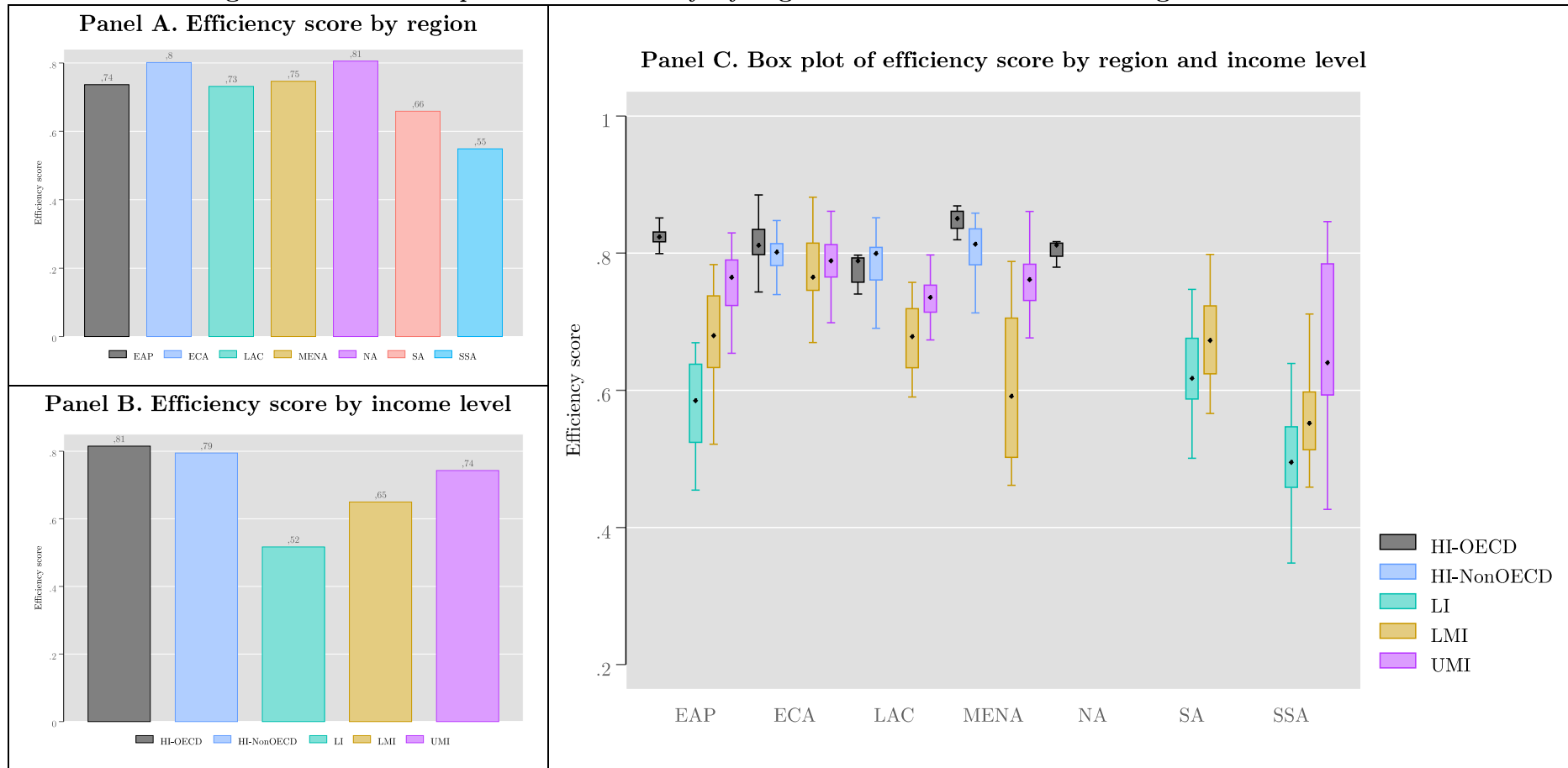
Table 5.4: Public expenditure efficiency – country average over 1990-2015

Country	I	II	III	IV	V	Country	I	II	III	IV	V	Country	I	II	III	IV	V	Country	I	II	III	IV	V
Albania	0.77	0.76	0.81	0.76	0.77	Cyprus	0.81	0.84	0.79	0.80	0.85	Kuwait	0.77	0.84	0.61	0.67	0.76	Romania	0.77	0.78	0.80		
Algeria	0.75	0.76	0.79	0.69	0.72	Czech Republic	0.83	0.83	0.84	0.81	0.84	Kyrgyz Republic	0.74	0.69	0.80	0.72	0.68	Russian Federation	0.80	0.82	0.82	0.76	0.79
Angola	0.44	0.49	0.49	0.38	0.43	Denmark	0.81	0.84	0.76	0.79	0.84	Lao PDR	0.59	0.61	0.62	0.57	0.60	Rwanda	0.52	0.52	0.55	0.50	0.51
Argentina	0.78	0.79	0.81	0.76	0.79	Djibouti	0.49	0.51	0.54	0.48	0.51	Latvia	0.80	0.81	0.82	0.78	0.81	Sao Tome and Principe	0.65	0.62	0.72	0.63	0.63
Armenia	0.83	0.77	0.84	0.81	0.78	Dominica	0.75	0.75	0.80	0.74	0.75	Lebanon	0.83	0.83	0.85	0.83	0.84	Saudi Arabia	0.76	0.81	0.71	0.65	0.72
Australia	0.82	0.85	0.82	0.81	0.85	Dominican Republic	0.75	0.75	0.76	0.74	0.76	Lesotho	0.48	0.51	0.54	0.47	0.50	Senegal	0.55	0.57	0.58	0.54	0.56
Austria	0.81	0.84	0.77	0.80	0.84	Ecuador	0.72	0.73	0.75	0.69	0.72	Lithuania	0.76	0.78	0.79	0.76	0.79	Serbia	0.78	0.78	0.84	0.77	0.78
Azerbaijan	0.76	0.76	0.78	0.69	0.71	Egypt, Arab Rep.	0.76	0.76	0.79	0.72	0.74	Luxembourg	0.82	0.86	0.66	0.81	0.87	Seychelles	0.78	0.79	0.80	0.77	0.80
Bahamas, The	0.80	0.83	0.80	0.79	0.83	El Salvador	0.73	0.73	0.75	0.71	0.73	Macedonia, FYR	0.76	0.75	0.82	0.75	0.76	Sierra Leone	0.48	0.50	0.50	0.45	0.48
Bahrain	0.84	0.86	0.80	0.82	0.87	Estonia	0.78	0.79	0.80	0.77	0.81	Madagascar	0.53	0.54	0.55	0.51	0.53	Slovak Republic	0.81	0.81	0.84	0.80	0.82
Bangladesh	0.60	0.60	0.61	0.59	0.60	Ethiopia	0.46	0.47	0.48	0.43	0.45	Malawi	0.53	0.52	0.58	0.51	0.51	Slovenia	0.83	0.84	0.84	0.83	0.86
Barbados	0.80	0.80	0.83	0.79	0.81	Fiji	0.74	0.74	0.78	0.73	0.74	Malaysia	0.79	0.80	0.80	0.75	0.78	South Africa	0.64	0.68	0.67	0.62	0.67
Belarus	0.81	0.80	0.85	0.79	0.81	Finland	0.80	0.83	0.76	0.78	0.83	Mali	0.47	0.49	0.49	0.45	0.48	Spain	0.83	0.84	0.82	0.82	0.85
Belgium	0.81	0.84	0.77	0.80	0.84	France	0.80	0.83	0.78	0.79	0.83	Malta	0.81	0.83	0.81	0.80	0.84	Sri Lanka	0.76	0.75	0.78	0.75	0.75
Belize	0.72	0.73	0.76	0.71	0.72	Gabon	0.66	0.71	0.66	0.59	0.65	Mauritania	0.54	0.57	0.57	0.48	0.52	St. Vincent & the Grenadines	0.75	0.75	0.79	0.74	0.75
Benin	0.54	0.55	0.56	0.52	0.55	Gambia, The	0.57	0.57	0.60	0.56	0.57	Mauritius	0.81	0.81	0.83	0.80	0.82	Sudan	0.55	0.58	0.57	0.53	0.56
Bhutan	0.66	0.67	0.71	0.64	0.67	Georgia	0.84	0.80	0.86	0.84	0.80	Mexico	0.73	0.76	0.75	0.71	0.75	Swaziland	0.51	0.56	0.53	0.50	0.55
Bolivia	0.65	0.66	0.70	0.63	0.65	Germany	0.83	0.85	0.80	0.81	0.86	Moldova	0.74	0.70	0.81	0.73	0.70	Sweden	0.78	0.82	0.75	0.77	0.82
Botswana	0.58	0.63	0.62	0.57	0.62	Ghana	0.60	0.61	0.63	0.56	0.59	Mongolia	0.63	0.66	0.67	0.59	0.63	Switzerland	0.85	0.87	0.80	0.85	0.88
Brazil	0.74	0.76	0.72	0.73	0.76	Greece	0.81	0.83	0.82	0.80	0.84	Morocco	0.64	0.66	0.67	0.63	0.66	Tajikistan	0.69	0.63	0.71	0.69	0.63
Bulgaria	0.82	0.81	0.85	0.81	0.81	Guatemala	0.66	0.68	0.68	0.65	0.68	Mozambique	0.45	0.47	0.49	0.43	0.46	Tanzania	0.51	0.53	0.53	0.49	0.52
Burkina Faso	0.49	0.51	0.52	0.46	0.49	Guinea	0.50	0.53	0.52	0.47	0.50	Myanmar	0.67	0.67	0.68	0.65	0.67	Thailand	0.76	0.76	0.78	0.74	0.76
Burundi	0.47	0.48	0.50	0.43	0.45	Guinea-Bissau	0.52	0.54	0.54	0.49	0.52	Namibia	0.57	0.61	0.61	0.56	0.60	Togo	0.54	0.55	0.56	0.51	0.53
Cabo Verde	0.69	0.68	0.75	0.68	0.69	Honduras	0.65	0.65	0.69	0.64	0.65	Nepal	0.66	0.64	0.68	0.65	0.64	Trinidad and Tobago	0.73	0.76	0.75	0.70	0.74
Cambodia	0.56	0.57	0.57	0.55	0.57	Hungary	0.76	0.78	0.79	0.75	0.79	Netherlands	0.82	0.84	0.78	0.81	0.85	Tunisia	0.75	0.74	0.78	0.72	0.74
Cameroon	0.55	0.58	0.57	0.53	0.57	Iceland	0.81	0.84	0.77	0.80	0.85	New Zealand	0.82	0.84	0.82	0.80	0.84	Turkey	0.82	0.83	0.83	0.80	0.84
Canada	0.78	0.82	0.76	0.77	0.82	India	0.65	0.65	0.68	0.64	0.65	Nicaragua	0.65	0.65	0.69	0.63	0.65	Ukraine	0.80	0.77	0.85	0.78	0.76
Central African Rep.	0.44	0.46	0.46	0.43	0.45	Indonesia	0.74	0.74	0.74	0.71	0.73	Niger	0.44	0.46	0.46	0.42	0.45	United Arab Emirates	0.83	0.87	0.68	0.79	0.87
Chad	0.45	0.48	0.46	0.41	0.45	Iran, Islamic Rep.	0.74	0.76	0.76	0.68	0.72	Norway	0.83	0.86	0.72	0.80	0.86	United Kingdom	0.84	0.86	0.83	0.83	0.87
Chile	0.78	0.80	0.79	0.74	0.77	Ireland	0.83	0.85	0.80	0.82	0.86	Pakistan	0.63	0.65	0.64	0.62	0.65	United States	0.81	0.85	0.76	0.80	0.85
China	0.66	0.63	0.70	0.65	0.63	Israel	0.85	0.86	0.85	0.85	0.87	Panama	0.71	0.75	0.76	0.73	0.76	Uruguay	0.81	0.81	0.84	0.80	0.81
Colombia	0.70	0.72	0.75	0.68	0.71	Italy	0.82	0.84	0.79	0.81	0.85	Paraguay	0.74	0.71	0.74	0.69	0.71	Vietnam	0.75	0.72	0.80	0.72	0.71
Comoros	0.64	0.61	0.66	0.62	0.61	Japan	0.82	0.84	0.81	0.81	0.85	Peru	0.72	0.73	0.74	0.69	0.72	Yemen, Rep.	0.54	0.57	0.58	0.48	0.53
Congo, Rep.	0.54	0.58	0.56	0.46	0.51	Jordan	0.76	0.75	0.82	0.75	0.75	Philippines	0.69	0.69	0.71	0.68	0.69	Zambia	0.47	0.50	0.50	0.46	0.50
Costa Rica	0.74	0.74	0.77	0.72	0.74	Kazakhstan	0.83	0.84	0.84	0.77	0.80	Poland	0.81	0.82	0.84	0.80	0.83	Zimbabwe	0.59	0.59	0.63	0.56	0.57
Cote d'Ivoire	0.53	0.56	0.55	0.51	0.55	Kenya	0.54	0.56	0.57	0.53	0.56	Portugal	0.80	0.82	0.81	0.79	0.82						
Croatia	0.80	0.81	0.83	0.79	0.81	Korea, Rep.	0.84	0.85	0.84	0.83	0.86	Qatar	0.84	0.87	0.64	0.77	0.86						

Source: Authors' calculations

Note: The table reports countries average efficiency scores for the various specifications in Table 5.2.

Figure 5.9: Public expenditure efficiency by region and income level – Average over 1990-2015



Source: Authors' calculations

test was aimed at testing the effect of input changes. Finally, considering that the public expenditures made during a year are likely to impact the results only the years following their realization, an additional sensitivity test is proposed to ensure that the results are robust to a time lag (delay) of the inputs.

The first robustness check, which consists in using the MOI as output, results in an average change in efficiency of 1.9 percent (see Table 5.4, column II). Most countries experience an increase in the efficiency score. Countries experiencing declines in efficiency scores are middle-income countries. While the efficiency scores change only slightly (for example the average absolute value of the deviations in efficiency scores is 0.02 and only 5 countries present an absolute value of the deviation in efficiency score greater than 0.05), the ranking of countries is changed. In particular, oil-rich countries (Qatar, United Arab Emirates) and countries with a very high standard of living (Luxembourg, United States) have seen their rankings improve significantly.

Following these results, we assess the effects of the endowment in natural resources, which is associated with a significant size of the public sector. Indeed, natural resource revenues can be used to finance public spending. These incomes can be consumed⁹⁵ or distributed for patronage purposes such as public sector employment or other benefits targeted at a specific group (Robinson *et al.*, 2006). Adding natural resources rent in percent of GDP as additional input has a minor change on the results (see Table 5.2 and 6.4, columns IV and V). The comparison of columns II and V shows a slight change in countries' average score: the average absolute value of the differences is 0.01. Only five countries have absolute efficiency score gaps greater than 0.05. All of these countries are very rich in natural resources. While these results are not enough to prove the negative role of natural resources on public expenditure outcomes, they are to be linked to the literature about the political economy of natural resources, in particular theories stating that natural resources have negative effects on the quality of institutions.⁹⁶ Moreover, our results may indicate inefficiency in the allocation of revenue from natural resources rent in these countries.

The second robustness check aims at assessing the effect of a change of the input, in particular, total public expenditure as a percentage of GDP is replaced by total public expenditure per capita. This substitution results in an average change in efficiency of 2.1 percent. The efficiency scores increase when we use public expenditure per capita.⁹⁷ High-income countries are those that experience a decline in efficiency, all other

⁹⁵ For instance, in the form of government transfer to individuals.

⁹⁶ See Cabrales and Hauk (2011); Robinson *et al.* (2006); Robinson and Torvik (2005); Torvik (2002) for more discussion.

⁹⁷ While for most countries the efficiency score increases, this strategy does not significantly change our baseline results: the average absolute value of the deviations remains low (0.03).

countries experience an increase in efficiency (see Table 5.4, column III). These results illustrate a decreasing marginal return (concavity effect) of public expenditure.

Finally, the third robustness check is based on the hypothesis of a certain inertia between public expenditure and its effects on the outcomes indicators. This test consists in delaying the inputs from one to three years (see Table E.4.1 and Table E.4.2). Along with a slight decrease in the explanatory power of the model in the first step regression (measured by the coefficient of determination), the introduction of delays only induced a small change in the results (Table E.4.1). In terms of efficiency, the introduction of delays only results in a very marginal improvement in efficiency, but the trends in scores remain unchanged (see Table E.4.2).

5.4.3. Analysis of the efficiency scores for a few countries

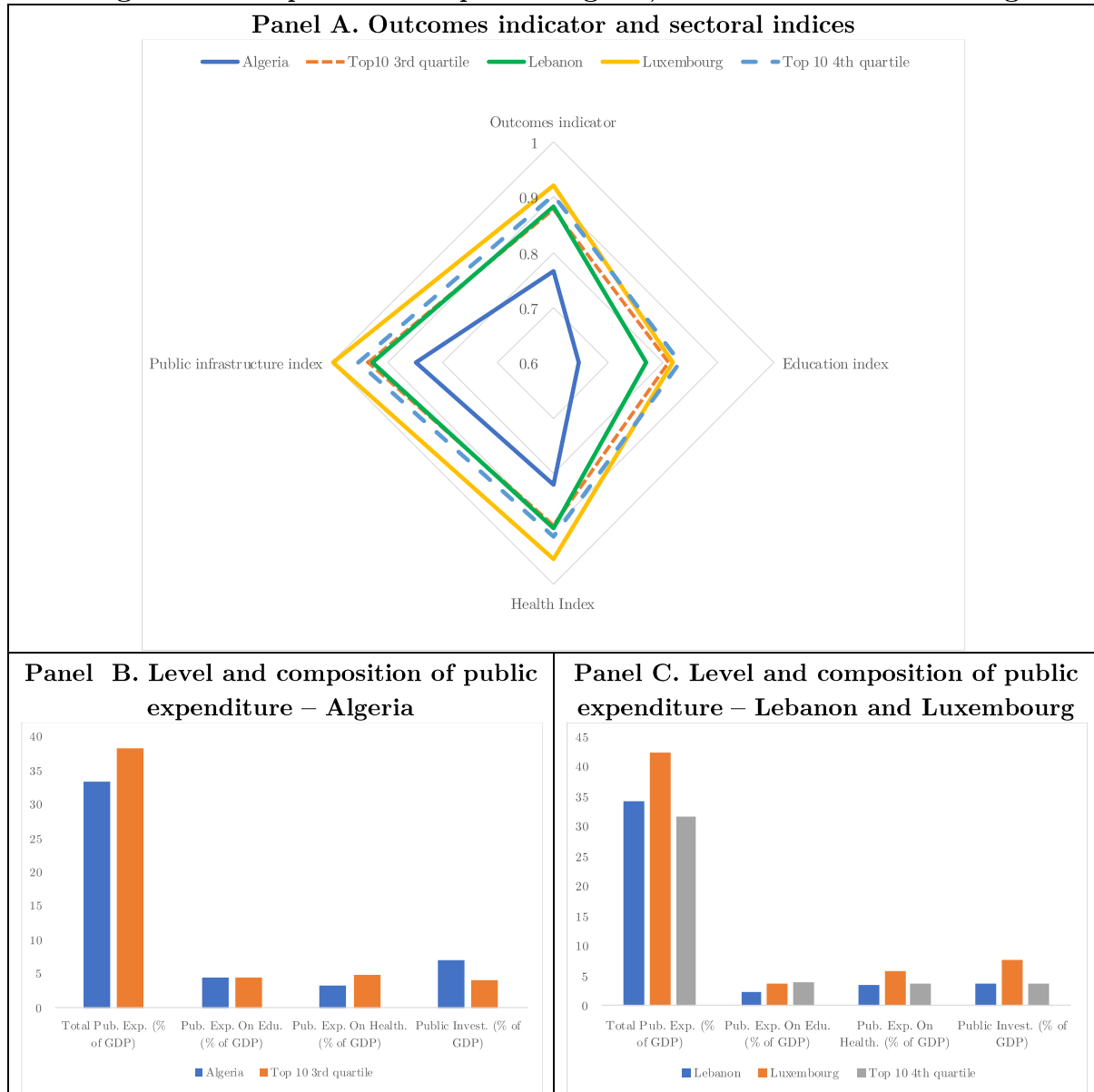
For illustrative purpose, this section presents in detail the public expenditure efficiency obtained from the baseline specification for a few countries: Algeria, Lebanon and Luxembourg.

Algeria is ranked 69th with an average efficiency score of 0.75.⁹⁸ On average, the outcomes indicator is 0.77 (0.8 over the period 2006-2010) for a level of public expenditure of 33 percent of GDP (74th). The country devotes a little less than 30% of total public expenditure to productive spending. Algeria is among the countries in the 3rd quartile of the efficiency score. Compared to the top 10 countries of the 3rd quartile, the country performs worse. The difference is particularly pronounced for the education index. The country also devotes a small proportion of its public expenditure to productive spending, with exception of public investment.

Lebanon is ranked 8th in terms of efficiency with an efficiency score of 0.83 on average while the average level of public expenditure is relatively low at around 34 percent of GDP (69th). Lebanon has an efficiency score comparable or even higher than some richer countries such as Luxembourg (18th in terms of efficiency). In addition to the potential decreasing returns to scale of public expenditure beyond a certain level, this can be explained by the relative lower level of public expenditure devoted to public expenditure 34 percent of GDP while Luxembourg spends more 42 percent of GDP.

⁹⁸ Due to missing data, efficiency scores are available from 2006 to 2010.

Figure 5.11: Inputs and output in Algeria, Lebanon and Luxembourg



Source: Authors' calculations

5.5. Conclusion

We present a measure of public expenditure efficiency for 146 countries over the period 1995-2015. From sectoral indices, we construct a one-dimensional outcomes indicator of public expenditure. We then propose a stochastic frontier model to rank countries according to the efficiency of their public spending.

Sub-Saharan Africa and South Asia appear to be lagging behind with efficiency scores of 0.55 and 0.66, respectively, while the average efficiency over the period is 0.71. East Asia, the Middle East and Latin America have similar level of efficiency, and the ranking is dominated by Europe and Central Asia countries along with North America. The analysis by income level shows an improvement in efficiency as the country's

income level increases. OECD countries are characterized by low dispersion in general. High-income non-OECD countries also score well but are characterized by greater heterogeneity, especially for countries in the Middle East or in Latin America and the Caribbean.

Beyond the analysis presented in this report, we developed a user interface ("Shiny") allowing for simplified replication and modification of the study. The analysis is made perfectly flexible so that the robustness of the results obtained can be tested and the study can be repeated and modified in order to generate efficiency scores adapted to the needs of the analyses carried out. In order to ensure that the replication and modification of the study is done in all rigor and to avoid the risks of misinterpretation, we have developed a detailed guide for using the application.

A development of this analysis will be to explain the quality of public spending beyond the level of income of countries. The mobilization of tax revenues, indebtedness and its nature (multilateral or bilateral), the political regime are all potential determinants of the quality of public expenditure that can be studied.

5.6. References

- Afonso, A. and D. Furceri (2010). Government size, composition, volatility and economic growth. *European Journal of Political Economy* 26(4), 517–532.
- Afonso, A. and M. St. Aubyn (2006). Cross-country efficiency of secondary education provision: A semi-parametric analysis with non-discretionary inputs. *Economic Modelling* 23(3), 476–491.
- Afonso, A., L. Schuknecht, and V. Tanzi (2005). Public sector efficiency: An international comparison. *Public Choice* 123(3-4), 321–347.
- Aigner, D., C. K. Lovell, and P. Schmidt (1977). Formulation and estimation of stochastic frontier production function models. *Journal of econometrics* 6(1), 21–37.
- Aschauer, D. A. (1989). Is public expenditure productive? *Journal of monetary economics* 23(2), 177–200.
- Azfar, O. and J. Livingston (2002). Federalist disciplines or local capture? An empirical analysis of decentralization in Uganda. *Center for Institutional Reform and the Informal Center, University of Maryland*.
- Badunengo, O., Y. Kolomyitseva, and P. Mozharovskyi (2019). Nonparametric and Stochastic Efficiency and Productivity Analysis.
- Barro, R. J. (1990). Government Spending in a Simple Model of Endogenous Growth. *Journal of Political Economy* 98(5), S103–S125.
- Barro, R. J. (1991). Economic growth in a cross section of countries. *The quarterly journal of economics* 106(2), 407–443.
- Barro, R. J. (2001). Human capital and growth. *The American Economic Review* 91(2), 12–17.
- Battese, G. E. and T. J. Coelli (1988). Prediction of firm-level technical efficiencies with a generalized frontier production function and panel data. *Journal of Econometrics* 38(3), 387–399.
- Battese, G. E., & Coelli, T. J. (1992). Frontier production functions, technical efficiency and panel data: with application to paddy farmers in India. *Journal of productivity analysis*, 3(1), 153-169.
- Besley, T. and A. Case (1995). Incumbent Behavior: Vote-Seeking, Tax-Setting, and Yardstick Competition. *The American Economic Review* 85(1), 25–45.

- Bird, R. and E. R. Rodriguez (1999). Decentralization and poverty alleviation. International experience and the case of the Philippines. *Public Administration and Development: The International Journal of Management Research and Practice* 19(3), 299–319.
- Butler, J. S. and R. Moffitt (1982, May). A Computationally Efficient Quadrature Procedure for the One-Factor Multinomial Probit Model. *Econometrica* 50(3), 761.
- Cabrales, A., & Hauk, E. (2011). The Quality of Political Institutions and the Curse of Natural Resources. *The Economic Journal*, 121(551), 58-88.
- Clements, B. (2002). How efficient is education spending in Europe? *European Review of Economics and Finance* 1(1), 3–26.
- Colombi, R., S. C. Kumbhakar, G. Martini, and G. Vittadini (2014). Closed-skew normality in stochastic frontiers with individual effects and long/short-run efficiency. *Journal of Productivity Analysis* 42(2), 123–136.
- Cornwell, C., P. Schmidt, and R. C. Sickles (1990). Production frontiers with cross-sectional and time-series variation in efficiency levels. *Journal of econometrics* 46(1-2), 185–200.
- Dabla-Norris, E., J. Brumby, A. Kyobe, Z. Mills, and C. Papageorgiou (2012). Investing in public investment: An index of public investment efficiency. *Journal of Economic Growth* 17(3), 235–266.
- Devarajan, S., V. Swaroop, and H.-f. Zou (1996, April). The composition of public expenditure and economic growth. *Journal of monetary economics* 37(2), 313–344.
- Easterly, W. and S. Rebelo (1993). Fiscal policy and economic growth. *Journal of monetary economics* 32(3), 417–458.
- Enikolopov, R. and E. Zhuravskaya (2007). Decentralization and political institutions. *Journal of public economics* 91(11-12), 2261–2290.
- Evans, D. B., A. Tandon, C. J. Murray, and J. A. Lauer (2000). The Comparative Efficiency of National Health Systems in Producing Health: An Analysis of 191 Countries. World Health Organization 29(29), 36.
- Facchini, F. (2014). The determinants of public spending: A survey in a methodological perspective. *MPRA Paper, University Library of Munich, Germany* (53006).
- Faguet, J.-P. (2004). Does decentralization increase government responsiveness to local needs? Evidence from Bolivia. *Journal of public economics* 88(3), 867–893.

- Filippini, M. and W. Greene (2016, April). Persistent and transient productive inefficiency: A maximum simulated likelihood approach. *Journal of Productivity Analysis* 45(2), 187–196.
- Galiani, S., P. Gertler, and E. Schargrotsky (2008). School decentralization: Helping the good get better but, leaving the poor behind. *Journal of public economics* 92(10-11), 2106–2120.
- Gazin, P., Cot, M., Robert, V., & Bonnet, D. (1988). La perception du paludisme en Afrique au Sud du Sahara. In *Annales de la Société Belge de Médecine Tropicale* (Vol. 68, No. 1, pp. 1-3).
- Greene, W. (2005). Reconsidering heterogeneity in panel data estimators of the stochastic frontier model. *Journal of Econometrics* 126(2), 269–303.
- Grigoli, F. and J. Kapsoli (2018). Waste not, want not: The efficiency of health expenditure in emerging and developing economies. *Review of Development Economics* 22(1), 384–403.
- Grigoriou, C. and G. Rota-Graziosi (2008). Working versus schooling: The impact of social expenditure. *Recherches économiques de Louvain* 74(1), 33–52.
- Gupta, S. and M. Verhoeven (2001). The efficiency of government expenditure Experiences from Africa. *Journal of Policy Modeling*, 35.
- Hayek, F. A. (1948). *Individualism and Economic Order*. University of Chicago Press.
- Herrera, S. and G. Pang (2005). *Efficiency of Public Spending in Developing Countries: An Efficiency Frontier Approach*, Volume 3645. World Bank Publications.
- Hjalmarsson, L., S. C. Kumbhakar, and A. Heshmati (1996). DEA, DFA and SFA: A comparison. *Journal of Productivity Analysis* 7(2-3), 303–327.
- Human Development Report (2010). The real wealth of nations: Pathways to human development.
- International Monetary Fund (2014). *Legacies, Clouds, Uncertainties*. Number 2014, Oct in World Economic Outlook. Washington, DC: International Monetary Fund. OCLC: 903272739.
- International Monetary Fund (2015). Making Public Investment more Efficient. Washington, DC: International Monetary Fund.

Jayasuriya, R. and Q. Wodon (2003). World Development Report 2003 Dynamic Development in a Sustainable World Background Paper. pp. 22.

Kumbhakar, S. C. (1990, October). Production frontiers, panel data, and time-varying technical inefficiency. *Journal of Econometrics* 46(1), 201–211.

Kumbhakar, S. C., G. Lien, and J. B. Hardaker (2014, April). Technical efficiency in competing panel data models : A study of Norwegian grain farming. *Journal of Productivity Analysis* 41(2), 321–337.

Kumbhakar, S. C., H.-J. Wang, and A. P. Horncastle (2015). *A Practitioner's Guide to Stochastic Frontier Analysis Using Stata*. Cambridge: Cambridge University Press.

Lee, J. (1992). Optimal size and composition of government spending. *Journal of the Japanese and International Economies* 6(4), 423–439.

Lee, Y. H. and P. Schmidt (1993). A production frontier model with flexible temporal variation in technical efficiency. *The measurement of productive efficiency: Techniques and applications*, 237–255.

Lucas Jr, R. E. (1988). On the mechanics of economic development. *Journal of monetary economics* 22(1), 3–42.

Mankiw, N. G., D. Romer, and D. N. Weil (1992). A contribution to the empirics of economic growth. *The quarterly journal of economics* 107(2), 407–437.

Martin, P. and C. A. Rogers (1995, November). Industrial location and public infrastructure. *Journal of International Economics* 39(3-4), 335–351.

Meeusen, W. and J. van Den Broeck (1977, June). Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error. *International Economic Review* 18(2), 435.

Munnell, A. H. (1992, November). Policy Watch: Infrastructure Investment and Economic Growth. *Journal of Economic Perspectives* 6(4), 189–198.

Munnell, A. H. and L. M. Cook (1990). How does public infrastructure affect regional economic performance? *New England economic review* (Sep), 11–33.

Mushkin, S. J. (1962, October). Health as an Investment. *Journal of Political Economy* 70(5, Part 2), 129–157.

Oates, W. E. (1972). *Fiscal federalism*. Books.

- Odeck, J. (2007). Measuring technical efficiency and productivity growth: A comparison of SFA and DEA on Norwegian grain production data. *Applied Economics* 39(20), 2617–2630.
- OECD (2008). *Handbook on Constructing Composite Indicators: Methodology and User Guide*. Paris: OECD. OCLC: 259710751.
- Pitt, M. M. and L.-F. Lee (1981). The measurement and sources of technical inefficiency in the Indonesian weaving industry. *Journal of Development Economics* 9(1), 43–64.
- Robalino, D. A., O. F. Picazo, and A. Voetberg (2001). *Does Fiscal Decentralization Improve Health Outcomes? Evidence from a Cross-Country Analysis*. The World Bank.
- Robinson, J. A. and R. Torvik (2005). White elephants. *Journal of public economics* 89(2-3), 197–210.
- Robinson, J. A., R. Torvik, and T. Verdier (2006). Political foundations of the resource curse. *Journal of Development Economics* 79(2), 447–468.
- Roller, L.-H. and L. Waverman (2001). Telecommunications infrastructure and economic development: A simultaneous approach. *American economic review* 91(4), 909–923.
- Romer, P. M. (1990). Endogenous Technological Change. *Journal of Political Economy* 98(5, Part 2), S71–S102.
- Salmon, P. (1987). Decentralisation as an incentive scheme. *Oxford review of economic policy* 3(2), 24–43.
- Seabright, P. (1996). Accountability and decentralisation in government: An incomplete contracts model. *European economic review* 40(1), 61–89.
- Shelton, C. A. (2007, December). The size and composition of government expenditure. *Journal of public economics* 91(11-12), 2230–2260.
- Sow, M. and M. I. F. Razafimahefa (2015). *Fiscal Decentralization and the Efficiency of Public Service Delivery*. Number 15-59. International Monetary Fund.
- Tiebout, C. M. (1956). A pure theory of local expenditures. *Journal of political economy* 64(5), 416–424.

Torvik, R. (2002). Natural resources, rent seeking and welfare. *Journal of Development Economics* 67(2), 455–470.

Tsionas, E. G., and Kumbhakar, S. C. (2014). Firm heterogeneity, persistent and transient technical inefficiency: A generalized true random-effects model. *Journal of Applied Econometrics*, 29(1), 110-132.

Wang, E. C. and E. Alvi (2011). Relative Efficiency of Government Spending and Its Determinants: Evidence from East Asian Countries. *Eurasian Economic Review* 1(1), 3–28.

Winkler, D. R. and T. Rounds (1996). Municipal and private sector response to decentralization and school choice. *Economics of Education Review* 15(4), 365–376.

Yohou, D. H. (2015). In Search of Fiscal Space in Africa: The Role of the Quality of Government Spending.

Zagler, M. and G. Durnecker (2003, July). Fiscal Policy and Economic Growth. *Journal of Economic Surveys* 17(3), 397–418.

E. Appendix to chapter V

E.1. Appendix: Methodological notes

Figure E.1.1: Explanatory diagram on how to calculate the outcomes indicator

	Dimension	Health	Education	Public infrastructure	Income
STEP 1: CALCULATION OF SECTORAL INDICES	Selected standardized variables	Infants mortality rate. Mortality rate among children under five years. Female adult's mortality rate. Life expectancy at birth.	Gross enrolment ratio. Pupil-teacher ratio. Mean years of schooling. Expected years of schooling.	Percentage of the population with access to electricity. Percentage of the population with access to an improved water source. Proportion of paved roads in percentage of total roads.	GDP per capita
	Principal Component Analysis	↓	↓	↓	↓
	Indices	Standardized health index (SHI)	Standardized education index (SEI)	Standardized public infrastructure index (SPII)	Standardized income index (SII)
STEP 2: CALCULATION OF THE OUTCOMES INDICATOR	Weighting	Weights allocation for the indices health (H), education (E), Public infrastructure (PI), and Income (I)			
	Geometric mean	Weighted geometric mean of indices = $\sqrt{(H+E+PI+I)}{SHI^H * SEI^E * SPII^{PI} * SII^I}$			

Brief presentation the Shiny application

This appendix provides a summary of the tools used for the analysis. For more details on these tools and their use, refer to the methodological guide developed for this purpose.

An R-Shiny application has been developed and accompanies this report. This application automates the calculation of the sectoral indices, the outcomes indicator and the efficiency scores. It also allows to perform robustness tests or to carry out extensions of the analysis by changing the composition of the sectoral indices or of the overall outcomes indicator. It is also possible to calculate the efficiency scores by three second generation stochastic frontier methods. These are the models of Battese and Coelli (1992), Kumbhakar (1990) and Kumbhakar (1990) modified. The GTRE estimation procedure by Kumbhakar, Lien, and Hardaker (2014), used in this study, is not available under R. The solution envisaged was to set up a pseudo-connection between R and Stata. This pseudo-connection allows using Stata via R. Due to Stata licensing issues this part can only be used locally and has been removed from the web application. An estimate of GTRE is available in the “npsf” package from Badunengo et al. (2019).⁹⁹ However, the difficulty of estimating the log-likelihood mentioned in the methodology (section 5.4.1) makes the use not optimal for a web application¹⁰⁰.

The efficiency scores obtained by the three second-generation stochastic frontier methods are different from those obtained by the method of Kumbhakar, Lien, and Hardaker (2014). However, this difference is not huge. The trend in scores and efficiency levels is the same for all methods. However, the second-generation methods accentuate the differences: efficient countries tend to be very efficient (with scores closer to 1) and ineffective ones to be very inefficient (with scores closer to 0).

⁹⁹ Available at: <https://cran.r-project.org/web/packages/npsf/npsf.pdf>

¹⁰⁰ We very often encounter a convergence issue. For 1000 observations, the estimation time can reach a day. We faced similar difficulties when trying to replicate the multistep procedure of Kumbhakar et al. (2014) using R. The estimation times for the second and third step were too high. However, we would like to thank Professor Subal Kumbhakar, Christopher Frank Parmeter, David Bernstein and Valentin Zelenyuk for their availability and responsiveness.

E.2. Appendix: Sectoral indices: Country average over 1990-2015

Table E.2.1: Sectoral indices – country average over 1990-2015

Country	Indices				Country	Indices				Country	Indices				Country	Indices								
	E	H	PI	I		E	H	PI	I		E	H	PI	I		E	H	PI	I					
Afghanistan	0.311	0.503	0.258	0.275	Congo, Dem. Rep.	0.410	0.423	0.171	0.157	Iran, Islamic Rep.	0.660	0.828	0.863	0.648	Morocco	0.512	0.787	0.689	0.484	Spain	0.827	0.969	0.997	0.763
Albania	0.728	0.887	0.807	0.520	Congo, Rep.	0.465	0.539	0.397	0.475	Iraq	0.588	0.784	0.846	0.592	Mozambique	0.270	0.344	0.195	0.151	Sri Lanka	0.745	0.880	0.654	0.513
Algeria	0.647	0.820	0.848	0.609	Costa Rica	0.716	0.930	0.754	0.601	Ireland	0.860	0.950	0.975	0.799	Myanmar	0.464	0.638	0.468	0.317	St. Kitts and Nevis	0.730	0.809	0.830	0.697
Angola	0.469	0.371	0.283	0.453	Cote d'Ivoire	0.362	0.384	0.482	0.391	Israel	0.887	0.961	1.000	0.745	Namibia	0.642	0.589	0.463	0.535	St. Lucia	0.716	0.861	-	0.604
Antigua and Barbuda	0.790	0.877	0.761	0.692	Croatia	0.783	0.923	0.956	0.674	Italy	0.830	0.969	1.000	0.791	Nepal	0.536	0.653	0.544	0.301	St. Vincent and the Grenadines	0.765	0.838	0.823	0.558
Argentina	0.825	0.885	0.776	0.661	Cuba	0.821	0.931	0.812	-	Jamaica	0.644	0.863	0.840	0.558	Netherlands	0.899	0.956	0.969	0.815	Sudan	0.347	0.590	0.414	0.378
Armenia	0.750	0.844	0.937	0.450	Cyprus	0.778	0.959	0.895	0.764	Japan	0.828	0.981	0.933	0.788	New Zealand	0.921	0.950	0.897	0.762	Suriname	0.747	0.803	0.742	0.615
Aruba	-	-	-	0.796	Czech Republic	0.851	0.931	0.999	0.726	Jordan	0.732	0.850	0.979	0.553	Nicaragua	0.558	0.800	0.569	0.427	Swaziland	0.577	0.464	0.319	0.519
Australia	0.940	0.965	0.831	0.795	Denmark	0.904	0.942	1.000	0.817	Kazakhstan	0.807	0.779	0.916	0.643	Niger	0.177	0.390	0.221	0.189	Sweden	0.901	0.970	0.862	0.801
Austria	0.846	0.957	1.000	0.808	Djibouti	0.250	0.557	0.545	0.370	Kenya	0.551	0.561	0.259	0.357	Nigeria	0.486	0.338	0.340	0.432	Switzerland	0.945	0.970	1.000	0.853
Azerbaijan	0.756	0.743	0.846	0.549	Dominica	0.747	0.888	0.784	0.565	Kiribati	0.696	0.680	-	0.325	Norway	0.965	0.964	0.932	0.869	Syrian Arab Republic	0.602	0.867	0.825	-
Bahamas, The	0.798	0.866	0.848	0.728	Dominican Republic	0.686	0.799	0.753	0.562	Korea, Dem. People's Rep.	-	0.785	0.494	-	Oman	0.599	0.878	0.802	0.817	Tajikistan	0.707	0.689	0.704	0.314
Bahrain	0.763	0.910	0.944	0.821	Ecuador	0.716	0.839	0.644	0.565	Korea, Rep.	0.818	0.942	0.910	0.717	Pakistan	0.367	0.596	0.762	0.435	Tanzania	0.388	0.484	0.246	0.309
Bangladesh	0.420	0.685	0.437	0.323	Egypt, Arab Rep.	0.611	0.779	0.920	0.550	Kuwait	0.711	0.907	0.940	0.922	Palau	-	-	-	0.646	Thailand	0.660	0.853	0.895	0.600
Barbados	0.796	0.889	0.974	0.658	El Salvador	0.654	0.814	0.667	0.520	Kyrgyz Republic	0.731	0.774	0.870	0.366	Panama	0.717	0.883	0.715	0.620	Timor-Leste	0.580	0.572	-	0.272
Belarus	0.799	0.871	0.975	0.591	Equatorial Guinea	0.504	0.424	-	0.604	Lao PDR	0.537	0.560	0.368	0.384	Papua New Guinea	0.381	0.646	0.129	0.396	Togo	0.502	0.519	0.324	0.257
Belgium	0.892	0.952	0.942	0.800	Eritrea	0.277	0.568	0.320	0.293	Latvia	0.829	0.869	0.866	0.640	Paraguay	0.668	0.816	0.677	0.525	Tonga	0.793	0.856	0.739	0.466
Belize	0.778	0.828	0.685	0.535	Estonia	0.858	0.891	0.814	0.684	Lebanon	0.769	0.899	0.928	0.630	Peru	0.738	0.818	0.585	0.545	Trinidad and Tobago	0.721	0.819	0.805	0.708
Benin	0.373	0.504	0.373	0.307	Ethiopia	0.275	0.476	0.143	0.181	Lesotho	0.541	0.417	0.393	0.329	Philippines	0.654	0.778	0.604	0.470	Tunisia	0.693	0.857	0.865	0.556
Bhutan	0.567	0.625	0.648	0.451	Fiji	0.759	0.807	0.748	0.532	Liberia	0.512	0.410	0.250	0.142	Poland	0.883	0.911	0.889	0.663	Turkey	0.641	0.826	0.817	0.658
Bolivia	0.732	0.658	0.557	0.470	Finland	0.871	0.957	0.900	0.789	Libya	-	0.841	0.719	0.718	Portugal	0.829	0.945	0.948	0.736	Turkmenistan	-	0.680	0.722	0.537
Bosnia and Herzegovina	-	0.909	0.876	0.493	France	0.839	0.962	1.000	0.788	Liechtenstein	0.895	-	-	-	Qatar	0.758	0.929	0.967	0.982	Tuvalu	-	-	-	0.396
Botswana	0.679	0.572	0.533	0.608	Gabon	0.670	0.623	0.602	0.682	Lithuania	0.847	0.885	0.759	0.657	Romania	0.762	0.866	0.786	0.638	Uganda	0.472	0.405	0.200	0.246
Brazil	0.791	0.817	0.704	0.623	Gambia, The	0.377	0.554	0.525	0.290	Luxembourg	0.818	0.956	0.999	0.922	Russian Federation	0.808	0.830	0.908	0.685	Ukraine	0.825	0.846	0.965	0.529
Brunei Darussalam	0.802	0.913	-	0.928	Georgia	0.834	0.851	0.882	0.468	Macedonia, FYR	0.721	0.886	0.877	0.581	Rwanda	0.386	0.403	0.296	0.224	United Arab Emirates	0.730	0.913	0.990	0.934
Bulgaria	0.800	0.879	0.982	0.610	Germany	0.890	0.954	0.997	0.801	Madagascar	0.542	0.580	0.182	0.279	Samoa	0.712	0.841	0.735	0.468	United Kingdom	0.873	0.951	1.000	0.783
Burkina Faso	0.252	0.444	0.309	0.247	Ghana	0.533	0.585	0.486	0.372	Malawi	0.446	0.383	0.325	0.203	Sao Tome and Principe	0.594	0.685	0.682	0.358	United States	0.913	0.930	0.889	0.833
Burundi	0.294	0.450	0.304	0.191	Greece	0.818	0.961	0.972	0.738	Malaysia	0.718	0.896	0.899	0.677	Saudi Arabia	0.780	0.867	0.808	0.832	Uruguay	0.787	0.900	0.911	0.640
Cabo Verde	0.631	0.800	0.731	0.434	Grenada	0.809	0.859	0.821	0.584	Maldives	0.645	0.814	-	0.581	Senegal	0.295	0.609	0.463	0.332	Uzbekistan	0.742	0.756	0.894	0.407
Cambodia	0.466	0.623	0.223	0.307	Guatemala	0.514	0.762	0.662	0.513	Mali	0.185	0.362	0.230	0.298	Serbia	0.812	0.890	0.889	0.586	Vanuatu	0.679	0.802	0.445	0.383
Cameroon	0.433	0.423	0.392	0.385	Guinea	0.262	0.431	0.333	0.286	Malta	0.771	0.955	0.974	0.731	Seychelles	0.761	0.879	0.902	0.689	Venezuela, RB	-	0.865	0.771	0.662
Canada	0.873	0.960	0.822	0.800	Guinea-Bissau	0.400	0.427	0.290	0.283	Marshall Islands	-	0.733	-	0.409	Sierra Leone	0.398	0.174	0.222	0.239	Vietnam	0.621	0.865	0.680	0.399
Cayman Islands	-	-	0.980	0.848	Guyana	0.635	0.740	0.626	0.471	Mauritania	0.354	0.598	0.241	0.400	Singapore	-	0.964	0.998	0.864	West Bank and Gaza	0.670	0.832	0.905	0.434
Central African Republic	0.142	0.283	0.256	0.191	Haiti	0.440	0.551	0.376	0.302	Mauritius	0.701	0.866	0.985	0.618	Slovak Republic	0.812	0.911	0.973	0.686	Yemen, Rep.	0.442	0.618	0.391	0.435
Chad	0.198	0.344	0.143	0.275	Honduras	0.578	0.808	0.597	0.428	Mexico	0.661	0.871	0.757	0.652	Slovenia	0.861	0.942	0.977	0.729	Zambia	0.496	0.374	0.270	0.372
Chile	0.769	0.925	0.742	0.659	Hungary	0.843	0.888	0.828	0.695	Micronesia, Fed. Sts.	0.727	0.754	0.542	0.405	Solomon Islands	0.581	0.758	0.379	0.323	Zimbabwe	0.550	0.434	0.509	0.339
China	0.671	0.854	0.758	0.471	Iceland	0.967	0.974	0.811	0.791	Moldova	0.726	0.813	0.881	0.403	Somalia	-	0.375	0.081	-					
Colombia	0.676	0.852	0.685	0.580	India	0.514	0.651	0.664	0.395	Mongolia	0.666	0.713	0.442	0.507	South Africa	0.684	0.599	0.640	0.600					
Comoros	0.546	0.576	0.673	0.282	Indonesia	0.668	0.745	0.706	0.528	Montenegro	-	0.906	0.907	0.625	South Sudan	0.312	0.357	-	0.391					

Source: Authors' calculations

E.3. Appendix: Summary of public expenditure efficiency

Table E.3.1: Summary of public expenditure efficiency – Sensitivity analysis

Efficiency	Mean	Standard deviation.	Minimum	Maximum
I	0.707	0.123	0.348	0.885
II	0.719	0.121	0.370	0.911
III	0.719	0.115	0.365	0.894
IV	0.686	0.127	0.337	0.873
V	0.713	0.127	0.365	0.923

Source: Authors' calculations

Note: The table reports the summary statistics of efficiency scores for the various specifications in Table 5.2.

E.4. Appendix: Additional sensitivity analysis

Table E.4.1: Step-one results of the approach of Kumbhakar *et al.* (2014) – additional sensitivity analysis

Variables	BOI			
	Baseline Results (I)	Delay: 1 year	Delay: 2 years	Delay: 3 years
Total public expenditure (% of PIB)	0.003*** (0.0002)	0.003*** (0.0002)	0.002*** (0.0002)	0.002*** (0.0002)
Pub. exp. on edu. (% of total pub. exp.)	0.002*** (0.0003)	0.002*** (0.0003)	0.001*** (0.0003)	0.001*** (0.0003)
Pub. exp. on health (% of total pub. exp.)	0.004*** (0.0004)	0.005*** (0.0005)	0.005*** (0.0005)	0.005*** (0.0004)
Pub. investment (% of total pub. exp.)	0.001*** (0.0001)	0.001*** (0.0001)	0.001*** (0.0001)	0.001*** (0.0001)
Constant	0.531*** (0.0172)	0.538*** (0.0170)	0.553*** (0.0168)	0.572*** (0.0166)
Observations	2488	2392	2296	2200
R-squared	0.278	0.268	0.259	0.236
Number of countries	146	147	147	147

Note: Standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). The table reports the results for the first step of the estimation procedure of public expenditure efficiency.

Table E.4.2: Summary of public expenditure efficiency – additional sensitivity analysis

	Efficiency	Mean	Standard deviation.	Minimum	Maximum
Baseline Results (I)	Time-varying	0.852	0.037	0.639	1.000
	Persistent	0.830	0.140	0.519	0.995
	Total	0.707	0.123	0.348	0.885
Delay: 1 year	Time-varying	0.856	0.035	0.680	1.000
	Persistent	0.829	0.140	0.517	0.995
	Total	0.710	0.122	0.373	0.890
Delay: 2 years	Time-varying	0.861	0.034	0.697	1.000
	Persistent	0.830	0.140	0.516	0.995
	Total	0.715	0.123	0.387	0.894
Delay: 3 years	Time-varying	0.877	0.033	0.729	1.000
	Persistent	0.819	0.139	0.507	1.000
	Total	0.718	0.125	0.404	0.898

Source: Authors' calculations

Note: The table reports the summary statistics of efficiency scores for the various specifications in Table E.4.1.

Table E.4.3: Public expenditure efficiency – country average over 1990–2015 (additional sensitivity analysis)

Country	Baseline results	Delay: 1 year	Delay: 2 years	Delay: 3 years	Country	Baseline results	Delay: 1 year	Delay: 2 years	Delay: 3 years	Country	Baseline results	Delay: 1 year	Delay: 2 years	Delay: 3 years	Country	Baseline results	Delay: 1 year	Delay: 2 years	Delay: 3 years
Albania	0.77	0.78	0.78	0.78	Cyprus	0.81	0.82	0.83	0.84	Korea, Rep.	0.84	0.85	0.85	0.86	Qatar	0.84	0.85	0.85	0.85
Algeria	0.75	0.76	0.77	0.78	Czech Republic	0.83	0.83	0.83	0.84	Kuwait	0.77	0.78	0.79	0.80	Romania	0.77	0.77	0.78	0.78
Angola	0.44	0.45	0.46	0.47	Denmark	0.81	0.81	0.82	0.83	Kyrgyz Republic	0.74	0.74	0.75	0.75	Russian Federation	0.80	0.81	0.81	0.81
Argentina	0.78	0.78	0.78	0.78	Djibouti	0.49	0.49	0.50	0.51	Lao PDR	0.59	0.60	0.61	0.61	Rwanda	0.52	0.52	0.53	0.53
Armenia	0.83	0.83	0.83	0.83	Dominica	0.75	0.76	0.76	0.76	Latvia	0.80	0.80	0.81	0.82	Sao Tome and Principe	0.65	0.65	0.66	0.67
Australia	0.82	0.82	0.83	0.83	Dominican Republic	0.75	0.75	0.75	0.75	Lebanon	0.83	0.83	0.84	0.83	Saudi Arabia	0.76	0.76	0.77	0.78
Austria	0.81	0.81	0.82	0.83	Ecuador	0.72	0.72	0.73	0.73	Lesotho	0.48	0.49	0.50	0.51	Senegal	0.55	0.56	0.56	0.57
Azerbaijan	0.76	0.77	0.78	0.78	Egypt, Arab Rep.	0.76	0.77	0.78	0.78	Lithuania	0.76	0.77	0.77	0.78	Serbia	0.78	0.78	0.79	0.79
Bahamas, The	0.80	0.80	0.80	0.80	El Salvador	0.73	0.72	0.72	0.72	Luxembourg	0.82	0.82	0.82	0.83	Seychelles	0.78	0.78	0.78	0.78
Bahrain	0.84	0.84	0.85	0.85	Estonia	0.78	0.78	0.79	0.79	Macedonia, FYR	0.76	0.76	0.76	0.77	Sierra Leone	0.48	0.48	0.48	0.47
Bangladesh	0.60	0.60	0.61	0.61	Ethiopia	0.46	0.46	0.46	0.47	Madagascar	0.53	0.52	0.52	0.52	Slovak Republic	0.81	0.81	0.81	0.82
Barbados	0.80	0.81	0.81	0.82	Fiji	0.74	0.75	0.75	0.76	Malawi	0.53	0.52	0.52	0.52	Slovenia	0.83	0.83	0.84	0.85
Belarus	0.81	0.81	0.82	0.83	Finland	0.80	0.80	0.81	0.82	Malaysia	0.79	0.80	0.80	0.81	South Africa	0.64	0.64	0.64	0.64
Belgium	0.81	0.81	0.82	0.83	France	0.80	0.80	0.81	0.82	Mali	0.47	0.47	0.48	0.48	Spain	0.83	0.83	0.84	0.84
Belize	0.72	0.73	0.74	0.74	Gabon	0.66	0.66	0.67	0.67	Malta	0.81	0.81	0.82	0.83	Sri Lanka	0.76	0.76	0.76	0.77
Benin	0.54	0.54	0.55	0.55	Gambia, The	0.57	0.57	0.58	0.58	Mauritania	0.54	0.55	0.55	0.55	St. Vincent & the Grenadines	0.75	0.75	0.76	0.76
Bhutan	0.66	0.66	0.66	0.66	Georgia	0.84	0.85	0.85	0.86	Mauritius	0.81	0.81	0.82	0.82	Sudan	0.55	0.56	0.56	0.56
Bolivia	0.65	0.65	0.66	0.66	Germany	0.83	0.82	0.83	0.84	Mexico	0.73	0.74	0.74	0.74	Swaziland	0.51	0.51	0.51	0.51
Botswana	0.58	0.59	0.59	0.60	Ghana	0.60	0.60	0.60	0.61	Moldova	0.74	0.75	0.75	0.76	Sweden	0.78	0.79	0.80	0.80
Brazil	0.74	0.75	0.76	0.76	Greece	0.81	0.82	0.83	0.83	Mongolia	0.63	0.64	0.65	0.65	Switzerland	0.85	0.85	0.85	0.86
Bulgaria	0.82	0.82	0.83	0.83	Grenada	-	0.78	0.79	0.79	Morocco	0.64	0.66	0.67	0.68	Tajikistan	0.69	0.69	0.69	0.70
Burkina Faso	0.49	0.49	0.49	0.49	Guatemala	0.66	0.66	0.66	0.66	Mozambique	0.45	0.46	0.46	0.47	Tanzania	0.51	0.50	0.50	0.50
Burundi	0.47	0.47	0.48	0.48	Guinea	0.50	0.51	0.51	0.51	Myanmar	0.67	0.67	0.68	0.67	Thailand	0.76	0.76	0.77	0.77
Cabo Verde	0.69	0.70	0.71	0.71	Guinea-Bissau	0.52	0.53	0.54	0.54	Namibia	0.57	0.57	0.57	0.57	Togo	0.54	0.55	0.55	0.55
Cambodia	0.56	0.56	0.56	0.56	Honduras	0.65	0.65	0.65	0.65	Nepal	0.66	0.67	0.67	0.68	Trinidad and Tobago	0.73	0.74	0.75	0.75
Cameroon	0.55	0.56	0.56	0.56	Hungary	0.76	0.77	0.78	0.78	Netherlands	0.82	0.82	0.83	0.84	Tunisia	0.75	0.75	0.76	0.76
Canada	0.78	0.78	0.79	0.79	Iceland	0.81	0.81	0.82	0.82	New Zealand	0.82	0.82	0.82	0.83	Turkey	0.82	0.82	0.82	0.82
Central African Rep.	0.44	0.44	0.44	0.44	India	0.65	0.66	0.67	0.67	Nicaragua	0.65	0.65	0.65	0.65	Ukraine	0.80	0.80	0.81	0.81
Chad	0.45	0.45	0.45	0.45	Indonesia	0.74	0.74	0.75	0.75	Niger	0.44	0.45	0.45	0.45	United Arab Emirates	0.83	0.83	0.83	0.84
Chile	0.78	0.78	0.78	0.78	Iran, Islamic Rep.	0.74	0.75	0.75	0.76	Norway	0.83	0.83	0.84	0.85	United Kingdom	0.84	0.84	0.85	0.86
China	0.66	0.66	0.67	0.67	Ireland	0.83	0.84	0.84	0.85	Pakistan	0.63	0.64	0.64	0.64	United States	0.81	0.81	0.81	0.81
Colombia	0.70	0.70	0.70	0.70	Israel	0.85	0.85	0.86	0.88	Panama	0.74	0.73	0.74	0.74	Uruguay	0.81	0.80	0.81	0.81
Comoros	0.64	0.64	0.64	0.64	Italy	0.82	0.82	0.83	0.84	Paraguay	0.71	0.71	0.71	0.71	Vietnam	0.75	0.76	0.77	0.77
Congo, Rep.	0.54	0.55	0.55	0.56	Japan	0.82	0.81	0.82	0.82	Peru	0.72	0.72	0.72	0.72	Yemen, Rep.	0.54	0.55	0.56	0.57
Costa Rica	0.74	0.73	0.73	0.73	Jordan	0.76	0.77	0.77	0.78	Philippines	0.69	0.69	0.69	0.69	Zambia	0.47	0.47	0.47	0.48
Cote d'Ivoire	0.53	0.54	0.54	0.54	Kazakhstan	0.83	0.83	0.84	0.84	Poland	0.81	0.82	0.82	0.83	Zimbabwe	0.59	0.60	0.61	0.62
Croatia	0.80	0.80	0.81	0.82	Kenya	0.54	0.55	0.55	0.55	Portugal	0.80	0.81	0.82	0.82					

Source: Authors' calculations

Note: The table reports countries average efficiency scores for the various specifications in Table E.4.1.

E.5. Appendix: Summary table of data, definition, sources, number of observations, temporal depth

Category	Variables	Obs.	Mean	Std. Dev.	Min.	Max.	Period covered	Number of countries	Min Numb. Obs. / country	Max Numb. Obs. / country	Sources
Public expenditure	Total public expenditure (% of GDP)	4190	31.84	17.90	0.00	539.23	1990-2015	190	2	26	TCdata360, World Bank (Source WEO)
	Total public expenditure per capita PPP constant 2011*	4132	5680.10	7328.14	0.00	52759.34	1990-2015	189	2	26	
	Expenditure on education (% of GDP)	2531	4.52	2.01	0.00	44.33	1990-2015	128	1	25	WDI, World Bank; WHO
	Expenditure on education per capita PPP constant 2011*	2439	837.67	941.56	0.00	5680.74	1990-2015	123	1	25	
	Expenditure on education (% of Tot. Exp)*	2251	15.29	5.75	3.08	63.73	1990-2015	121	1	25	
	Expenditure on health (% of GDP)	4106	3.77	2.45	0.04	28.05	1990-2015	192	3	26	ICSD, IMF
	Expenditure on health per capita PPP constant 2011*	3956	718.64	1000.75	0.24	6259.76	1990-2015	185	3	26	
	Expenditure on health (% of Tot. Exp)*	3728	11.58	5.04	0.77	41.43	1990-2015	186	3	26	
	Public investment (% of GDP)	4381	5.14	4.23	0.00	54.24	1990-2015	169	16	26	ICSD, IMF
Public investment per capita PPP constant 2011*	4243	768.81	1240.46	0.00	12827.82	1990-2015	167	16	26		
Public investment (% of Tot. Exp)*	3767	19.04	16.30	0.00	231.55	1990-2015	168	11	26		
Education	Gross enrolment ratio	4112	100.31	17.67	20.30	175.24	1990-2015	174	1	26	EDSTAT, World Bank; PNUD
	Pupil-teacher ratio	3417	26.44	13.76	5.23	100.24	1990-2015	152	1	26	
	Expected years of schooling	4759	11.61	3.34	2.10	20.70	1990-2015	191	1	26	
	Mean years of schooling	4390	7.34	3.15	0.30	13.40	1990-2015	188	1	26	
Health	Mortality rate among children under five years (for 1000)	4990	51.98	54.89	2.20	328.90	1990-2015	192	24	26	EDSTAT; WDI, World Bank
	Infants mortality rate (% of 1000 live births)	5017	36.24	33.05	1.70	173.10	1990-2015	193	25	26	
	Female adult's mortality rate (for 1000)	4993	163.65	114.04	25.66	685.03	1990-2015	198	1	26	
	Life expectancy at birth	5181	68.12	9.73	27.61	84.28	1990-2015	203	2	26	
Infrastructure	Percentage of the population with access to electricity	5181	75.95	32.84	0.01	100.00	1990-2014	214	8	25	WDI, World Bank; WHO
	Percentage of the population with access to an improved water source.	5002	84.35	18.25	13.20	100.00	1990-2015	199	12	26	
	Proportion of paved roads (% of total roads)	2482	53.07	33.43	0.80	100.00	1990-2013	125	1	24	IRF; World Bank
Income	GDP per capita PPP constant 2011	4811	15356.48	18758.71	247.44	135318.80	1990-2015	195	1	26	EDSTAT, World Bank
Human capital	Human capital	3600	2.36	0.69	1.03	3.73	1990-2014	144	25	25	Penn World Table 9
Productivity	Total Factor Productivity	2899	0.66	0.32	0.11	2.49	1990-2014	116	24	25	
HDI	Human Development Index	4348	0.65	0.17	0.19	0.95	1990-2015	188	6	26	World Bank; UNDP
	Education index (HDI approach)*	4390	0.57	0.19	0.08	0.94	1990-2015	188	1	26	
	Health index (HDI approach)*	5181	0.74	0.15	0.12	0.99	1990-2015	203	2	26	
Resources endowment	Total natural resources rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents	4921	7.10	11.54	0.00	89.17	1990-2015	198	2	26	WDI, World Bank

Note: The data presented in the table are the values of the variables before the cleaning process (outlier treatment for example). Depending on the case, cleaning and processing of data was carried out. Several data sources were combined to obtain the longest possible series. * denotes author's on calculation using the sources. WEO: World Economic Outlook; WDI: World Development Indicator; WHO: World Health Organization; ICSD: International Capital Stock Dataset; UNDP: United Nation Development Program; EDSTAT: Education Statistics; IRF: International Road Federation.

« Le monde est vaste, mais celui qui n'a pas de chance s'y coince la tête. » ~
Proverbe malien.

6. Chapter VI: La qualité de la dépense publique : Principaux déterminants et quelques effets

This chapter is a joint work with H el ene Djoufelkit (AFD), Harouna Kinda (CERDI-CNRS) and Gr egoire Rota-Graziosi (CERDI-CNRS). It is part of a report intended to French Agency of Development (AFD) on quality of public expenditure.

Résumé

Nous identifions les déterminants de la qualité des dépenses publiques suivant une approche à la La Porta et al. (1999). Cet article avait établi la supériorité du système juridique de type (common law) à l'égard de son alternative (civil right) expliquant ainsi la moindre qualité des gouvernements de pays en développement non anglophones. Nous répliquons l'analyse de La Porta et al. (1999) et confirmons ses résultats. Puis, nous développons une analyse similaire en substituant la multitude d'indicateurs utilisés par La Porta et al. (1999) par un seul indicateur unidimensionnel récemment développés par Caldeira et al. (2021). Celui-ci permet d'appréhender les substituabilités ou complémentarités potentielles des dépenses publiques sectorielles (éducation, santé, infrastructure) sur la qualité de la dépense publique. La différence entre les systèmes légaux n'est plus significative. En outre, lorsque le système légal est combiné à l'origine coloniale du pays, le système juridique de type code civil a un impact positif. De plus, contrairement à La Porta et al. (1999), le catholicisme aurait un effet positif alors que l'Islam n'entraîne aucun effet négatif significatif. Les anciennes colonies belges, chinoises et françaises présentent une qualité des dépenses publiques inférieures à celles britanniques, qui s'avère moindre que celles danoises ou hollandaises. Enfin, nous concluons qu'une amélioration de la qualité favorise la croissance et réduit les inégalités sur les deux à trois premières années, ces effets positifs s'estompant par la suite.

Mots clés : Dépenses publiques ; Système légal, Développement économique.

JEL Codes : H5, H11, P50, O43

6.1. Introduction

La qualité des institutions participe à la croissance économique et au bien-être de la population. La littérature en sciences économiques¹⁰¹ a mis en évidence plusieurs mécanismes. Ainsi, selon North (1990) les institutions affectent la performance économique par leurs effets sur les coûts de production et de transaction. Acemoglu et al. (2001) souligne le rôle du risque d'expropriation, du renforcement des droits de propriété ou de l'Etat de droit. La qualité institutionnelle résulterait selon Acemoglu et al. (2002) des stratégies de colonisation, qui s'expliqueraient par l'environnement ou la géographie des colonies affectant la mortalité des colonisateurs et leur stratégie. Ces différences institutionnelles à leur tour constituent une source majeure des différences en revenu par tête. Easterly et Levine (2003) complète les analyses précédentes en insistant sur le rôle de l'esclavage pour les européens, en particulier dans les colonies dont l'économie était fondée sur les ressources naturelles ou les produits de base. Ces colonies étaient historiquement associées à une concentration du pouvoir entre des propriétaires des grandes plantations ou des mines (Sokoloff et Engerman, 2000). Easterly et Levine (2003) établissent ainsi une relation négative entre la richesse des pays en ressources naturelles et leur développement économique qui s'expliquerait par la qualité institutionnelle. Pour Hall et Jones (1999), celle-ci est une composante des infrastructures sociales, qui améliore la productivité. Selon Churchill et Smyth (2017), la diversité ethnique d'un pays augmente son niveau de pauvreté en détériorant la qualité des dépenses publiques. Desmet et al. (2020) confirment ce résultat en se concentrant sur trois dimensions des dépenses publiques : éducation, santé et infrastructures publiques.

La Porta et al. (1999) analyse la qualité des gouvernements en appréciant leur intervention dans l'économie et leur efficacité par une multitude d'indicateurs. Ces auteurs cherchent à déterminer les principaux facteurs de réussite ou d'échec des gouvernements. Ils identifient ainsi la fragmentation ethnolinguistique, la religion et le système juridique comme des facteurs essentiels à la qualité des gouvernants. Ces résultats ont suscité de multiples travaux académiques pour confirmer, infirmer ou affiner ces résultats. Ainsi, pour Alesina, et al. (1999) ou Easterly et Levine (1997) notamment, la fragmentation ethnique est une mesure exogène des politiques de redistribution et du risque de conflits qui détériore l'efficacité des gouvernements et des dépenses publiques. La religion définit des contraintes informelles comme l'éthique, la tolérance, la confiance, les conventions ou même les codes de conduite de la société

¹⁰¹ Une liste non exhaustive inclue (Acemoglu et al., 2002 ; 2001 ; Easterly 2001 ; Easterly et Levine 2003 ; Hall et Jones 1999). Pour une discussion plus complète, voir Acemoglu et Robinson (2008).

qui influencent la performance économique à long terme des pays (North, 1989 ; La Porta et al., 1999).

Le troisième facteur, à savoir le système juridique, a suscité un vif débat puisque les pays de tradition juridique de type code civil (« civil right »), comme le modèle français, apparaîtrait moins performant tant par la qualité de leur gouvernement que par leurs résultats économiques (croissance, développement économique). A contrario, le système juridique britannique de type droit commun (« common law ») serait supérieur notamment par une moindre intervention publique dans la sphère privée, une meilleure protection des droits de propriétés et un plus grand respect des contrats limitant ainsi les risques d'expropriation et favorisant le développement financier et économique des pays. Dans une revue de la littérature liée à la théorie du système juridique, La Porta et al. (2008) reconnaissent néanmoins que le système du code civil peut s'avérer préférable dans une société désordonnée, si le désordre n'est pas excessif.

L'objet de cet article est d'apprécier les déterminants de la qualité des dépenses publiques et d'étudier les effets de cette qualité sur la croissance économique et l'évolution des inégalités dans chaque pays. Dans un premier temps, nous répliquons¹⁰² strictement l'analyse de La Porta et al. (1999). Nous confirmons leurs résultats : la fragmentation ethnique, le système juridique et la religion expliquent la qualité des dépenses publiques. Puis, nous considérons la nationalité de la puissance coloniale, un facteur important pour La Porta et al. (1999) que ces auteurs ne pouvaient pas alors intégrer dans leurs analyses empiriques faute de données suffisantes. Acemoglu et al, (2001 ; 2002) ou Nunn (2007) ont étudié le pouvoir explicatif et persistant de l'histoire coloniale d'un pays sur la qualité de ses institutions au sens large. L'introduction de cette variable explicative ne modifie pas drastiquement les résultats.

Dans un second temps, nous apprécions les déterminants de la qualité des dépenses publiques en utilisant un indicateur unidimensionnel d'efficacité récemment développé par Caldeira et al. (2021)¹⁰³. Cet indicateur permet de mieux appréhender les effets de complémentarité ou de substituabilité des dépenses publiques sectorielles (éducation, santé, infrastructure) que la multitude d'indicateurs utilisés par La Porta et al. (1999). Comme La Porta et al. (1999), nous considérons les mêmes variables explicatives de cette qualité, à savoir : la fragmentation ethnolinguistique, la religion, le système juridique, mais également la nationalité de la puissance coloniale.

L'effet du système juridique sur la qualité de la dépense publique n'apparaît plus si déterminant. La différence entre les systèmes juridiques n'est pas statistiquement significative dans la plupart des spécifications. En outre, lorsque le système légal est

¹⁰² Cet effort de répllication est devenu une nécessité en sciences économiques (voir Anderson et Kichkha, 2017).

¹⁰³ La base de données est disponible à l'adresse suivante : <https://data.cerdi.uca.fr/afd-pubexp/>

combiné à l'origine coloniale, le système légal de type code civil aurait un impact positif sur la qualité de la dépense. Contrairement à La Porta et al. (1999), le catholicisme serait également associé à une meilleure qualité des dépenses publiques. Quant à l'Islam, son effet négatif n'est plus significatif. Enfin, les pays colonisés par la Belgique, la Chine et la France présenteraient une moindre qualité de leurs dépenses publiques que ceux colonisés par la Grande-Bretagne. En revanche, les pays colonisés par le Danemark et les Pays Bas afficheraient une meilleure qualité.

Avant de conclure, nous apprécions l'effet de la qualité de la dépense publique mesurée par l'indicateur unidimensionnel de Caldeira et al. (2021) sur la croissance et les inégalités. Appliquant la méthode de projection locale proposée par Jordà (2005), nous observons qu'une amélioration de cette qualité à un instant t favorise la croissance économique les deux premières années suivantes et réduit les inégalités les trois premières années, ces effets s'estompant au-delà. Le reste du document est organisé ainsi : la section 6.2 présente la méthodologie et les données ; la section 6.3 présente les résultats obtenus et la section 6.4 conclut.

6.2. Méthodologie et données

6.2.1. Procédure de répliation et d'extension

Nous suivons l'approche de répliation présentée par Clemens (2017)¹⁰⁴. Clemens (2017) la définit comme l'utilisation d'un échantillon différent d'une population et l'emploi de la même spécification empirique¹⁰⁵. Le travail de répliation idéal aurait été ce que Clemens (2017) décrit comme la vérification à savoir l'utilisation du même échantillon, de la même population et de la même spécification empirique¹⁰⁶. Si les données de La Porta et al. (1999) sont disponibles, leur méthodologie empirique complète ne l'est pas. Sans information sur les traitements préalables effectués par les auteurs sur les données, il paraît difficile de déterminer quels sont les pays inclus dans chacune des régressions. Par exemple, une régression sur la base brute aboutit à 126 observations pour l'indice de droit de propriété et 155 pour l'indice de propriété contre 124 et 152 respectivement dans l'article d'origine.

Pour notre travail de reproduction, le seul traitement effectué a été la suppression de 17 pays de la base (voir Tableau F.1.1) pour la liste de ces pays). Ces pays ont été supprimés car ils n'existent plus (anciens noms de pays qui sont eux-mêmes inclus dans

¹⁰⁴ En particulier, nous utilisons l'étape qu'il appelle la reproduction. Hamermesch (2007) appelle cette étape la reproduction statistique.

¹⁰⁵ Pour ce travail de répliation, nous utilisons exclusivement la base de données des auteurs disponibles à l'adresse https://scholar.harvard.edu/files/shleifer/files/qgov_web.xls.

¹⁰⁶ Hamermesch (2007) appelle cette étape la reproduction pure.

la base, sécession, ou réunification). Ces pays ont également la particularité de partager les mêmes code ISO que d'autres pays qui sont dans la base.

La difficulté d'indentification des pays inclus dans les différentes régressions rend de travail de répliation encore plus important. Elle permet de tester la robustesse des résultats des auteurs sur un sous échantillon de leur base d'origine. Après la reproduction des résultats, nous proposons une extension de leur analyse en utilisant le statut colonial comme déterminant.

6.2.2. Stratégie d'estimation des déterminants de la qualité des dépenses publiques

Pour l'analyse de l'effet des caractéristiques politiques, historiques et culturelles sur la qualité des dépenses publiques, nous utilisons les déterminants et les variables de contrôle issus de La Porta et al. (1999). Ensuite, nous ajoutons à la régression des variables de contrôle supplémentaires. A l'instar de Alesina et Zhuravskaya (2011), nous estimons l'effets des déterminants sur la moyenne de notre indicateur de qualité des dépenses publiques. Alesina et Zhuravskaya (2011) utilisent la moyenne des variables afin de travailler sur les données en coupe transversale. Nos variables d'intérêt étant fixes dans le temps, cette stratégie nous permet d'estimer leur effet sur la qualité des dépenses publiques.

Nous estimons les équations suivantes :

$$Q_i = \alpha + \beta F_i + \gamma^L Z_i^L + \delta X_i + \varepsilon_i, \quad \forall L \in \{J, R, C\} \quad (\text{eq. 6.1})$$

$$Q_i = \alpha + \beta F_i + \sum_{L \in \{J, R\}} \gamma^L Z_i^L + \delta X_i + \varepsilon_i \quad (\text{eq. 6.2})$$

$$Q_i = \alpha + \beta F_i + \sum_{L \in \{J, R, C\}} \gamma^L Z_i^L + \delta X_i + \varepsilon_i \quad (\text{eq. 6.3})$$

Où Q représente notre indicateur de mesure de la qualité des dépenses publiques. F désigne l'indice de fragmentation ethnique. Les variables J et C désignent respectivement le système judiciaire et le colonisateur pour les pays ayant été colonisé. R mesure la part des principales religions dans la population. X est un vecteur contenant les variables de contrôle.

Les équations (6.26.1) et (6.3) sont caractérisées par l'inclusion simultanée (ensemble ou deux à deux) des variables J , R , C , qui sont susceptibles d'être corrélées entre elles. Néanmoins, ces régressions peuvent nous éclairer sur quel facteur l'emporte sur l'autre.

La qualité des dépenses publiques est mesurée par l'indicateur d'efficience qui couvre 146 pays sur la période 1990-2015. L'indicateur est tiré de Caldeira et al. (2021) et est construit en trois étapes. Dans une première étape, des indices sectoriels de mesure

des résultats dans les secteurs éducation, santé et infrastructure publique sont élaborés. La seconde étape consiste à agréger ces indices sectoriels pour obtenir un indicateur unidimensionnel de résultat de la dépense publique. Dans la dernière étape, un modèle à frontière stochastique est utilisé pour estimer l'indicateur d'efficience en ayant pour output l'indicateur unidimensionnel de résultats et pour inputs les dépenses publiques totales (en pourcentage du PIB ou par tête) et la part des dépenses des secteurs éducation, santé et infrastructure publique dans les dépenses publiques totales. Cette mesure de la qualité de la dépense publique présente plusieurs avantages. Elle intègre l'ensemble des secteurs affectés par les dépenses publiques. Elle permet également de capter simultanément les effets des variables utilisées pour construire les indices sectoriels ainsi que les potentiels effets de complémentarité.

Les données sur la qualité des dépenses publiques sont issues d'un panel non cylindré. La moyenne par pays résulte d'un nombre différent d'observations. Afin de tenir compte de ce problème, nous pondérons les coefficients ainsi que les écart-types par l'inverse du nombre d'observation pour chaque pays (voir Dupraz, 2013 pour une dérivation explicite de l'estimateur MCO avec cette méthode de pondération). Une stratégie similaire a été utilisée par Mitts (2019)¹⁰⁷.

Les variables concernant le système légal (S.L.) et le poids de chaque religion dans la population (R) sont issues de La Porta et al (1999). La première variable est une variable binaire qui prend la valeur 1 si le système judiciaire du pays est inspiré de l'un des systèmes suivants : anglais, français, allemand, scandinave ou socialiste. Les variables muettes ont été regroupées en une seule variable cardinale pour une comparaison des systèmes légaux. La seconde variable mesure simplement la part de la population appartenant en 1980 à une des religions principales (catholicisme, islam ou protestantisme). La variable colonisation (C) provient de la base du Centre d'études prospectives et d'information internationales (CEPII). Elle est également une variable binaire qui prend la valeur 1 si le pays a été colonisé pendant une longue période. Lorsqu'un pays a subi deux phases (ou plus) de colonisation par des puissances différentes, nous retenons le premier colon. Cette variable a été également recodée pour en faire une variable cardinale. Suivant la littérature pertinente sur le sujet, le vecteur X de variables de contrôle est composé de : la latitude du pays (voir Hall et Jones, 1999 pour plus de discussion)¹⁰⁸, la moyenne du PIB sur la période 1990-2015 pour le niveau de développement des pays¹⁰⁹, le nombre d'années de conflits entre 1990 et 2015

¹⁰⁷ L'auteur présente d'ailleurs dans son annexe en ligne les possibilités d'implémentation avec les logiciels R et STATA ainsi qu'une simulation de Monte Carlo démontrant que cette stratégie de pondération aboutit à des coefficients non biaisés.

¹⁰⁸ Pour Acemoglu et al. (2002), cette variable peut refléter l'importance de la géographie pour l'établissement des colons.

¹⁰⁹ L'utilisation du PIB de la période de départ ne change pas nos résultats. Ces résultats sont disponibles si requises.

et la moyenne des rentes issues des ressources naturelles (voir Beck et Laeven, 2006 pour plus de discussion). La latitude du pays est issue de La Porta et al. (1999), le nombre d'années de conflit est tiré de la base UCDP/PRIO, version 20.1 (voir Gleditsch et al., 2002 ; Pettersson et Öberg, 2020)¹¹⁰, tandis que le PIB et les rentes issues des ressources naturelles sont tirés de la base de données indicateurs de développement dans le monde de la banque mondiale.

Nous utilisons la mesure de fragmentation ethnolinguistique de Easterly et Levine (1997). Ces auteurs proposent un indice de fragmentation ethnolinguistique, qui par la suite a été repris par de nombreux travaux dont La Porta et al. (1999). Nous utilisons également l'indice de fragmentation ethnique d'Alesina et al. (2003)¹¹¹ pour l'analyse de robustesse. Ces indices varient tous entre 0 et 1, où la valeur 0 correspond à un pays peu fragmenté. Toutefois, ils présentent différentes couvertures géographiques. D'où le choix de les utiliser séparément afin de comparer les résultats et de tester la sensibilité de l'indicateur de qualité des dépenses publiques à la mesure de la fragmentation ethnique et au choix du groupe de pays retenu.

Enfin, la dernière analyse de sensibilité consiste à exploiter la dimension panel de notre indicateur. Nous utilisons une régression à effet aléatoire permettant ainsi de prendre en compte l'évolution de l'indicateur dans les pays et de contrôler pour les facteurs non observables liés au temps. Cette stratégie empirique permet également d'utiliser les valeurs des variables évoluant dans le temps, à savoir le PIB, la rente issue des ressources naturelles et les conflits. Cette stratégie nous permet également d'affiner la variable conflit en utilisant l'intensité du conflit¹¹². En effet, pour deux pays ayant le même nombre d'années de conflit, le type de conflit et/ou l'intensité du conflit peuvent être différents. Par exemple, la Côte d'Ivoire et la Libye ont le même nombre d'années de conflits sur la période 1990 et 2015. Cependant, les deux pays ont connu simultanément une situation de conflits uniquement en 2011. De plus l'intensité du conflit, mesurée par le nombre de morts¹¹³, est de l'ordre 1 pour 38¹¹⁴. L'utilisation du nombre de morts issus des conflits soulèvent une difficulté supplémentaire. En effet, la

¹¹⁰ Ne sont retenus que les conflits armés qui concernent les Etats caractérisés par l'utilisation de la force entre les deux parties et qui résultent en un bilan d'au moins 25 décès durant une année civile.

¹¹¹ L'utilisation de l'indice de fragmentation ethnique de Fearon (2003) ne change pas substantiellement nos résultats. Nous affichons uniquement les résultats de robustesse avec l'indice d'Alesina et al. (2003) car il couvre un plus grand nombre de pays de notre échantillon. Les résultats de robustesse avec l'indice de fragmentation ethnique de Fearon (2003) sont disponibles si requises.

¹¹² Esteban et al. (2012) recommande le nombre total de morts par an comme proxy de l'intensité du conflit.

¹¹³ La base UCDP/PRIO estime le nombre de décès imputables aux conflits entre 1989 et 2019 (voir Pettersson et Öberg, 2020)

¹¹⁴ Voir Bellamy et Williams (2011) pour une discussion approfondie des deux conflits en Côte d'Ivoire et en Libye, en particulier l'utilisation de la force militaire dans une optique de protection des civils.

variable est très étalée vers la droite et contient un très grand nombre de zéros, or l'estimateur des moindres carrés que nous utilisons suppose une relation linéaire entre la variable dépendante et les variables explicatives. Pour pallier ce problème, nous recourons à la transformation de Box et Cox (1964). Les auteurs ont proposé une technique de transformation de puissance paramétrique définie par un (ou deux) paramètre λ visant à réduire les anomalies dans les données et s'assurer que les hypothèses habituelles pour un modèle linéaire tiennent.

La transformation de Box Cox à un paramètre λ s'écrit :

$$y^{(\lambda)} = \begin{cases} \frac{y^\lambda - 1}{\lambda} & (\lambda \neq 0), \\ \log y & (\lambda = 0) \end{cases}$$

La transformation de Box Cox à deux paramètres λ_1 et λ_2 s'écrit :

$$y^{(\lambda)} = \begin{cases} \frac{(y + \lambda_2)^{\lambda_1} - 1}{\lambda_1} & (\lambda \neq 0), \\ \log (y + \lambda_2) & (\lambda = 0) \end{cases}$$

Le but du model de transformation de Box Cox est d'inférer le ou les paramètres de transformation. Box et Cox (1964) décrivent pour cela deux méthodes : une méthode basée sur le maximum de vraisemblance et une méthode bayésienne.

Le nombre de morts issus des combats contenant beaucoup de zéros, nous avons utilisé la transformation de Box Cox à deux paramètres. Les paramètres de transformation ont été estimés en utilisant la méthode du maximum de vraisemblance. Cette variable transformée est ensuite utilisée comme variable de mesure de l'intensité du conflit dans chaque pays à chaque période. Nous nous sommes inspirés de l'article de Hyndman et Grunwald (2000) pour appliquer la transformation de Box Cox à une distribution étalée vers la droite contenant un nombre élevé de zéros.

6.2.1. Stratégie d'estimation de l'effet de l'amélioration de la qualité des dépenses publiques sur la croissance et les inégalités

La seconde étape de l'analyse porte sur les effets d'une amélioration de la qualité des dépenses publiques sur la croissance économique et les inégalités. Nous illustrons le lien entre l'impact de la dépense publique sur la croissance (respectivement les inégalités), conditionnellement du niveau de l'indice d'efficacité de la dépense publique. Nous utilisons la méthode de projection locale de Jordà (2005). L'idée centrale de cette méthode consiste à estimer la réponse impulsionnelle de l'output suite à un choc sur l'input à travers des projections locales à chaque période d'intérêt. Cette méthode permet donc de se passer de l'extrapolation dans des horizons de plus en plus éloignés

d'un modèle donné en utilisant des vecteurs autorégressifs (VAR). En suivant Auerbach et Gorodnichenko (2012), la première régression utilisant la croissance économique comme variable dépendante est spécifiée comme suit :

$$y_{i,t+h} - y_{i,t} = \alpha_i^h + \gamma_t^h + \beta_1^h \Delta F(z_t) G_{i,t}^g + \beta_2^h \Delta(1 - F(z_t)) G_{i,t}^g + \varphi^h \Delta X_{i,t} + \varepsilon_{i,t}^h \quad (\text{eq. 6.4})$$

$$Gini_{i,t+h} - Gini_{i,t} = \alpha_i^h + \gamma_t^h + \beta_1^h \Delta F(z_{it}) G_{i,t}^g + \beta_2^h \Delta(1 - F(z_{it})) G_{i,t}^g + \varphi^h \Delta X_{i,t} + \varepsilon_{i,t}^h \quad (\text{eq. 6.5})$$

$$h = 0, \dots, 5$$

Où y est le logarithme du PIB réel par tête (parité de pouvoir d'achat), $Gini$ est logarithme de l'indice d'inégalité des revenus, α_i sont des effets spécifiques fixes pays, γ_t sont des effets spécifiques fixes temporels, $G_{i,t}^g$ est le logarithme de la dépense de consommation finale (parité de pouvoir d'achat), et $F(z_t)$ est une fonction qui varie entre 0 et 1 pour permettre des réponses différenciées sur la croissance du PIB selon le groupe de l'efficacité de la dépense publique (faible et élevé). Plus précisément :

$$F(z_t) = \frac{\exp(-z_t)}{1 + \exp(-z_t)}$$

Où z_t est notre indicateur de qualité de la dépense publique. L'indicateur est standardisé afin d'avoir une moyenne nulle et une variance égale à un. Les coefficients β_1^h et β_2^h peuvent être interprétés comme décrivant, respectivement, le système d'efficacité faible de la dépense publique ($F(z_t) \approx 1$), et d'efficacité élevée de la dépense publique ($F(z_t) \approx 0$). $\Delta X_{i,t}$ est la variation du vecteur des variables de contrôles et φ est le vecteur des coefficients estimés. Le vecteur de contrôles inclut le PIB réel par habitant, le service total de la dette publique, le taux d'inflation en pourcentage du PIB, l'indice global de développement financier, le commerce en pourcentage du PIB, l'investissement public, le taux d'intérêt réel, l'aide public au développement par habitant et la croissance de la population. L'ensembles des données pour les contrôles provienne de la base de données indicateurs de développement dans le monde de la banque mondiale.

L'utilisation des projections locales présente plusieurs avantages. Premièrement, elle permet d'estimer les effets directs et indirects des dépenses publiques sur la croissance économique. Deuxièmement, cette stratégie est robuste aux problèmes de mauvaises spécifications car elle estime la réponse impulsionnelle directe de la régression individuelle à chaque horizon temporel h . Troisièmement, cette méthode d'estimation est souple avec une spécification non linéaire et dépendante de l'état pour tenir compte du réalisme de l'analyse économétrique. Enfin, la projection locale est largement utilisée dans l'appréciation des multiplicateurs budgétaires, les crises financières et les consolidations budgétaires (Auerbach et Gorodnichenko, 2012 ; Banerjee et Zampolli, 2019 ; Jordà, 2005 ; Jordà et Taylor, 2016).

La méthodologie utilisée est similaire à celle de International Monetary Fund (2015). La seule différence est que notre indice d'efficacité varie dans le temps pour chaque pays de l'échantillon. Plus précisément, la spécification économétrique utilise une régression à effets fixes permettant d'estimer des effets variables de la dépense publique sur la croissance en fonction du degré d'efficacité de la dépense publique.

Les indicateurs du degré d'efficacité (faible et élevé) ont été simultanément introduits dans la régression afin de comparer les impacts sur les variations du PIB/habitant et de l'indice d'inégalité de revenus de Gini en pourcentage selon l'horizon ($h = 1, \dots, 5$)¹¹⁵. La dépense de consommation finale (anciennement consommation totale) est la somme des dépenses de consommation finale des ménages (consommation privée) et des dépenses de consommation finale des administrations publiques (consommation des administrations publiques).

6.3. Résultats

Nous présentons successivement les résultats de la réplication de La Porta et al. (1999), l'analyse des déterminants de la qualité des dépenses publiques et les effets de l'amélioration de la qualité des dépenses publiques sur la croissance économique et les inégalités.

6.3.1. Réplication de La Porta et al. (1999)

L'article de La Porta et al. (1999) demeure un des articles de référence sur la qualité des institutions. Les auteurs étudient l'effet des variables politiques et culturelles sur la performance des gouvernements. Leur analyse repose sur une base de données contenant 209 pays. La base est constituée à partir de multiples sources. Ceci implique différents nombres d'observations pour les variables¹¹⁶. La performance des gouvernements est mesurée par cinq dimensions et chaque dimension est approchée par une série de variables individuelles. Les dimensions et les variables sont :

- Intervention du gouvernement : Indice de protection des droits de propriété ; Indice de qualité de la réglementation des affaires ; Taux d'imposition marginal le plus élevé
- Efficacité des gouvernements : Indice de corruption ; Retards bureaucratiques ; Conformité fiscale ; Salaire moyen des employés du gouvernement

¹¹⁵ Le coefficient de Gini peut être donné sous la forme d'une proportion : Il est égal à 0 lorsque la répartition est égale et à 1 si le revenu total de la société correspond à celui d'une seule personne/unité de ménage.

¹¹⁶ Pour rappel, la base des auteurs est disponible en ligne. Mais le programme des régressions a été élaboré par nos soins.

- Fourniture de biens et services publics : Taux de mortalité infantile ; Résultats scolaires ; Taux d'analphabétisme ; Indice de qualité des infrastructures
- Taille du secteur public : Transferts et subventions ; Dépenses de consommation du gouvernement ; Indice de la taille des sociétés publiques dans l'économie ; Emploi dans le secteur public
- Liberté politique : Indice des droits politiques ; Indice de démocratie

La Porta et al. (1999) régressent chaque variable de mesure de la performance des gouvernements sur les déterminants. Les résultats de réplication sont présentés dans les tableaux Annexe : Résultats de réplication et d'extension de La Porta et al. (1999)

à Tableau F.3.6. Ils confirment les conclusions de ces auteurs. Pour la majorité des régressions, les signes ainsi que les significativités sont les mêmes.

La fragmentation ethnolinguistique est associée à plus d'interventionnisme, une moindre efficacité des gouvernements, une moindre fourniture de biens publics, une taille plus petite du gouvernement et moins de liberté politique. Cependant, les résultats ne sont pas robustes à l'introduction de variables de contrôle.

Les pays ayant le système légal allemand présente des résultats similaires à ceux avec le système légal britannique. Tous les autres systèmes sont en général plus interventionnistes. A l'exception du système scandinave, tous les autres systèmes sont moins efficaces et caractérisés par moins de liberté politique que le système légal britannique. Le système scandinave est le plus efficace et permet plus de liberté politique. Les différences de fourniture de biens et services publics entre les systèmes socialiste et britannique sont mitigées. Les systèmes légaux français et britanniques ne sont pas très différents quant à la taille du gouvernement. Le système scandinave est caractérisé par une taille plus grande tandis que les résultats sont mixtes pour le système socialiste.

Les pays colonisés par la Belgique, la Chine, la France, le Portugal et la Turquie ont des tendances plus interventionnistes comparé aux anciennes colonies britanniques. Ceux colonisés par le Danemark sont moins interventionnistes. Les autres ne sont pas très différents ou présentent des résultats mitigés. Concernant l'efficacité des gouvernements, les résultats sont mitigés pour les pays colonisés par l'Allemagne, le Danemark, le Japon, les Pays-Bas et la Russie quand ils sont comparés aux colonies britanniques. Les anciennes colonies de l'Espagne, de la France, du Portugal, la Turquie semblent moins efficaces. La fourniture de biens publics est moindre dans les anciennes colonies de la Belgique, de l'Espagne, de la France, des Pays-Bas, du Portugal. Les anciennes colonies du Danemark et de la Russie présentent de meilleurs niveaux de fourniture. Les autres affichent des niveaux assez similaires aux anciennes colonies britanniques. La taille du gouvernement semble relativement moins grande

dans les pays colonisés par la Belgique, l'Espagne, la France, le Japon, les Pays-Bas, la Turquie. Les pays colonisés par l'Allemagne, le Danemark affichent des niveaux similaires aux anciennes colonies britanniques. Enfin, les pays colonisés par la Russie ont une plus grande taille du gouvernement. Comparé aux anciennes colonies britanniques, les pays colonisés par l'Allemagne, le Danemark ont plus de liberté politique. Tandis que ceux colonisés par l'Espagne, le Japon, les Pays-Bas ne sont pas très différents. Les autres sont caractérisés par moins de liberté politique.

6.3.2. Déterminants de la qualité des dépenses publiques

Les résultats de l'analyse des déterminants de la qualité des dépenses publiques appréhendée par l'indicateur proposé par Caldeira et al. (2021) sont présentés dans le Tableau 6.1. Les tableaux Tableau 6.2 et Tableau 6.3 contiennent les analyses de robustesse.

La fragmentation ethnique est associée à une moindre qualité des dépenses publiques. Cette relation est robuste quelle que soit la mesure de fragmentation ethnique utilisée et donc à l'échantillon de pays, les différentes bases de fragmentation ethnique couvrant différents nombres de pays. La relation reste également robuste au changement de variables de contrôle¹¹⁷.

Ces résultats sont en lien avec les théories politiques des institutions. La fragmentation ethnique saisit la prédisposition des groupes ethniques au pouvoir à redistribuer (La Porta et al., 1999). Esman (1997) discute de façon assez complète l'effet des clivages ethniques sur des facteurs comme la taxation, la bureaucratie, les politiques et programmes par le canal des administrations publiques. Selon cet auteur, de multiples fonctions irréductibles du gouvernement comme les marchés publics, les infrastructures physiques, les politiques éducatives, la santé publique nécessitent l'allocation de ressources ou l'application de la coercition qui peuvent se faire de façon inéquitable via des processus formels ou informels en ligne avec les clivages ethniques. De plus, les programmes peuvent être mises en œuvre en faveur des communautés dominantes et non selon une optique de maximisation de leurs résultats. Les aides publiques ou les programmes sociaux peuvent être redirigés en faveur des ethnies privilégiées.

¹¹⁷ Nous ne présentons pas les résultats de toutes les combinaisons pour des raisons de brièveté

Tableau 6.1: Efficience des dépenses publiques, système légal (S.L.), colonisateur et religion

Variables	Efficience des dépenses publiques				
	[1]	[2]	[3]	[4]	[5]
Frag. Ethnoling	-0.142*** (0.035)	-0.105*** (0.033)	-0.139*** (0.038)	-0.115*** (0.037)	-0.120*** (0.044)
S.L. Français	-0.018 (0.020)			-0.033 (0.026)	0.037 (0.039)
S.L. Allemand	-0.032 (0.024)			-0.032 (0.023)	-0.008 (0.035)
S.L. Scandinave	-0.033 (0.026)			0.044 (0.053)	0.096 (0.082)
S.L. Socialiste	-0.044 (0.029)			-0.066** (0.028)	-0.018 (0.051)
Cath. (% Pop)		0.001* (0.000)		0.001** (0.001)	0.002* (0.001)
Musul. (% Pop)		-0.000 (0.000)		0.001 (0.001)	0.001 (0.001)
Autres (% Pop)		0.000 (0.000)		0.001** (0.001)	0.002* (0.001)
Col. Belgique			-0.144*** (0.038)		-0.200*** (0.040)
Col. Chine			-0.068 (0.042)		-0.090* (0.048)
Col. Allemagne			-0.051 (0.032)		-0.030 (0.038)
Col. Danemark			0.029 (0.041)		0.059*** (0.017)
Col. Espagne			-0.009 (0.025)		-0.080** (0.031)
Col. France			-0.075*** (0.025)		-0.097*** (0.037)
Col. Japon			0.003 (0.027)		
Col. Pays-Bas			0.062*** (0.022)		0.010 (0.042)
Col. Portugal			-0.050 (0.038)		-0.116*** (0.044)
Col. Russie			-0.024 (0.031)		
Col. Turquie			0.012 (0.025)		-0.010 (0.049)
Latitude	0.092 (0.059)	0.117* (0.060)	0.080 (0.076)	0.126** (0.063)	0.098 (0.082)
Moy PIB (PPP cst. 2011 \$ int., log)	0.018*** (0.005)	0.016*** (0.005)	0.014** (0.005)	0.016*** (0.005)	0.014*** (0.005)
Conflits (années)	-0.002* (0.001)	-0.002 (0.001)	-0.002 (0.001)	-0.002* (0.001)	-0.002 (0.001)

Variables	Efficience des dépenses publiques				
	[1]	[2]	[3]	[4]	[5]
Rente	-0.006*** (0.002)	-0.006*** (0.002)	-0.004* (0.002)	-0.005*** (0.002)	-0.004* (0.002)
Constante	0.307*** (0.113)	0.283** (0.118)	0.412*** (0.121)	0.245* (0.137)	0.260 (0.165)
Observations	119	119	98	119	98
R carré	0.656	0.668	0.648	0.687	0.691
R carré ajusté	0.627	0.644	0.578	0.651	0.606

Notes : Le tableau présente les résultats de régression de l'efficience des dépenses publiques sur la fragmentation ethnolinguistique d'Easterly et Levine (1997), la part des religions, les muettes de système légal et d'origine coloniale ainsi que les variables de contrôle. Les coefficients et les écart-types sont pondérés par l'inverse du nombre d'observations de chaque pays. *** $p < 0,01$, ** $p < 0,05$, * $p < 0,1$. Ecart-types robustes entre parenthèses.

La fragmentation ethnique peut conduire à une utilisation inefficace des institutions, comme la duplication des portefeuilles ministériels. Par exemple, entre 1980 et 1990, le Cameroun a eu au minimum deux ministres des finances. Ce nombre est passé à trois vers la fin des années 80 pour atteindre un maximum de 4 ministres des finances en 1991 (voir la base de données de Francois *et al.*, 2015). Dans le cas du Cameroun, les postes dupliqués étaient occupés par des ministres d'ethnies différentes, même en cas de changement du ministre. Les postes ministériels sont distribués entre les ethnies de façon à obtenir leur soutien. Cette politique peut entraîner une taille excessive des gouvernements et un gaspillage des ressources publiques.

L'effet du système légal s'avère en revanche peu robuste. La différence entre les systèmes légaux n'est pas statistiquement significative dans la plupart des spécifications. Lorsqu'ils sont significatifs, les résultats montrent que comparés au système légal britannique (*common law*), les autres systèmes ont une qualité des dépenses publiques moindres. Cependant, lorsque le système légal est combiné à l'origine coloniale, le signe de la variable muette système légal français devient positif.

Notre interprétation de ces résultats est que si l'origine légale contribue à comprendre le degré d'intervention des Etats et la nature du contrat social du pays, il explique peu la qualité qui en découle. Cela expliquerait pourquoi elle affecte certaines composantes des institutions et pas la qualité des dépenses publiques. Un Etat peut avoir des dépenses publiques importantes et avoir une intervention en termes de dépenses publiques importantes sans que cela ne détermine nécessairement la qualité des dépenses publiques engagées.

Il apparaît que le catholicisme est associé à une meilleure qualité des dépenses publiques. L'affiliation à la religion musulmane ne semble pas affecter la qualité des dépenses publiques. Ainsi, comparé au protestantisme, le catholicisme est associé à une meilleure qualité des dépenses publiques.

Tableau 6.2: Efficience des dépenses publiques, système légal (S.L.), colonisateur et religion

Variables	Efficience des dépenses publiques				
	[1]	[2]	[3]	[4]	[5]
Frag. Ethnique ADEKW	-0.135*** (0.038)	-0.110*** (0.035)	-0.170*** (0.045)	-0.111*** (0.039)	-0.154*** (0.046)
S.L. Français	-0.011 (0.020)			-0.036 (0.022)	0.088** (0.034)
S.L. Allemand	-0.045* (0.025)			-0.041 (0.026)	-0.013 (0.035)
S.L. Scandinave	-0.070** (0.029)			-0.000 (0.051)	0.015 (0.059)
S.L. Socialiste	0.003 (0.024)			-0.009 (0.025)	0.065 (0.043)
Cath. (% Pop)		0.001*** (0.000)		0.001** (0.001)	0.001 (0.001)
Musul. (% Pop)		0.001 (0.000)		0.001 (0.001)	0.000 (0.001)
Autres (% Pop)		0.001*** (0.000)		0.001* (0.001)	0.001 (0.001)
Col. Autriche			0.034 (0.023)		-0.044 (0.037)
Col. Belgique			-0.147*** (0.034)		-0.241*** (0.038)
Col. Chine			-0.104*** (0.034)		-0.149*** (0.046)
Col. Allemagne			-0.072** (0.031)		-0.094** (0.038)
Col. Danemark			0.006 (0.038)		0.070 (0.052)
Col. Espagne			-0.003 (0.025)		-0.118*** (0.032)
Col. France			-0.095*** (0.024)		-0.160*** (0.031)
Col. Hongrie			0.008 (0.023)		-0.070* (0.039)
Col. Japon			-0.027 (0.032)		
Col. Pays-Bas			0.066*** (0.022)		-0.027 (0.031)
Col. Portugal			-0.067 (0.054)		-0.167*** (0.053)
Col. Russie			0.035 (0.030)		0.009 (0.046)
Col. Turquie			0.021 (0.026)		-0.036 (0.043)
Latitude	0.182*** (0.062)	0.227*** (0.051)	0.091 (0.078)	0.211*** (0.066)	0.089 (0.081)

Variables	Efficience des dépenses publiques				
	[1]	[2]	[3]	[4]	[5]
Moy PIB (PPP cst. 2011 \$ int., log)	0.021*** (0.005)	0.017*** (0.005)	0.017*** (0.006)	0.018*** (0.005)	0.018*** (0.005)
Conflits (années)	-0.003** (0.001)	-0.002** (0.001)	-0.003** (0.001)	-0.003** (0.001)	-0.002* (0.001)
Rente (%PIB)	-0.002 (0.001)	-0.001 (0.001)	-0.000 (0.001)	-0.001 (0.001)	-0.001 (0.001)
Constante	0.220* (0.120)	0.194 (0.122)	0.366*** (0.128)	0.172 (0.136)	0.252* (0.148)
Observations	141	140	117	140	116
R carré	0.579	0.587	0.662	0.599	0.715
R carré ajusté	0.550	0.562	0.600	0.562	0.640

Notes : Le tableau présente les résultats de régression de l'efficience des dépenses publiques sur la fragmentation ethnolinguistique d'Alesina et al. (2003), la part des religions, les muettes de système légal et d'origine coloniale ainsi que les variables de contrôle. Les coefficients et les écart-types sont pondérés par l'inverse du nombre d'observations de chaque pays. *** p<0,01, ** p<0,05, * p<0,1. Ecart-types robustes entre parenthèses.

L'origine coloniale est généralement liée au système légal, mais il permet de capter plus de facteurs que ce dernier. La langue officielle, la référence en termes d'institutions, les relations bilatérales et même communautaires, les migrations ainsi que la formation de l'élite de bon nombre de pays du continent africain sont affectées par l'origine coloniale. Comparé aux pays colonisés par la Grande Bretagne, les pays colonisés par la Belgique, la Chine et la France présentent une moindre qualité de leurs dépenses publiques. En revanche, les pays colonisés par le Danemark et les Pays Bas affichent une meilleure qualité de leurs dépenses publiques.

Le niveau de revenu du pays est positivement associé à la qualité des dépenses publiques. Ce résultat est conforme à la littérature pertinente. Les pays plus riches ont un gouvernement plus efficace : ils ont un meilleur niveau de fourniture de biens publics compte tenu du niveau et de la composition de leurs dépenses publiques.

Les conflits détériorent la qualité des dépenses publiques. Ce résultat n'est guère surprenant puisqu'un conflit induit un changement du niveau et de la composition des dépenses publiques. Le conflit affecte également les résultats des dépenses publiques (destruction des infrastructures, accroissement du nombre de morts, cessation des cours dans les zones affectées par les conflits...). L'effet de l'intensité des conflits sur la qualité des dépenses publiques n'est pas significatif.

Enfin les rentes issues des ressources naturelles affichent un effet négatif sur la qualité des dépenses publiques. Cette relation est cependant peu robuste, en particulier à l'utilisation des données en panel.

Tableau 6.3 : Efficience des dépenses publiques, système légal (S.L.), colonisateur et religion

Variables	Efficience des dépenses publiques				
	[1]	[2]	[3]	[4]	[5]
Frag. Ethnoling	-0.161** (0.067)	-0.128*** (0.048)	-0.171*** (0.048)	-0.138*** (0.051)	-0.147*** (0.052)
S.L. Français	-0.037 (0.036)			-0.050 (0.032)	0.010 (0.054)
S.L. Allemand	-0.118** (0.057)			-0.066* (0.035)	-0.012 (0.044)
S.L. Scandinave	0.051 (0.065)			0.033 (0.070)	0.086 (0.092)
S.L. Socialiste	-0.071 (0.051)			-0.066* (0.034)	-0.057 (0.056)
Cath. (% Pop)		0.000 (0.001)		0.001 (0.001)	0.002 (0.001)
Musul. (% Pop)		-0.001 (0.001)		0.000 (0.001)	0.000 (0.001)
Autres (% Pop)		-0.000 (0.001)		0.000 (0.001)	0.001 (0.001)
Col. Belgique			-0.181*** (0.043)		-0.242*** (0.052)
Col. Chine			-0.085*** (0.033)		-0.021 (0.055)
Col. Allemagne			-0.031 (0.026)		-0.025 (0.053)
Col. Danemark			0.088* (0.046)		0.100*** (0.024)
Col. Espagne			-0.020 (0.027)		-0.118** (0.050)
Col. France			-0.058** (0.028)		-0.052 (0.048)
Col. Japon			-0.024 (0.030)		
Col. Pays-Bas			0.046 (0.049)		-0.003 (0.047)
Col. Portugal			-0.040 (0.054)		-0.109* (0.064)
Col. Russie			-0.007 (0.035)		
Col. Turquie			0.041 (0.026)		0.086 (0.057)
Latitude	-0.145	0.056	0.031	0.061	0.027

Variables	Efficience des dépenses publiques				
	[1]	[2]	[3]	[4]	[5]
	(0.105)	(0.077)	(0.086)	(0.074)	(0.088)
PIB (PPP cst. 2011 \$ int., log)	0.079***	0.045***	0.037***	0.046***	0.037***
	(0.004)	(0.007)	(0.008)	(0.007)	(0.008)
Conflits (années)	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Rente (%PIB)	0.001**	0.000*	0.000	0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-1.178***	-0.428***	-0.188	-0.468***	-0.305
	(0.122)	(0.160)	(0.199)	(0.167)	(0.203)
Effets fixes années	Oui	Oui	Oui	Oui	Oui
Observations	2015	2015	1626	2015	1626
Nombre de pays	119	119	98	119	98
R carré	0.282	0.429	0.442	0.452	0.502

Notes : Le tableau présente les résultats de régression de l'efficience des dépenses publiques sur la fragmentation ethnolinguistique d'Easterly et Levine (1997), la part des religions, les muettes de système légal et d'origine coloniale ainsi que les variables de contrôle. *** $p < 0,01$, ** $p < 0,05$, * $p < 0,1$. Ecart-types robustes entre parenthèses.

La prise en compte de tous ces facteurs simultanément nous permet de voir que le colonialisme a un effet significatif et important sur la qualité des dépenses publiques. Une explication plausible de ce rôle important du colonialisme peut être trouvée dans Acemoglu et al. (2002). Le colonialisme a non seulement perturbé les organisations sociales en place mais a conduit à l'établissement d'institutions extractives, qui visaient à maximiser les rentes des colons européens et non la croissance de long terme.

6.3.3. Effets de la qualité des dépenses publiques sur la croissance et les inégalités de revenus

L'utilisation des dépenses publiques comme source de croissance économique et de réduction des inégalités demeure largement débattue tant dans les économies en développement que dans les économies les plus avancées. Ainsi, les taux de croissance élevés de plusieurs pays émergents comme l'Inde, la Chine et le Brésil s'expliquent en partie par d'importants investissements publics. A contrario, plusieurs pays européens ont réduit leurs dépenses publiques contraints par leur endettement important. Pour Getachew and Turnovsky (2015), les dépenses publiques ne semblent pas avoir permis de réduire les inégalités.

Nous concentrons notre revue de la littérature sur les publications empiriques les plus récentes. Plusieurs articles ont étudié l'impact des dépenses publiques d'éducation, de santé ou d'infrastructures sur la croissance à long terme et l'inégalité. La qualité de ces dépenses publiques est en revanche peu évoquée.

Depuis Kneller et al. (1999), plusieurs travaux ont montré que les dépenses productives affectent positivement la croissance économique, contrairement aux dépenses non productives (Teles et Mussolini, 2014 ; Gemmell et al., 2016 ; Fournier et Johansson, 2016). Les dépenses d'infrastructure et d'éducation augmenteraient les revenus à long terme. Pour Gnangoin et al. (2019) en revanche, les dépenses publiques d'éducation n'améliorent pas les taux de croissance dans les pays asiatiques. Holzner et Mario (2010) constatent une corrélation positive (respectivement négative) entre les dépenses publiques et l'équité (respectivement la croissance).

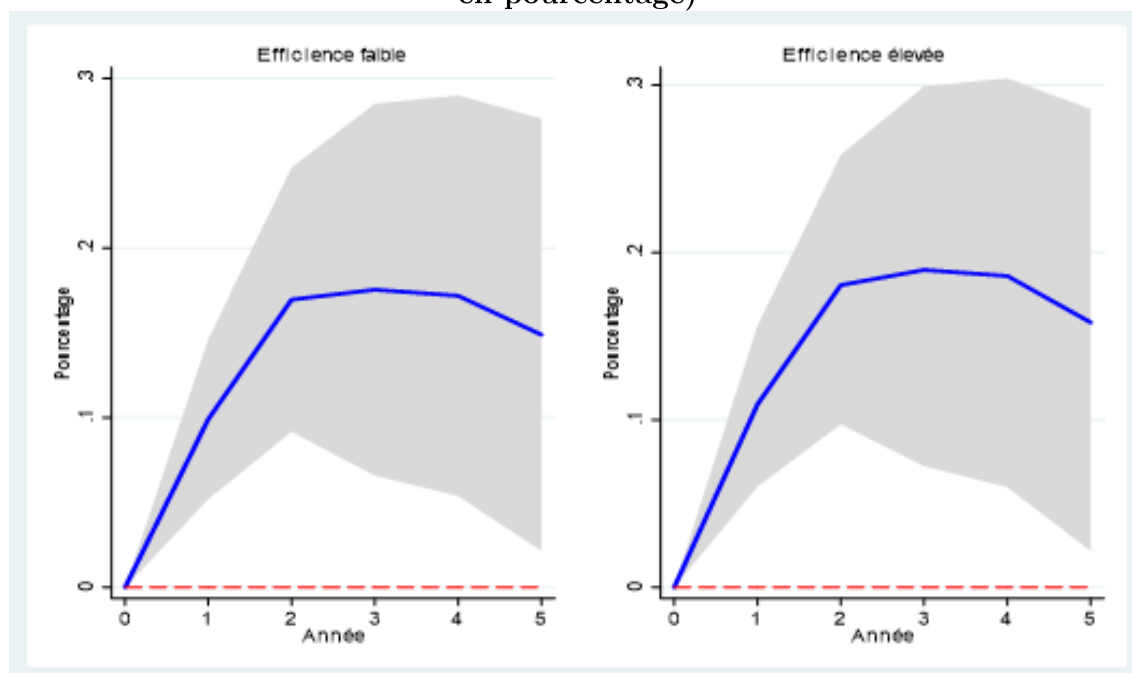
Tableau 6.4 : Réponse cumulative de la variation du PIB réel par tête à la variation de la qualité des dépenses publiques sur 6 ans (par rapport à l'année 0, en pourcentage)

	Année 0	Année 1	Année 2	Année 3	Année 4	Année 5
Dépenses publiques – efficacité faible	0.099*** (0.029)	0.170*** (0.047)	0.175** (0.067)	0.172** (0.072)	0.149* (0.077)	0.151** (0.073)
Dépenses publiques – efficacité élevée	0.109*** (0.030)	0.180*** (0.051)	0.190** (0.071)	0.186** (0.077)	0.158* (0.083)	0.162** (0.079)
Service total dettes publiques	-0.002** (0.001)	-0.002** (0.001)	-0.003** (0.001)	-0.003* (0.001)	-0.002 (0.002)	-0.003 (0.002)
Inflation	-0.001** (0.000)	-0.001* (0.001)	-0.001* (0.001)	-0.002** (0.001)	-0.002*** (0.001)	-0.002** (0.001)
Développement financier	0.067 (0.057)	0.008 (0.101)	-0.011 (0.148)	0.090 (0.172)	0.109 (0.192)	0.111 (0.200)
Commerce	0.000 (0.000)	0.000 (0.000)	0.001* (0.000)	0.001*** (0.000)	0.001** (0.001)	0.002** (0.001)
Investissement public	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001** (0.000)
Taux d'intérêt réel	-0.001* (0.000)	-0.001* (0.001)	-0.001* (0.001)	-0.002** (0.001)	-0.002*** (0.001)	-0.002** (0.001)
Aide public au développement	-0.001** (0.004)	-0.001 (0.005)	-0.002 (0.008)	-0.002 (0.010)	0.000 (0.013)	-0.000 (0.015)
Constante	0.021*** (0.000)	0.045*** (0.001)	0.072*** (0.001)	0.096*** (0.001)	0.123*** (0.001)	0.152*** (0.001)
Observations	709	709	709	708	665	621
Nombre de pays	59	59	59	59	59	59
R carré	0.247	0.189	0.151	0.138	0.104	0.082

Note : Le tableau présente les résultats de la fonction de réponse. Ecart-types entre parenthèses (***) $p < 0.01$, (**) $p < 0.05$, (*) $p < 0.1$.

Le Tableau 6.4 et la Figure 6.1 associée présentent l'effet d'un choc de la qualité de la dépense publique sur la croissance pour 6 années qui suivent ce choc. Nous observons qu'une amélioration de la qualité de la dépense publique améliore le PIB par habitant jusqu'à la deuxième année puis se stabilise. L'ampleur de l'effet augmente avec le degré d'efficacité. Par exemple, à la deuxième année nous observons une croissance du PIB par habitant de 0,175% ou de 0,190% pour un pays avec un degré d'efficacité faible ou forte.

Figure 6.1 : Réponse cumulative de la variation du PIB réel par tête à la variation de la qualité des dépenses publiques sur 6 ans (par rapport à l'année 0, en pourcentage)



Note : le graphique présente les résultats de la fonction de réponse basée sur la différence. Affichage de la bande d'erreur de 90%.

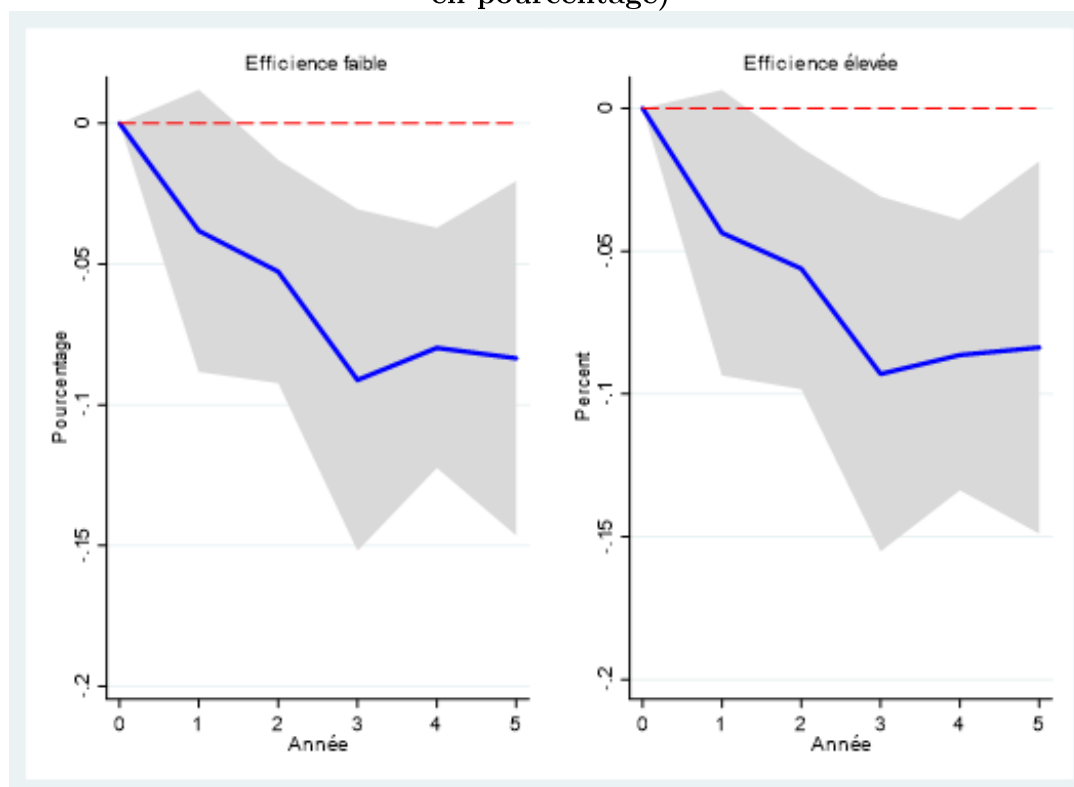
Tableau 6.5 : Réponse cumulative de la variation de l'inégalité de revenu à la variation de la qualité des dépenses publiques sur 6 ans (par rapport à l'année 0, en pourcentage)

	Année 0	Année 1	Année 2	Année 3	Année 4	Année 5
Dépenses pub – efficience faible	-0.038 (0.030)	-0.053** (0.024)	-0.091** (0.037)	-0.080*** (0.026)	-0.083** (0.038)	-0.094** (0.063)
Dépenses pub – efficience élevée	-0.044 (0.030)	-0.056** (0.026)	-0.093** (0.038)	-0.086*** (0.029)	-0.084** (0.040)	-0.098** (0.063)
PIB réel par tête	-0.019* (0.010)	-0.017 (0.013)	-0.037** (0.017)	-0.066*** (0.021)	-0.092*** (0.023)	-0.115*** (0.025)
Développement financier	-0.046 (0.057)	0.025 (0.089)	0.049 (0.102)	-0.101 (0.065)	0.002 (0.088)	-0.035 (0.100)
Commerce	-0.001 (0.000)	-0.000 (0.000)	-0.001*** (0.000)	-0.001 (0.001)	-0.001** (0.000)	-0.001* (0.001)
Aide public au développement	0.004** (0.002)	0.001 (0.001)	-0.002 (0.001)	0.004 (0.003)	0.004* (0.002)	0.009*** (0.003)
Croissance de la population	-0.003 (0.002)	-0.005 (0.003)	-0.018*** (0.006)	-0.020** (0.009)	-0.029*** (0.008)	-0.011 (0.019)
Constante	0.158** (0.078)	0.146 (0.105)	0.316** (0.136)	0.552*** (0.175)	0.762*** (0.188)	0.955*** (0.203)
Observations	432	401	366	337	309	284
Nombre de pays	47	45	43	42	39	39
R carré ajusté	0.049	0.006	0.077	0.107	0.164	0.182

Note : Le tableau présente les résultats de la fonction de réponse. Ecart-types entre parenthèses (***) $p < 0.01$, (**) $p < 0.05$, (*) $p < 0.1$.

De façon similaire, le Tableau 6.5 et la Figure 6.2 associée présentent l'effet d'un choc de la qualité de la dépense publique sur l'inégalité. La qualité de la dépense publique réduit les inégalités dès la première année. Cet effet est maximal à l'année 2 avec une réduction des inégalités de l'ordre 0,09%. Il s'avère légèrement plus important lorsque la qualité des dépenses publiques est meilleure.

Figure 6.2 : Réponse cumulative de la variation de l'inégalité de revenu à la variation de la qualité des dépenses publiques sur 6 ans (par rapport à l'année 0, en pourcentage)



Note : le graphique présente les résultats de la fonction de réponse basée sur la différence. Affichage de la bande d'erreur de 90%.

6.4. Conclusion

Nous répliquons les régressions de La Porta et al. (1999) et confirmons leurs résultats. Les pays fragmentés ethniquement sont caractérisés par une plus grande taille du gouvernement et plus d'interventionnisme. Ces pays sont relativement moins efficaces, ont une moindre fourniture de biens publics et sont caractérisés par moins de liberté politique. Au-delà de la fragmentation ethnolinguistique, les résultats montrent l'importance du système légal des pays. Nous constatons une certaine similarité entre les systèmes légaux britanniques et allemands. A l'exception du système scandinave, le système britannique est associé à plus d'efficacité et plus de liberté politique comparé aux autres systèmes.

Nous complétons l'analyse de La Porta et al. (1999) en considérant la nationalité de la puissance coloniale, une dimension proposée par les auteurs mais non utilisée faute de données disponibles. Nous concluons que les pays colonisés par la Belgique, la Chine et la France présentent une moindre qualité de leurs dépenses publiques par rapport aux pays colonisés par la Grande-Bretagne, alors que ceux colonisés par le Danemark et les Pays Bas affichent une meilleure qualité. Cette dimension rend le système légal non significatif modifiant à la marge les conclusions de La Porta et al. (1999).

Utilisant la mesure de la qualité de la dépense publique proposée par Caldeira et al. (2021), nous analysons les déterminants de cette mesure. La fragmentation ethnique et les conflits réduisent la qualité des dépenses publiques. La nationalité de la puissance coloniale et le niveau de revenu expliquent également cette qualité.

Enfin, nous apprécions l'effet de la qualité de la dépense publique sur la croissance et les inégalités. Nous appliquons la méthode de projection locale proposée par Jordà (2005), qui permet d'apprécier les conséquences d'un choc de qualité de la dépense publique sur la croissance et les inégalités. Nous concluons qu'une meilleure qualité de la dépense publique favorise la croissance économique les deux premières années après le choc et contribuent également à réduire les inégalités les trois premières années, ces effets s'estompant par la suite.

Comme le souligne La Porta et al. (2008) dans leur synthèse, la distinction entre les deux principaux systèmes légaux peut évoluer, voire converger sous la pression de la mondialisation. Notre analyse est loin d'être définitive. L'application R-Shiny développée pour la construction de l'indicateur d'efficacité des dépenses publiques (voir Caldeira et al., 2021) permet non seulement de répliquer sa construction, mais également de la modifier en pondérant différemment les secteurs (éducation, santé, infrastructure) ou en intégrant des données politiques. Un développement intéressant sera d'apprécier l'efficacité relative des pays dans leur gestion de la crise de la COVID 19 et si une différence selon le système juridique émerge.

6.5. Références

- Acemoglu, D., & Robinson, J. (2008). *The role of institutions in growth and development* (Vol. 10). Washington DC: World Bank.
- Acemoglu, D., Johnson, S., & Robinson, J. A. (2001). The colonial origins of comparative development: An empirical investigation. *American Economic Review*, 91(5), 1369-1401.
- Acemoglu, D., Johnson, S., & Robinson, J. A. (2002). Reversal of fortune: Geography and institutions in the making of the modern world income distribution. *The Quarterly Journal of Economics*, 117(4), 1231-1294.
- Alam, M. R., Kiterage, E., & Bizuayehu, B. (2017). Government effectiveness and economic growth. *Economic Bulletin*, 37(1), 222-227.
- Alesina, A., & Ferrara, E. L. (2005). Ethnic diversity and economic performance. *Journal of economic literature*, 43(3), 762-800.
- Alesina, A., & Zhuravskaya, E. (2011). Segregation and the Quality of Government in a Cross Section of Countries. *American Economic Review*, 101(5), 1872-1911.
- Alesina, A., Baqir, R., & Easterly, W. (1999). Public goods and ethnic divisions. *The Quarterly journal of economics*, 114(4), 1243-1284.
- Alesina, A., Devleeschauwer, A., Easterly, W., Kurlat, S., & Wacziarg, R. (2003). Fractionalization. *Journal of Economic growth*, 8(2), 155-194.
- Anderson, R. G., & Kichkha, A. (2017). Replication, meta-analysis, and research synthesis in economics. *American Economic Review*, 107(5), 56-59.
- Auerbach, A. J., & Gorodnichenko, Y. (2012). Measuring the output responses to fiscal policy. *American Economic Journal: Economic Policy*, 4(2), 1-27.
- Banerjee, R., & Zampolli, F. (2019). What drives the short-run costs of fiscal consolidation? Evidence from OECD countries. *Economic Modelling*, 82, 420-436.
- Beck, T., & Laeven, L. (2006). Institution building and growth in transition economies. *Journal of Economic Growth*, 11(2), 157-186.
- Bellamy, A. J., & Williams, P. D. (2011). The new politics of protection? Côte d'Ivoire, Libya and the responsibility to protect. *International Affairs*, 87(4), 825-850.

- Box, G. E. P., & Cox, D. R. (1964). An analysis of transformations. *Journal of the Royal Statistical Society: Series B (Methodological)*, 26(2), 211-243.
- Caldeira, E., Dama, A., Djoufelkit, H., Ehrhart, H., & Rota-Graziosi, G. (2021). Qualité de la dépense publique dans le monde: mesure et déterminants. Etudes et Documents du CERDI, <https://hal.uca.fr/hal-03129897>
- Churchill, S. A., & Smyth, R. (2017). Ethnic diversity and poverty. *World Development*, 95, 285-302.
- Clemens, M. A. (2017). The meaning of failed replications: A review and proposal. *Journal of Economic Surveys*, 31(1), 326-342.
- Desmet, K., Gomes, J. F., & Ortuño-Ortín, I. (2020). The geography of linguistic diversity and the provision of public goods. *Journal of Development Economics*, 143, 102384.
- Dupraz, Y. (2013). Using weights in Stata. *Paris School of Economics*, 1-6.
- Easterly, W. (2001). *The elusive quest for growth: economists' adventures and misadventures in the tropics*. MIT press.
- Easterly, W., & Levine, R. (1997). Africa's growth tragedy: policies and ethnic divisions. *The Quarterly Journal of Economics*, 112(4), 1203-1250.
- Easterly, W., & Levine, R. (2003). Tropics, germs, and crops: how endowments influence economic development. *Journal of Monetary Economics*, 50(1), 3-39.
- Esteban, J., Mayoral, L., & Ray, D. (2012). Ethnicity and conflict: An empirical study. *American Economic Review*, 102(4), 1310-42.
- Esteban, J., & Ray, D. (2011). Linking conflict to inequality and polarization. *American Economic Review*, 101(4), 1345-74.
- Fearon, J. D. (2003). Ethnic and cultural diversity by country. *Journal of Economic Growth*, 8(2), 195-222.
- Fournier, J. M., & Johansson, Å. (2016). The effect of the size and the mix of public spending on growth and inequality, Document de travail OCDE, <https://doi.org/10.1787/f99f6b36-en>
- Francois, P., Rainer, I., & Trebbi, F. (2015). How is power shared in Africa?. *Econometrica*, 83(2), 465-503.

- Gemmell, N., Kneller, R., & Sanz, I. (2016). Does the composition of government expenditure matter for long-run GDP levels?. *Oxford Bulletin of Economics and Statistics*, 78(4), 522-547.
- Getachew, Y. Y., & Turnovsky, S. J. (2015). Productive government spending and its consequences for the growth-inequality tradeoff. *Research in Economics*, 69(4), 621-640.
- Gleditsch, N. P., Wallensteen, P., Eriksson, M., Sollenberg, M., & Strand, H. (2002). Armed conflict 1946-2001: A new dataset. *Journal of Peace Research*, 39(5), 615-637.
- Gnangoin, Y. T. B., Du, L., Assamoi, G., Edjokou, A. J., & Kassi, D. F. (2019). Public spending, income inequality and economic growth in Asian countries: A panel GMM approach. *Economies*, 7(4), 115.
- Hall, R. E., & Jones, C. I. (1999). Why do some countries produce so much more output per worker than others?. *The Quarterly Journal of Economics*, 114(1), 83-116.
- Hamermesh, D. S. (2007). Replication in economics. *Canadian Journal of Economics/Revue canadienne d'économique*, 40(3), 715-733.
- Holzner, M. (2010). *Inequality, growth and public spending in Central, East and Southeast Europe* (No. 71). WIIW Working Paper.
- Hyndman, R. J., & Grunwald, G. K. (2000). Applications: Generalized Additive Modelling of Mixed Distribution Markov Models with Application to Melbourne's Rainfall. *Australian & New Zealand Journal of Statistics*, 42(2), 145-158.
- Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American Economic Review*, 95(1), 161-182.
- Jordà, Ò., & Taylor, A. M. (2016). The time for austerity: estimating the average treatment effect of fiscal policy. *The Economic Journal*, 126(590), 219-255.
- Kneller, R., Bleaney, M. F., & Gemmell, N. (1999). Fiscal policy and growth: evidence from OECD countries. *Journal of Public Economics*, 74(2), 171-190.
- La Ferrara, E., & Mele, A. (2006). Racial segregation and public school expenditure. *Center for Economic and Policy Research Discussion Paper* 5750.
- International Monetary Fund (2015). Making public investment more efficient. *Washington, DC: International Monetary Fund*.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. (1999). The quality of government. *The Journal of Law, Economics, and Organization*, 15(1), 222-279.

La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (2008). The economic consequences of legal origins. *Journal of economic literature*, 46(2), 285-332.

Mitts, J. (2019). I Promise to Pay. *The Journal of Law and Economics*, 62(1), 117-149.

North, D. C. (1989). Institutions and economic growth: An historical introduction. *World Development*, 17(9), 1319-1332.

North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge university press.

Nunn, N. (2007). Historical legacies: A model linking Africa's past to its current underdevelopment. *Journal of Development Economics*, 83(1), 157-175.

Pettersson, T., & Öberg, M. (2020). Organized violence, 1989–2019. *Journal of Peace Research*, 57(4), 597-613.

Rothstein, B. O., & Teorell, J. A. (2008). What is quality of government? A theory of impartial government institutions. *Governance*, 21(2), 165-190.

Sokoloff, K. L., & Engerman, S. L. (2000). Institutions, factor endowments, and paths of development in the new world. *Journal of Economic Perspectives*, 14(3), 217-232.

Teles, V. K., & Mussolini, C. C. (2014). Public debt and the limits of fiscal policy to increase economic growth. *European Economic Review*, 66, 1-15.

Wang, E. C., & Alvi, E. (2011). Relative efficiency of government spending and its determinants: Evidence from East Asian countries. *Eurasian Economic Review*, 1(1), 3-28.

F. Appendix to chapter VI

F.1. Annexe : Modifications apportées à la base d'origine

Tableau F.1.1: Listes des noms de pays supprimés des données originales de La Porta et al. (1999)

"Soviet union", "Germany, west", "Dahomey", "Rhodesia", "Abyssinia", "Congo", "Khmer rep", "Korea (before Spli", "Persia", "Zaire", "Gran Colombia", "Malagasy r", "Russia (before uss", "Siam", "North Vietnam (up", "South vietnam (up", "Serbia (before yu"

F.2. Annexe : Relations entre les variables

Figure F.2.1 : Relation entre le PIB par tête et l'indice d'efficacité des dépenses publiques

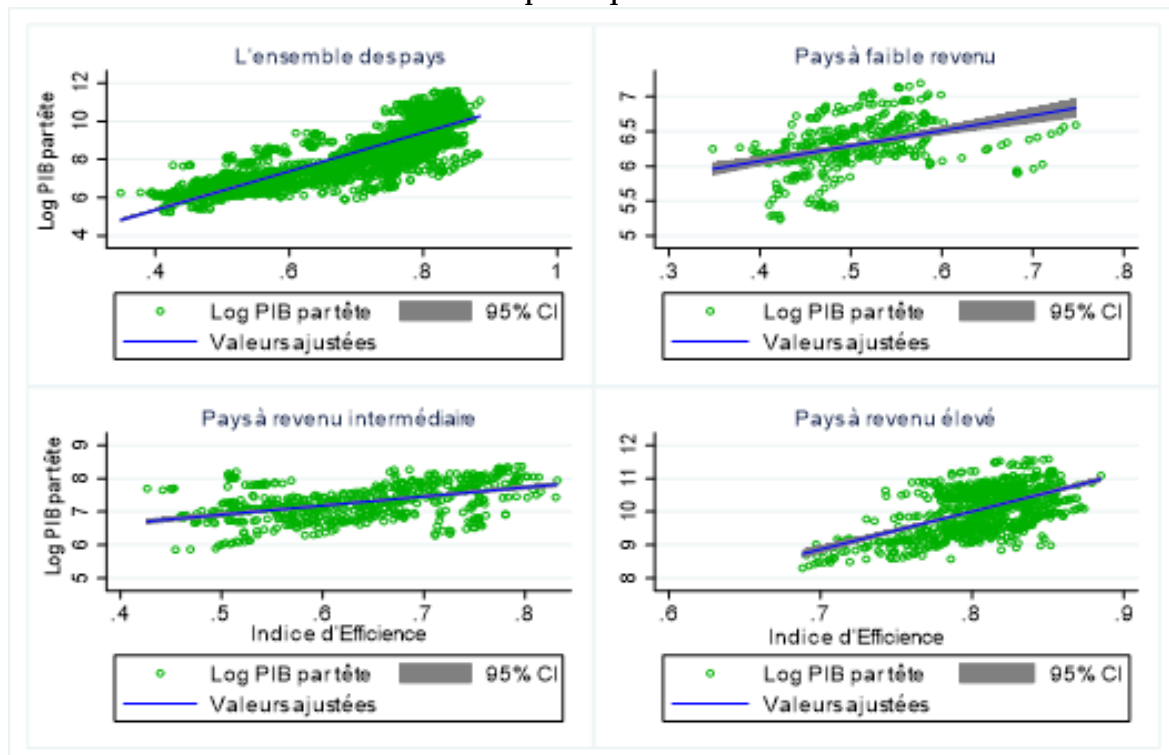
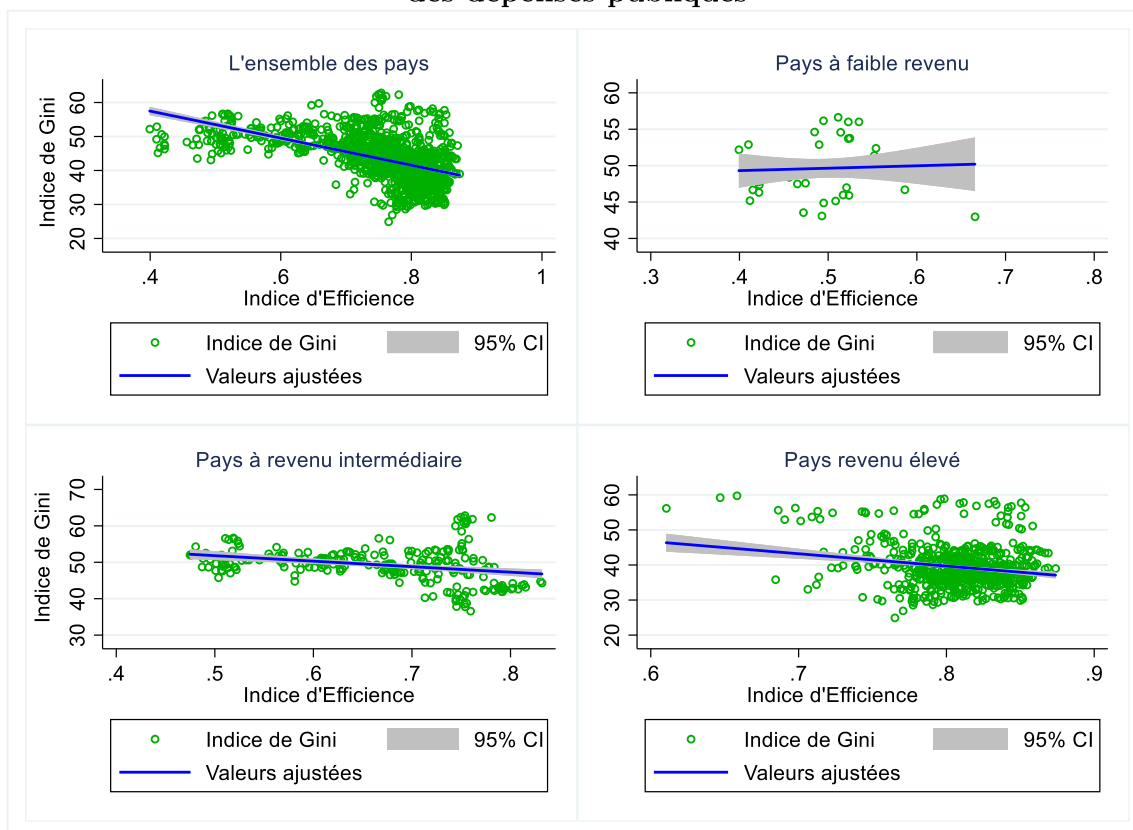


Figure F.2.2 : Relation entre l'indice d'inégalité de Gini et l'indice d'efficacité des dépenses publiques



F.3. Annexe : Résultats de réplication et d'extension de La Porta et al. (1999)

Tableau F.3.1 : réplication de La Porta et al. (1999) – Performance du gouvernement et système judiciaire sans variables de contrôle

Variables	Max. Taux d'imposition			Retards			Salaires pub.			Dépenses de			Emploi				
	Ind. Droits de Propriété	Ind. Réglementation des affaires	Ind. d'imposition marginal en 1994	Ind. Corruption	Ind. bureau cratiques	Ind. Conformité fiscale	Moy. / PIB par tête	Log. Mortalité infantile	Log. Résultats Scolaires	Taux d'alpha	Ind. Qualité infrastructures	Transferts et sub. % du PIB	Ind. Part Conso. % pub dans l'Eco.	Ind. Secteur pub. / Pop. Totale	Ind. Droits Politiques		
Frag. Ethnoling	-0.761** (0.301)	-1.125*** (0.280)	2.219 (5.715)	-1.945** (0.754)	-1.806** (0.685)	-1.471** (0.591)	0.496 (0.920)	1.465*** (0.184)	-0.996*** (0.168)	33.118*** (6.098)	-2.672*** (0.771)	-11.059*** (2.003)	-2.252 (1.516)	-1.433** (0.693)	-3.585*** (0.644)	-4.096*** (1.097)	-2.163*** (0.563)
S.J. Socialiste	-1.393*** (0.353)	-1.140*** (0.292)	12.078** (5.220)	0.010 (0.673)	-2.068*** (0.606)	-2.090*** (0.294)	-0.550* (0.284)	0.506** (0.235)	0.034 (0.322)	6.445 (7.737)	-3.622*** (0.949)	9.597*** (2.827)	-5.816*** (1.359)	-4.840*** (0.473)	-0.927 (0.805)	-5.432*** (0.780)	-1.651** (0.768)
S.J. Français	-0.671*** (0.202)	-0.469** (0.188)	0.910 (3.184)	-0.667 (0.514)	-1.402*** (0.401)	-1.560*** (0.255)	1.094*** (0.288)	0.389*** (0.132)	-0.288*** (0.109)	8.795** (4.198)	-1.702*** (0.473)	-1.737 (1.439)	-1.805 (1.135)	0.041 (0.469)	-1.136** (0.488)	-2.451*** (0.754)	-0.524 (0.364)
S.J. Allemand	1.107*** (0.221)	-0.100 (0.270)	9.838* (5.630)	1.732* (0.889)	0.563 (0.587)	-0.578* (0.338)	-0.359 (0.227)	-0.845*** (0.270)	0.182 (0.149)	-11.090** (4.318)	0.822 (0.739)	0.798 (3.355)	-1.626 (1.903)	0.659 (1.022)	-0.626 (1.004)	0.909 (1.767)	1.290*** (0.405)
S.J. Scandinave	0.903*** (0.286)	-0.106 (0.269)	18.555*** (5.306)	3.637*** (0.587)	0.429 (0.410)	-0.930*** (0.298)	-0.471* (0.255)	-1.240*** (0.141)	0.381*** (0.116)		0.526 (0.462)	8.442*** (3.076)	5.834*** (1.995)	-1.057 (0.758)	8.831*** (1.176)	3.433*** (0.807)	1.479*** (0.324)
Constant	3.953*** (0.236)	3.388*** (0.224)	37.421*** (3.219)	6.505*** (0.629)	6.025*** (0.397)	4.479*** (0.234)	1.563*** (0.270)	3.200*** (0.140)	1.850*** (0.116)	13.940*** (4.318)	7.343*** (0.481)	12.365*** (1.614)	16.439*** (1.248)	5.163*** (0.499)	5.273*** (0.553)	6.868*** (0.858)	5.680*** (0.346)
Observations	124	124	77	112	52	47	47	151	101	116	52	87	98	98	100	124	152
R carré	0.314	0.209	0.150	0.287	0.473	0.506	0.427	0.430	0.378	0.225	0.528	0.406	0.187	0.221	0.584	0.319	0.172
R carré ajusté	0.285	0.175	0.0906	0.253	0.416	0.446	0.357	0.411	0.345	0.197	0.477	0.370	0.143	0.179	0.562	0.290	0.143

Tableau F.3.2 : réplification de La Porta et al. (1999) – Performance du gouvernement et système judiciaire avec variables de contrôle

Variables	Ind. Droits de Propriété		Max. Taux d'imposition	Retards bureaucratiques			Salaires pub.		Log. Scolaires		Ind. Qualité d'infrastructures		Dépenses de Conso. PIB		Emploi pub. / Pop.		Ind. Droits Politiques
	Ind. Réglemen	Ind. Réglemen	marginal	Ind. Corruption	bureaucr	Conformité	Moy. / PIB par tête	Log. Mortalité infantile	Log. Résultats Scolaires	Taux d'alpha	Ind. Qualité d'infrastructures	Transferts et sub. % du PIB	Conso. PIB	Ind. Part Sociétés pub dans l'Eco.	Totale	Ind. Démocratie	Droits Politiques
Frag. Ethnoling	0.370 (0.268)	-0.242 (0.254)	14.351** (6.963)	0.801 (0.803)	0.860 (0.524)	-0.964 (0.731)	0.165 (0.690)	0.450*** (0.128)	-0.241* (0.124)	17.001*** (5.137)	1.056* (0.525)	-1.259 (1.789)	0.424 (1.631)	-1.185 (0.732)	-0.967* (0.572)	-0.416 (0.952)	-0.522 (0.590)
S.J. Socialiste	-1.082*** (0.265)	-0.604** (0.239)	9.818 (6.490)	0.320 (0.608)	-0.143 (0.547)	-1.451** (0.542)	-1.691*** (0.475)	-0.099 (0.165)	0.546*** (0.088)	-12.671 (8.775)	-1.349* (0.802)	6.690** (2.802)	-7.036*** (1.405)	-4.182*** (0.491)	0.604 (0.759)	-3.838*** (0.803)	-0.991 (0.678)
S.J. Français	-0.537*** (0.147)	-0.342** (0.137)	3.154 (3.041)	-0.342 (0.387)	-0.718*** (0.251)	-1.342*** (0.281)	0.517 (0.313)	0.211*** (0.074)	-0.190*** (0.070)	5.482* (3.044)	-0.766*** (0.273)	0.449 (1.057)	-1.360 (1.051)	0.099 (0.454)	-0.687** (0.336)	-2.011*** (0.555)	-0.306 (0.329)
S.J. Allemand	0.089 (0.250)	-0.878*** (0.265)	5.474 (6.003)	0.087 (0.533)	0.249 (0.286)	-0.616** (0.282)	0.094 (0.364)	0.053 (0.134)	-0.233*** (0.085)	-6.454* (3.274)	0.406 (0.370)	-3.802 (2.323)	-3.404* (1.938)	0.252 (1.027)	-2.606*** (0.923)	-2.479* (1.266)	-0.256 (0.335)
S.J. Scandinave	-0.492* (0.263)	-0.985*** (0.249)	8.654 (5.959)	0.898* (0.485)	-0.010 (0.254)	-0.844** (0.338)	-0.453 (0.371)	-0.230* (0.117)	-0.091 (0.100)		-0.387 (0.297)	-1.739 (3.340)	2.377 (2.222)	-0.924 (0.856)	6.643*** (1.220)	-0.722 (0.619)	-0.585 (0.410)
Latitude	1.543*** (0.499)	0.152 (0.545)	23.301** (9.686)	3.968*** (1.368)	-0.112 (0.932)	-0.828 (0.927)	1.925** (0.849)	-0.147 (0.304)	-0.296 (0.261)	26.771** (11.684)	1.495 (0.894)	22.376*** (3.967)	6.655** (3.243)	-2.851* (1.635)	0.184 (1.901)	1.442 (2.734)	2.056 (1.416)
Log PNB/tête	0.425*** (0.072)	0.441*** (0.077)	2.236 (1.782)	0.798*** (0.192)	0.874*** (0.153)	0.301 (0.183)	-0.642*** (0.150)	-0.524*** (0.041)	0.347*** (0.036)	-14.287*** (1.770)	1.031*** (0.167)	1.869*** (0.552)	0.591 (0.523)	0.502** (0.206)	1.236*** (0.247)	1.827*** (0.310)	0.656*** (0.198)
Constant	0.143 (0.505)	-0.118 (0.505)	9.335 (14.140)	-1.313 (1.457)	-1.997* (1.070)	2.048 (1.554)	6.406*** (1.145)	7.374*** (0.280)	-0.855*** (0.256)	113.080*** (12.914)	-2.869** (1.211)	-11.416*** (4.281)	9.471*** (3.459)	2.165* (1.299)	-4.656*** (1.519)	-7.713*** (1.763)	-0.069 (1.305)
Observations	122	122	77	112	52	47	47	149	100	114	52	87	98	98	99	123	150
R carré	0.626	0.518	0.296	0.575	0.761	0.554	0.604	0.837	0.752	0.599	0.831	0.719	0.269	0.270	0.762	0.620	0.333
R carré ajusté	0.603	0.488	0.225	0.546	0.723	0.474	0.533	0.829	0.733	0.577	0.804	0.694	0.212	0.213	0.744	0.597	0.300

Tableau F.3.3 : réplification de La Porta et al. (1999) – Performance du gouvernement et religion sans variables de contrôle

Variables	Ind. Droits de Propriété	Ind. Réglemen- tion des affaires	Max. Taux d'imposi- tion marginal en 1994	Ind. Corruption	Retards bureaucratiques	Conformité fiscale	Salaires pub.			Ind. Qualité d'infrastruc- tures	Ind. Transferts et sub. % du PIB	Dépenses de		Ind. Part Sociétés pub dans l'Eco.	Emploi secteur pub. / Pop. Totale	Ind. Démocratie	Ind. Droits Politiques
							Moy. / PIB par tête	Log. Mortalité infantile	Log. Résultats Scolaires			Taux d'alpha bétisme	Conso. % PIB				
Frag. Ethnoling	-0.543* (0.283)	-0.810*** (0.249)	-7.022 (5.340)	-2.460*** (0.594)	-0.979* (0.553)	-0.739 (0.606)	0.645 (0.985)	1.369*** (0.168)	-0.828*** (0.149)	27.717*** (5.465)	-1.479* (0.762)	-12.437*** (1.963)	-2.296 (1.436)	-0.536 (0.755)	-3.925*** (0.645)	-2.664*** (0.968)	-1.316** (0.511)
Cathol. (% Pop)	-0.014*** (0.003)	-0.005* (0.003)	-0.166*** (0.062)	-0.038*** (0.009)	-0.028*** (0.006)	-0.011*** (0.004)	0.012*** (0.004)	0.008*** (0.003)	-0.004*** (0.002)	0.086 (0.098)	-0.037*** (0.008)	-0.087** (0.033)	-0.096*** (0.018)	0.003 (0.009)	-0.077*** (0.016)	-0.056*** (0.011)	-0.013*** (0.005)
Musul. (% Pop)	-0.020*** (0.004)	-0.008*** (0.003)	-0.049 (0.060)	-0.045*** (0.008)	-0.039*** (0.007)	-0.008 (0.005)	0.022*** (0.004)	0.017*** (0.002)	-0.012*** (0.002)	0.382*** (0.096)	-0.048*** (0.009)	-0.111*** (0.028)	-0.063*** (0.020)	-0.009 (0.009)	-0.075*** (0.014)	-0.089*** (0.011)	-0.045*** (0.005)
Autres (% Pop)	-0.016*** (0.004)	-0.004 (0.004)	-0.104 (0.074)	-0.030*** (0.008)	-0.021** (0.008)	-0.000 (0.005)	0.008 (0.008)	0.009*** (0.003)	-0.004* (0.002)	0.149 (0.124)	-0.031** (0.012)	-0.074** (0.035)	-0.085*** (0.027)	-0.004 (0.012)	-0.078*** (0.015)	-0.073*** (0.013)	-0.028*** (0.007)
Constant	4.893*** (0.265)	3.430*** (0.228)	53.996*** (5.396)	9.778*** (0.763)	7.456*** (0.555)	3.897*** (0.324)	0.936*** (0.262)	2.495*** (0.223)	2.165*** (0.147)	4.138 (9.086)	9.207*** (0.715)	20.210*** (2.803)	22.827*** (1.555)	4.855*** (0.753)	11.701*** (1.407)	10.993*** (0.882)	7.325*** (0.414)
Observations	124	124	77	112	52	47	47	151	101	116	52	87	98	98	100	124	152
R carré	0.180	0.123	0.128	0.287	0.440	0.201	0.304	0.429	0.472	0.400	0.391	0.335	0.196	0.039	0.469	0.311	0.360
R carré ajusté	0.153	0.0933	0.0791	0.260	0.392	0.125	0.238	0.414	0.450	0.378	0.339	0.302	0.161	-0.00258	0.447	0.288	0.343

Tableau F.3.4 : Réplication de La Porta et al. (1999) – Performance du gouvernement et religion avec variables de contrôle

Variables	Ind. Droits de Propriété	Ind. Réglementation des affaires	Max. Taux d'imposition marginal en 1994	Ind. Corruption	Retards bureaucratiques	Conformité fiscale	Salaires pub.		Log. Résultats Scolaires	Log. Mortalité infantile	Taux d'alphabétisme	Ind. Qualité des infrastructures	Dépenses de l'Etat		Emploi secteur public		Ind. Droits Politiques
			Ind. Réglemen tion				Moy. / PIB par tête	Ind. Transferts et sub. % du PIB					Ind. Part Sociétés pub dans l'Eco.	Ind. Démocratie			
Frag. Ethnoling	0.649** (0.277)	-0.085 (0.254)	8.311 (6.555)	0.659 (0.806)	1.000** (0.472)	0.013 (0.587)	0.569 (0.871)	0.400*** (0.131)	-0.163 (0.128)	15.251*** (5.204)	1.700*** (0.567)	-0.707 (2.096)	0.062 (1.573)	-1.002 (0.822)	-1.369* (0.703)	0.676 (0.998)	0.043 (0.553)
Cathol. (% Pop)	-0.002 (0.002)	0.002 (0.003)	-0.028 (0.062)	-0.010 (0.008)	-0.012** (0.004)	-0.006 (0.005)	0.004 (0.004)	0.000 (0.001)	-0.001 (0.002)	0.029 (0.067)	-0.009 (0.005)	0.041 (0.029)	-0.074*** (0.019)	-0.006 (0.011)	-0.050*** (0.013)	-0.022* (0.012)	-0.001 (0.005)
Musul. (% Pop)	-0.004 (0.004)	0.004 (0.004)	0.083 (0.061)	-0.011 (0.008)	-0.015** (0.007)	0.006 (0.007)	0.010* (0.006)	0.005*** (0.002)	-0.006*** (0.002)	0.245*** (0.072)	-0.010 (0.009)	0.002 (0.030)	-0.031 (0.023)	-0.007 (0.010)	-0.043*** (0.012)	-0.038*** (0.013)	-0.031*** (0.007)
Autres (% Pop)	-0.001 (0.003)	0.007** (0.003)	0.004 (0.078)	-0.002 (0.007)	-0.003 (0.005)	0.005 (0.005)	-0.001 (0.010)	-0.002 (0.002)	-0.001 (0.002)	0.034 (0.091)	-0.000 (0.005)	0.035 (0.032)	-0.066** (0.028)	-0.011 (0.013)	-0.046*** (0.014)	-0.028** (0.013)	-0.014** (0.007)
Latitude	0.944 (0.590)	-0.605 (0.546)	24.810** (10.025)	4.428*** (1.364)	-0.057 (0.902)	-1.419* (0.800)	-0.507 (0.924)	-0.481* (0.248)	0.096 (0.275)	8.250 (13.304)	0.792 (1.028)	28.601*** (3.803)	0.364 (3.177)	-5.661*** (1.955)	2.299 (1.766)	0.440 (2.579)	2.543*** (0.946)
Log PNB/tête	0.509*** (0.090)	0.504*** (0.081)	2.493 (1.905)	0.754*** (0.165)	0.861*** (0.153)	0.634*** (0.110)	-0.292 (0.183)	-0.489*** (0.037)	0.275*** (0.039)	-12.114*** (1.228)	1.249*** (0.179)	0.870* (0.497)	1.073** (0.514)	0.678*** (0.248)	0.947*** (0.250)	1.748*** (0.311)	0.413*** (0.155)
Constant	-0.559 (0.646)	-1.076* (0.604)	11.799 (14.859)	-0.551 (1.615)	-1.503 (1.187)	-1.496 (1.224)	4.269*** (1.540)	7.255*** (0.306)	-0.411 (0.318)	97.117*** (10.515)	-4.464*** (1.405)	-8.454* (5.001)	12.111*** (4.532)	2.142 (1.932)	0.852 (2.268)	-6.259*** (2.305)	2.191* (1.294)
Observations	122	122	77	112	52	47	47	149	100	114	52	87	98	98	99	123	150
R carré	0.555	0.480	0.303	0.579	0.772	0.482	0.399	0.850	0.758	0.671	0.814	0.692	0.259	0.149	0.630	0.578	0.479
R carré ajusté	0.531	0.453	0.243	0.554	0.742	0.404	0.309	0.843	0.743	0.652	0.789	0.669	0.211	0.0931	0.606	0.556	0.457

Tableau F.3.5 : Réplication de La Porta et al. (1999) – Performance du gouvernement, système judiciaire et religion sans variables de contrôle

Variables	Max. Taux d'imposition			Retards bureaucratiques			Salaires pub. Moy. / Log.			Ind. Qualité d'infrastructures			Dépenses de Conso. PIB		Emploi secteur pub. / Pop.		Ind. Droits Politiques	
	Ind. Propriété	Ind. Réglement des affaires	Ind. marginal en 1994	Ind. Corruption	Ind. bureaux	Conformité fiscale	PIB par tête	Mortalité infantile	Log. Résultats Scolaires	Taux d'alphabétisme	Ind. Qualité d'infrastructures	Transferts et sub. % du PIB	Conso. PIB	Ind. Part Sociétés pub dans l'Eco.	Emploi secteur pub. / Pop. Totale	Ind. Démocratie	Droits Politiques	
Frag. Ethnoling	-0.609** (0.306)	-1.102*** (0.287)	-1.056 (6.060)	-1.949** (0.805)	-1.704*** (0.553)	-1.542** (0.584)	0.912 (0.860)	1.255*** (0.182)	-0.790*** (0.159)	26.975*** (5.644)	-2.563*** (0.624)	-10.274*** (2.276)	-3.180* (1.620)	-1.404* (0.767)	-3.382*** (0.680)	-3.328*** (1.144)	-1.359** (0.559)	
S.J. Socialiste	-1.363*** (0.374)	-1.314*** (0.341)	13.541*** (4.769)	-0.019 (0.661)	-1.879*** (0.580)	-1.952*** (0.307)	-0.785*** (0.273)	0.602** (0.265)	-0.020 (0.299)	4.101 (9.912)	-3.343*** (0.794)	10.087*** (2.782)	-5.111*** (1.538)	-4.839*** (0.528)	-0.591 (0.914)	-4.854*** (0.877)	-1.198 (0.773)	
S.J. Français	-0.721** (0.282)	-0.333 (0.240)	4.461 (4.816)	-0.322 (0.544)	-0.761** (0.352)	-1.361*** (0.291)	1.216*** (0.309)	0.417** (0.162)	-0.280** (0.115)	9.109* (5.146)	-0.934** (0.385)	-1.521 (2.283)	-0.842 (1.222)	0.318 (0.531)	-1.131** (0.504)	-2.416*** (0.885)	-0.459 (0.409)	
S.J. Allemand	1.024*** (0.205)	-0.151 (0.239)	9.774* (5.686)	1.494* (0.880)	0.217 (0.449)	-0.575* (0.320)	-0.064 (0.287)	-0.748*** (0.268)	0.157 (0.142)	-13.068** (6.173)	0.404 (0.664)	0.793 (3.110)	-1.718 (1.963)	0.437 (1.024)	-0.703 (0.933)	0.535 (1.509)	1.042*** (0.372)	
S.J. Scandinave	0.882* (0.508)	-0.029 (0.420)	13.182 (9.734)	2.390 (1.666)	-2.734*** (0.725)	-1.608*** (0.519)	-0.376 (0.651)	-1.447*** (0.253)	0.304 (0.252)		-3.556*** (1.078)	5.747 (6.612)	0.430 (3.243)	-2.448* (1.447)	8.026*** (1.918)	1.311 (2.062)	0.531 (0.652)	
Cath. (% Pop)	0.003 (0.007)	0.000 (0.006)	-0.118 (0.129)	-0.016 (0.020)	-0.043*** (0.008)	-0.011 (0.007)	-0.004 (0.007)	-0.005 (0.004)	0.001 (0.003)	-0.054 (0.129)	-0.055*** (0.012)	-0.029 (0.080)	-0.081** (0.034)	-0.017 (0.017)	-0.007 (0.017)	-0.012 (0.027)	-0.003 (0.009)	
Musul. (% Pop)	-0.005 (0.007)	-0.004 (0.006)	-0.003 (0.120)	-0.025 (0.019)	-0.053*** (0.008)	-0.006 (0.008)	0.004 (0.008)	0.005 (0.004)	-0.007** (0.003)	0.265** (0.129)	-0.066*** (0.012)	-0.055 (0.073)	-0.052* (0.031)	-0.027* (0.015)	-0.015 (0.015)	-0.051** (0.025)	-0.035*** (0.009)	
Autres (% Pop)	-0.001 (0.006)	0.004 (0.006)	-0.041 (0.119)	-0.013 (0.018)	-0.039*** (0.009)	-0.008 (0.007)	0.006 (0.009)	-0.003 (0.004)	-0.002 (0.004)	0.086 (0.157)	-0.051*** (0.012)	-0.045 (0.070)	-0.069* (0.039)	-0.016 (0.017)	-0.015 (0.016)	-0.034 (0.025)	-0.018* (0.009)	
Constant	3.971*** (0.519)	3.277*** (0.436)	43.524*** (10.346)	7.881*** (1.866)	9.624*** (0.652)	5.244*** (0.560)	1.380* (0.717)	3.456*** (0.285)	1.926*** (0.284)	8.942 (9.852)	12.000*** (1.047)	15.429** (6.515)	22.590*** (2.625)	6.707*** (1.513)	6.231*** (1.473)	9.253*** (2.312)	6.738*** (0.735)	
Observations	124	124	77	112	52	47	47	151	101	116	52	87	98	98	100	124	152	
R carré	0.355	0.240	0.204	0.321	0.665	0.533	0.501	0.526	0.512	0.425	0.691	0.420	0.235	0.260	0.594	0.429	0.389	
R carré ajusté	0.310	0.187	0.111	0.268	0.603	0.434	0.396	0.499	0.470	0.388	0.634	0.361	0.166	0.194	0.558	0.390	0.355	

Tableau F.3.6 : réplification de La Porta et al. (1999) – Performance du gouvernement, système judiciaire et religion avec variables de contrôle

Variables	Ind. Réglementation des affaires		Max. Taux d'imposition marginal en 1994	Retards bureaucratiques			Salaires pub. Moy. / Log.			Ind. Qualité d'infrastructures			Dépenses de Conso. PIB		Emploi secteur pub. / Ind. Droits		
	Droits de Propriété	Ind. Réglementation des affaires	Ind. Corruption	Ind. Corruption	Conformité fiscale	PIB par tête	Mortalité infantile	Résultats Scolaires	Taux d'alphabétisme	Transferts et sub. % du PIB	Conso. PIB	Ind. Part Sociétés pub dans l'Eco.	Totale	Ind. Démocratie	Droits Politiques		
Frag. Ethnoling	0.416 (0.272)	-0.271 (0.254)	11.827* (6.837)	0.713 (0.877)	0.388 (0.517)	-0.844 (0.703)	0.515 (0.720)	0.406*** (0.133)	-0.175 (0.125)	12.946** (5.147)	0.560 (0.562)	-0.477 (2.079)	-0.570 (1.624)	-1.336 (0.834)	-0.949 (0.584)	-0.166 (1.015)	-0.152 (0.575)
S.J. Socialiste	-1.218*** (0.308)	-0.837*** (0.283)	11.915* (6.400)	0.028 (0.587)	-0.441 (0.605)	-1.052** (0.504)	-1.894*** (0.514)	0.142 (0.175)	0.410*** (0.101)	-10.105 (9.937)	-1.668** (0.808)	6.017* (3.056)	-5.725*** (1.456)	-4.194*** (0.588)	0.637 (0.862)	-4.105*** (0.976)	-1.255* (0.686)
S.J. Français	-0.619*** (0.191)	-0.250 (0.168)	5.065 (4.264)	-0.127 (0.434)	-0.358 (0.292)	-1.090*** (0.263)	1.169*** (0.338)	0.263*** (0.082)	-0.186*** (0.069)	7.203* (3.663)	-0.327 (0.297)	0.224 (1.303)	-0.596 (1.112)	0.314 (0.539)	-0.776* (0.411)	-2.075*** (0.653)	-0.366 (0.375)
S.J. Allemand	0.071 (0.241)	-0.905*** (0.182)	5.190 (5.737)	-0.015 (0.570)	0.109 (0.297)	-0.590** (0.275)	0.432 (0.305)	0.100 (0.127)	-0.222** (0.093)	-4.563 (4.734)	0.248 (0.456)	-3.702 (2.340)	-3.484* (2.084)	0.212 (1.018)	-2.599*** (0.945)	-2.360** (1.167)	-0.340 (0.460)
S.J. Scandinave	-0.207 (0.420)	-0.635 (0.402)	9.434 (7.563)	0.816 (1.190)	-1.614*** (0.577)	-1.127* (0.581)	-1.357* (0.766)	-0.499** (0.212)	-0.200 (0.195)		-2.107** (0.800)	-0.466 (4.407)	-1.267 (3.067)	-2.252 (1.391)	7.006*** (1.600)	-1.314 (1.664)	-1.555** (0.648)
Cath. (% Pop)	0.005 (0.004)	0.003 (0.004)	-0.030 (0.093)	-0.003 (0.015)	-0.024*** (0.008)	-0.007 (0.008)	-0.020** (0.009)	-0.005** (0.003)	-0.000 (0.003)	-0.060 (0.090)	-0.027** (0.010)	0.025 (0.043)	-0.065** (0.031)	-0.018 (0.018)	0.005 (0.013)	0.001 (0.022)	-0.002 (0.008)
Musul. (% Pop)	0.002 (0.005)	0.004 (0.005)	0.091 (0.090)	-0.005 (0.014)	-0.028*** (0.010)	0.003 (0.010)	-0.020* (0.010)	-0.000 (0.002)	-0.005* (0.002)	0.176** (0.089)	-0.031** (0.013)	-0.005 (0.041)	-0.028 (0.032)	-0.022 (0.016)	0.008 (0.012)	-0.023 (0.021)	-0.033*** (0.009)
Autres (% Pop)	0.004 (0.004)	0.008* (0.004)	0.032 (0.100)	0.004 (0.013)	-0.018** (0.008)	-0.003 (0.008)	-0.009 (0.010)	-0.005** (0.003)	-0.001 (0.003)	0.044 (0.109)	-0.019* (0.010)	0.018 (0.041)	-0.052 (0.038)	-0.017 (0.018)	0.005 (0.014)	-0.011 (0.022)	-0.015* (0.009)
Latitude	1.724*** (0.581)	0.173 (0.593)	18.990 (11.556)	4.203*** (1.431)	0.055 (1.159)	-1.056 (0.791)	2.447** (0.925)	-0.424 (0.288)	0.020 (0.267)	4.920 (13.142)	1.718 (1.060)	24.264*** (3.954)	3.748 (3.372)	-2.546 (1.862)	-0.014 (2.090)	2.993 (2.682)	3.839*** (1.089)
Log PNB/tête	0.393*** (0.093)	0.459*** (0.092)	3.052 (1.996)	0.764*** (0.200)	0.704*** (0.231)	0.428** (0.175)	-0.803*** (0.187)	-0.476*** (0.042)	0.294*** (0.039)	-12.279*** (1.356)	0.854*** (0.237)	1.593*** (0.531)	0.940 (0.572)	0.405* (0.239)	1.284*** (0.286)	1.507*** (0.335)	0.314* (0.163)
Constant	-0.009 (0.718)	-0.732 (0.681)	3.500 (15.243)	-1.093 (2.126)	1.357 (2.021)	1.294 (2.028)	8.580*** (1.853)	7.433*** (0.369)	-0.456 (0.337)	100.603*** (10.948)	0.649 (2.224)	-11.588** (5.357)	12.366** (5.380)	4.393* (2.292)	-5.407** (2.341)	-5.043* (2.947)	3.070** (1.413)
Observations	122	122	77	112	52	47	47	149	100	114	52	87	98	98	99	123	150
R carré	0.636	0.545	0.349	0.581	0.808	0.607	0.667	0.863	0.795	0.691	0.863	0.727	0.314	0.287	0.764	0.649	0.502
R carré ajusté	0.603	0.503	0.251	0.539	0.761	0.498	0.575	0.853	0.772	0.664	0.830	0.691	0.235	0.204	0.737	0.618	0.466

Tableau F.3.7 : Extension de La Porta et al. (1999) – Performance du gouvernement et colonisateur sans variables de contrôle

Variables	Ind. Droits de Propriété	Ind. Réglementation des affaires	Max. Taux d'imposition	Ind. Corruption	Retards bureaucratiques	Conformité fiscale	Salaires pub.	Log. Mortalité infantile	Log. Résultats Scolaires	Taux d'alphabétisme	Ind. Qualité des infrastructures	Transferts et sub. % du PIB	Dépenses de	Ind. Part Sociétés pub dans l'Eco.	Emploi secteur pub. / Pop. Totale	Ind. Démocratie	Ind. Droits Politiques
			Ind. marginal en 1994				Moy. / PIB par tête						Conso. PIB				
Frag. Ethnoling	-0.364 (0.317)	-0.933*** (0.321)	0.026 (6.078)	-1.694** (0.777)	-1.511 (1.111)	-1.624* (0.784)	-0.321 (1.273)	1.225*** (0.195)	-0.708*** (0.183)	27.192*** (6.616)	-1.692 (1.274)	-8.038*** (2.125)	-2.861 (2.023)	-1.728** (0.860)	-3.050*** (0.637)	-1.470 (1.263)	-1.538** (0.637)
Col. Belgique	-2.121*** (0.442)	-1.678*** (0.432)						1.474*** (0.147)	-0.991*** (0.115)	34.222*** (6.768)		-8.725*** (1.592)	-3.884 (2.925)	-0.134 (0.966)	-4.480*** (0.518)	-5.208*** (0.940)	-3.799*** (0.496)
Col. Chine	-0.608*** (0.230)	-0.144 (0.228)		0.580 (0.567)				0.959*** (0.140)								-4.096*** (0.908)	0.757** (0.343)
Col. Allemagne	0.125 (0.387)	-0.307 (0.215)	6.546* (3.322)	1.655*** (0.573)	-2.199*** (0.691)	-2.127*** (0.329)		-0.052 (0.193)	0.386*** (0.132)	14.231*** (4.501)	-4.168*** (0.820)	6.325*** (1.631)	-7.814*** (1.387)	-4.730*** (0.540)	-0.637 (0.506)	0.619 (3.212)	1.370*** (0.434)
Col. Danemark	1.402*** (0.224)	-0.119 (0.222)		3.883*** (0.552)		-1.598*** (0.302)		-1.403*** (0.137)	0.357*** (0.110)			0.374 (1.521)	1.356 (1.299)	-1.025** (0.509)		4.822*** (0.887)	1.797*** (0.335)
Col. Espagne	-0.307 (0.250)	-0.269 (0.247)	-9.106** (3.473)	-1.277** (0.601)	-1.529** (0.582)	-1.533*** (0.431)	0.773* (0.443)	0.314** (0.153)	-0.037 (0.125)	-5.824 (4.824)	-1.897** (0.683)	-4.336*** (1.456)	-4.386*** (1.511)	0.954 (0.660)	-1.659** (0.668)	-0.760 (1.006)	0.023 (0.455)
Col. France	-0.925*** (0.245)	-0.381 (0.244)	11.531* (5.973)	-0.938* (0.507)	-1.447* (0.792)		0.831 (0.584)	0.647*** (0.142)	-0.604*** (0.112)	19.301*** (4.557)	-2.319** (1.087)	-4.227*** (1.291)	-1.181 (1.400)	0.128 (0.557)	-1.348** (0.512)	-3.834*** (0.751)	-1.449*** (0.497)
Col. Japon	1.365*** (0.249)	-0.213 (0.245)	5.543 (4.216)	0.003 (0.925)	0.109 (0.931)	-0.904** (0.334)		-0.109 (0.150)	0.120 (0.112)	-12.919*** (4.501)	-0.345 (1.028)	-6.952*** (2.014)	-3.295 (2.747)	0.022 (0.778)	-2.709*** (0.525)	-3.137*** (1.081)	0.644* (0.369)
Col. Pays-Bas	0.233 (0.555)	-0.031 (0.477)	-3.471* (1.767)	0.136 (1.876)	-1.340** (0.553)	-0.254 (0.505)		-0.514* (0.296)	-0.118 (0.085)	-22.530*** (6.659)	-1.925*** (0.633)	-3.664*** (0.832)	-5.595*** (0.987)	-1.605*** (0.479)	-0.740** (0.355)	0.342 (3.597)	0.334 (1.168)
Col. Portugal	-0.704 (0.433)	-0.999*** (0.335)	-3.455 (3.231)	0.084 (0.708)	-1.483** (0.678)	-2.150*** (0.321)		0.739*** (0.133)	-0.630*** (0.164)	14.211*** (4.798)	-1.557* (0.805)	0.659 (1.601)	-4.651*** (1.362)	-2.302*** (0.531)	-0.967** (0.411)	-3.079*** (1.098)	0.705 (0.666)
Col. Russie	1.403*** (0.223)	-0.115 (0.220)	19.544*** (2.968)	3.891*** (0.549)	0.151 (0.642)	-0.680** (0.300)	-0.854** (0.365)	-1.450*** (0.136)	0.595*** (0.109)		0.943 (0.763)	5.975*** (1.512)	2.890** (1.292)	0.984* (0.507)	7.756*** (0.477)	4.830*** (0.883)	1.805*** (0.334)
Col. Turquie	-0.856 (0.625)	-0.889* (0.483)	1.545 (3.113)	0.206 (0.693)	-1.958* (1.067)	-1.894*** (0.311)	0.100 (0.927)	0.081 (0.390)	0.178 (0.113)	3.023 (11.246)	-1.920 (1.484)	7.908*** (2.200)	-1.393 (2.666)	-4.031*** (0.902)	-0.168 (1.088)	-2.684 (1.789)	-0.485 (1.242)
Constant	3.635*** (0.249)	3.213*** (0.245)	38.453*** (3.537)	6.287*** (0.611)	5.758*** (0.721)	4.381*** (0.348)	2.188*** (0.457)	3.316*** (0.150)	1.722*** (0.123)	15.769*** (4.501)	6.735*** (0.856)	11.089*** (1.703)	17.150*** (1.446)	5.198*** (0.561)	4.921*** (0.525)	5.325*** (0.969)	5.356*** (0.369)
Observations	102	102	59	91	34	29	31	128	83	105	34	68	78	78	80	100	128
R carré	0.301	0.190	0.375	0.247	0.374	0.577	0.164	0.470	0.514	0.422	0.430	0.542	0.179	0.263	0.461	0.309	0.228
R carré ajusté	0.207	0.0803	0.261	0.142	0.140	0.377	-0.00351	0.414	0.438	0.367	0.217	0.452	0.0427	0.140	0.383	0.214	0.148

Tableau F.3.8 : Extension de La Porta et al. (1999) – Performance du gouvernement et colonisateur avec variables de contrôle

Variables	Max. Taux d'imposition			Salaires pub.				Dépenses de				Emploi secteur			Ind. Droits Politiques		
	Ind. Droits de Propriété	Ind. Réglementation des affaires	Ind. marginal en 1994	Retards bureaucratiques	Conformité fiscale	Moy. / PIB par tête	Log. Mortalité infantile	Log. Résultats Scolaires	Taux d'alphabétisme	Ind. Qualité des infrastructures	Transferts et sub. % du PIB	Conso. PIB	Ind. Part Sociétés pub. dans l'Eco.	Emploi pub. / Pop. Totale			
			Corruption											Démocratie			
Frag. Ethnoling	0.534* (0.298)	-0.146 (0.281)	4.657 (8.091)	0.191 (0.883)	0.624 (0.673)	-0.989 (0.711)	-0.365 (0.963)	0.510*** (0.148)	-0.058 (0.148)	17.238** (6.682)	1.402** (0.627)	-2.362 (2.122)	-0.785 (2.335)	-1.137 (0.940)	-1.561*** (0.560)	0.636 (1.122)	-0.385 (0.640)
Col. Belgique	-0.796 (0.484)	-0.497 (0.486)						0.320** (0.149)	-0.194 (0.135)	14.185* (7.907)		-1.053 (1.941)	-0.952 (3.258)	0.936 (1.093)	-2.045*** (0.590)	-1.668* (0.975)	-2.026*** (0.664)
Col. Chine	-0.792*** (0.216)	-0.014 (0.194)		0.417 (0.556)				0.726*** (0.138)								-3.916*** (0.913)	0.393 (0.523)
Col. Allemagne	-0.055 (0.138)	-0.410 (0.352)	4.855 (4.901)	0.785 (0.510)	-1.074*** (0.241)	-1.354*** (0.402)		-0.044 (0.331)	0.594*** (0.118)	9.325** (3.946)	-3.296*** (0.339)	2.404 (1.637)	-8.902*** (1.536)	-4.134*** (0.600)	-0.599 (0.710)	-0.718 (2.901)	1.080*** (0.289)
Col. Danemark	-0.251 (0.275)	-1.413*** (0.230)		1.068 (0.717)		-1.566*** (0.358)		-0.324** (0.136)	-0.298*** (0.097)			-8.050*** (1.954)	-1.767 (2.063)	-1.516* (0.761)		0.328 (0.954)	-0.559 (0.528)
Col. Espagne	-0.151 (0.195)	-0.195 (0.200)	-7.102 (4.424)	-0.829 (0.574)	-0.744* (0.367)	-1.265** (0.443)	0.597 (0.382)	0.198** (0.090)	0.089 (0.095)	-5.324 (3.772)	-0.627 (0.379)	-1.813 (1.236)	-3.691** (1.576)	0.979 (0.698)	-1.479** (0.591)	-0.814 (0.910)	0.215 (0.421)
Col. France	-0.661*** (0.206)	-0.052 (0.186)	12.392** (5.556)	-0.500 (0.511)	-0.054 (0.311)		0.260 (0.614)	0.316*** (0.103)	-0.425*** (0.100)	12.299*** (4.357)	-0.561 (0.408)	-2.927*** (1.038)	-0.663 (1.267)	0.521 (0.529)	-0.878** (0.366)	-2.932*** (0.691)	-1.112** (0.509)
Col. Japon	0.954*** (0.159)	-0.530*** (0.140)	5.315 (4.180)	-0.733 (0.737)	0.183 (0.294)	-0.806*** (0.221)		0.097 (0.084)	-0.092 (0.103)	-6.472* (3.478)	-0.182 (0.346)	-7.586*** (2.097)	-3.870 (2.782)	-0.403 (1.069)	-3.183*** (0.469)	-5.171*** (1.337)	0.016 (0.318)
Col. Pays-Bas	-0.274 (0.220)	-0.605** (0.233)	-1.446 (2.160)	-0.676 (1.028)	-0.408 (0.358)	-0.261 (0.227)		-0.028 (0.100)	0.023 (0.072)	-18.168*** (3.203)	-0.453 (0.326)	-0.776 (0.773)	-4.687*** (0.982)	-1.464*** (0.496)	-0.386 (0.334)	-1.810 (1.508)	-0.290 (0.927)
Col. Portugal	-0.385 (0.462)	-0.693** (0.298)	-0.301 (4.266)	0.741 (0.753)	-0.558 (0.407)	-1.930*** (0.336)		0.264 (0.168)	-0.322** (0.138)	5.663 (4.533)	0.164 (0.403)	5.078*** (1.458)	-3.530** (1.667)	-2.594*** (0.730)	-0.084 (0.356)	-2.043** (0.945)	1.332 (0.819)
Col. Russie	-0.163 (0.269)	-1.321*** (0.224)	14.522*** (4.503)	1.231* (0.698)	-0.645** (0.307)	-0.587 (0.359)	-0.971 (0.593)	-0.452*** (0.135)	-0.006 (0.094)		-0.771* (0.396)	-2.141 (1.905)	-0.083 (1.994)	0.585 (0.740)	5.786*** (0.853)	0.627 (0.947)	-0.434 (0.518)
Col. Turquie	-1.193* (0.686)	-1.095* (0.658)	0.497 (3.144)	-0.207 (0.722)	-2.027* (1.149)	-1.657*** (0.226)	-0.576 (1.383)	0.180 (0.486)	-0.028 (0.061)	16.864 (13.486)	-1.955 (1.483)	5.548*** (1.942)	-2.266 (2.648)	-3.974*** (0.718)	0.042 (1.459)	-3.645** (1.722)	-1.014 (1.328)
Latitude	1.627** (0.688)	0.402 (0.692)	10.407 (11.071)	3.098* (1.646)	-0.510 (1.100)	-1.231 (1.142)	2.392 (1.633)	-0.232 (0.371)	0.182 (0.254)	12.633 (14.090)	1.745 (1.077)	17.952*** (3.733)	4.713 (4.100)	-1.986 (1.995)	-0.552 (2.185)	1.089 (3.260)	2.472 (1.506)
Log PNB/tête	0.418*** (0.085)	0.500*** (0.089)	0.906 (1.683)	0.738*** (0.206)	1.022*** (0.121)	0.444*** (0.122)	-0.567** (0.271)	-0.472*** (0.050)	0.310*** (0.039)	-11.519*** (1.996)	1.190*** (0.154)	0.790 (0.541)	0.619 (0.685)	0.675** (0.259)	1.098*** (0.274)	1.664*** (0.349)	0.546** (0.222)
Constant	0.021 (0.583)	-0.650 (0.591)	27.065* (14.925)	-0.398 (1.601)	-2.924*** (0.862)	0.922 (0.884)	5.944*** (1.926)	6.998*** (0.356)	-0.790** (0.319)	96.671*** (16.808)	-4.306*** (1.123)	-1.585 (4.378)	10.730** (4.896)	0.597 (1.754)	-3.198* (1.681)	-7.118*** (2.017)	0.583 (1.518)
Observations	100	100	59	91	34	29	31	126	82	103	34	68	78	78	79	99	126
R carré	0.583	0.543	0.398	0.458	0.801	0.711	0.339	0.802	0.794	0.632	0.854	0.719	0.219	0.347	0.661	0.543	0.340
R carré ajusté	0.514	0.468	0.257	0.367	0.701	0.523	0.138	0.777	0.755	0.588	0.781	0.651	0.0606	0.214	0.600	0.467	0.257

F.3.9: Efficience des dépenses publiques, système judiciaire, colonisateur et religion – Spécification de La Porta et al. (1999)

Variables	Efficience des dépenses publiques									
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Frag. Ethnoling	-0.255*** (0.035)	-0.117*** (0.028)	-0.225*** (0.032)	-0.101*** (0.025)	-0.196*** (0.037)	-0.114*** (0.028)	-0.206*** (0.039)	-0.098*** (0.026)	-0.179*** (0.046)	-0.086*** (0.030)
S.J. Français	-0.043* (0.022)	-0.022 (0.015)					-0.068** (0.027)	-0.045*** (0.016)	0.007 (0.052)	0.006 (0.035)
S.J. Allemand	0.032 (0.025)	-0.050 (0.032)					0.032 (0.029)	-0.053 (0.034)	0.047 (0.033)	0.040* (0.022)
S.J. Scandinave	0.014 (0.024)	-0.083*** (0.019)					0.128** (0.062)	0.066 (0.044)	0.197** (0.084)	0.097* (0.057)
S.J. Socialiste	-0.062* (0.035)	0.019 (0.029)					-0.075** (0.034)	-0.003 (0.027)	-0.058 (0.059)	0.060 (0.053)
Cath. (% Pop)			0.000 (0.000)	0.001*** (0.000)			0.002** (0.001)	0.002*** (0.000)	0.002** (0.001)	0.002*** (0.001)
Musul. (% Pop)			-0.001** (0.000)	0.001*** (0.000)			0.001 (0.001)	0.002*** (0.000)	0.001 (0.001)	0.002*** (0.001)
Autres (% Pop)			0.000 (0.000)	0.002*** (0.000)			0.001** (0.001)	0.002*** (0.000)	0.002** (0.001)	0.002*** (0.001)
Col. Belgique					-0.270*** (0.032)	-0.134*** (0.031)			-0.302*** (0.052)	-0.120*** (0.040)
Col. Chine					-0.127*** (0.023)	-0.082*** (0.022)			-0.113** (0.051)	-0.162*** (0.047)
Col. Allemagne					-0.009 (0.046)	-0.028 (0.065)			0.035 (0.045)	-0.013 (0.033)
Col. Danemark					0.055** (0.023)	-0.060** (0.027)			0.022*** (0.004)	0.011*** (0.003)
Col. Espagne					-0.009 (0.023)	0.004 (0.016)			-0.063 (0.043)	-0.009 (0.030)
Col. France					-0.105*** (0.027)	-0.051** (0.020)			-0.102* (0.052)	-0.074* (0.038)
Col. Japon					0.066** (0.025)	0.046*** (0.016)				
Col. Pays-Bas					0.091*** (0.019)	0.055 (0.069)			0.062 (0.051)	0.021 (0.077)
Col. Portugal					-0.084** (0.039)	-0.021 (0.028)			-0.131** (0.054)	-0.028 (0.038)
Col. Russie					0.041* (0.023)	-0.065** (0.027)				
Col. Turquie					0.036 (0.031)	0.061* (0.032)			0.039 (0.053)	-0.005 (0.046)
Latitude		-0.045 (0.051)		-0.015 (0.050)		-0.023 (0.060)		-0.053 (0.049)		-0.061 (0.054)
Log PNB/tête		0.068*** (0.008)		0.068*** (0.008)		0.062*** (0.008)		0.072*** (0.008)		0.073*** (0.008)
Constant	0.801*** (0.025)	0.273*** (0.057)	0.778*** (0.031)	0.124* (0.068)	0.776*** (0.025)	0.310*** (0.062)	0.663*** (0.069)	0.059 (0.073)	0.603*** (0.093)	0.051 (0.082)
Observations	120	118	120	118	98	96	120	118	98	96
R carré	0.428	0.748	0.426	0.767	0.565	0.776	0.493	0.791	0.613	0.828
R carré ajusté	0.403	0.732	0.406	0.754	0.504	0.738	0.456	0.771	0.530	0.785

« Le monde est un palabre, une causerie, un dialogue » ~ Proverbe malien.

7. General Conclusion

Les recettes fiscales représentent une réponse crédible au besoin de financement des pays pauvres. L'accroissement de leur niveau associé à une utilisation efficiente des dépenses publiques assurerait aux pays en développement un élargissement leur espace budgétaire. Ce duo *collecte more spend better* incite au civisme fiscal et à la transparence. Il contribue également à améliorer la gouvernance et la redevabilité des gouvernements vis-à-vis des gouvernés. Les différents chapitres présentés abordent cette problématique.

Les résultats du chapitre i montrent que le faible niveau de recettes fiscales en Afrique sub-saharienne est associé à un faible effort fiscal. Autrement dit, les pays en développement d'Afrique sub-saharienne n'exploite pas suffisamment leur potentiel fiscal. Ce faible niveau d'effort fiscal est lié aux facteurs variables du prélèvement fiscal comme la politique fiscale, la performance de l'administration fiscale.

Les résultats du chapitre 1 concerne la conception de la politique fiscale. Une fragmentation du pouvoir de taxation peut émerger du design de la politique fiscale surtout dans les pays caractérisés par un secteur important (ressources naturelles par exemple). Cette fragmentation du pouvoir de taxation aboutit à une concurrence fiscale pour taxer le même revenu. Il en découle un niveau faible de recettes fiscales comparé à un régime sans fragmentation compte tenu de la déductibilité des impôts payés. Les résultats pointent vers une substituabilité des instruments fiscaux entre le secteur concerné et le reste de l'économie.

Dans le chapitre 2, nous explorons l'effet de la libéralisation des échanges sur les recettes fiscales. Les résultats montrent que la libéralisation des échanges n'a pas eu les effets positifs escomptés. Au contraire, les périodes de libéralisation ont entraîné une perte de recettes fiscales à court termes et aucun effet significatif à moyen termes. La libéralisation entraîne aussi un changement de la structure des recettes fiscales, en orientant celles-ci vers les impôts indirects. Dans ce chapitre, nous illustrons l'importance de la capacité de l'état, en particulier l'élaboration par les institutions de mesures adéquates afin d'accompagner la transformation de l'économie.

Le chapitre 3 met en évidence une manifestation contagieuse entre pays. Les manifestations reflètent le mécontentement d'une population (ou du moins une partie) mécontente. Mécontentement qui découle en général d'actions politiques ou gouvernementales (inefficiente). Les manifestations renvoient aussi à l'action publique et à sa mise en œuvre. Dans de nombreux cas, elles signalent juste un Etat inefficent.

Le chapitre 4 démontre l'importance de la paix et de la stabilité dans les pays pauvres. La recrudescence de violences plonge beaucoup d'Etats d'Afrique sub-saharienne dans

une situation de fragilité. Comme les manifestations, les conflits peuvent être liés à l'action gouvernementale. Toutefois, ils sont plus étroitement liés à la faible capacité de l'Etat ou traduisent une inefficience plus grande. Nous mesurons dans ce chapitre la perte de recettes fiscales qui provient des conflits internes. Les conflits empêchent le bon fonctionnement de l'Etat dans les zones affectées. Il devient impossible de lever l'impôt et si cela est possible les violences réduisent considérablement l'efficacité et l'efficience de l'administration fiscale. Les conflits entraînent aussi des destructions et surtout la baisse des activités économiques dans les zones de conflits et leurs relations économiques avec les autres parties du territoire. Cela conduit à une réduction de la base taxable et donc des impôts collectés. Ce chapitre illustre non seulement la faible capacité des Etats d'Afrique sub-saharienne mais démontre aussi le rôle de certaines spécificités (richesses en ressources naturelles, fragmentation ethnique). La combinaison de la faible capacité et de ces spécificités aboutit aux conflits violents et empêche la construction d'un Etat stable.

Le chapitre 5 développe une mesure de la qualité des dépenses publiques. Il permet de comparer les pays selon la qualité de leurs dépenses publiques. Il en ressort que les pays en développement sont peu efficaces. Cela soulève la question d'une meilleure utilisation des ressources publiques. On y retrouve aussi des éléments pouvant expliquer la faible mobilisation des recettes fiscales. La collecte des impôts doit s'accompagner de mesure de redistribution efficace des dépenses publiques. Au-delà des dépenses productives efficaces, il est important que les pays développent des mesures adéquates de redistributions. La plupart des pays développés ont mis en place des mécanismes de soutien (à la fois aux personnes physiques et morales) à la suite de la pandémie de Covid 19. Ces mécanismes renforcent le civisme fiscal car au-delà du simple soutien dans une situation difficile. Les personnes voient directement l'utilité de l'impôt. Si les citoyens perçoivent l'utilité des impôts payés à travers les dépenses publiques réalisées, cela pourrait contribuer à réduire leur aversion à payer l'impôt.

Le dernier chapitre s'intéresse d'une part aux déterminants de l'efficience des dépenses publiques. D'autre part, il analyse l'effet des dépenses publiques de qualité sur la croissance économique et les inégalités. La fragmentation ethnique et l'origine coloniale semblent déterminer les différences de qualité. Aussi, les dépenses de qualité favorisent la croissance économique et réduisent les inégalités.

Le travail de recherche implique de se poser des questions, de ce fait problématiser constitue le plus grand apport du chercheur. Très souvent, il est incapable de fournir une réponse évidente aux problèmes posés, car ceux-ci sont généralement multidimensionnels et/ou profondément enracinés. Lorsqu'il est capable de fournir une réponse, le défi est de fournir des informations pouvant être utilisées par les décideurs,

sans modifier le message lui-même (Slemrod, 1999). Malgré ces difficultés, nous allons nous efforcer de fournir quelques recommandations de politiques économiques.

Un accroissement de la capacité de l'Etat

Les pays en développement doivent urgemment améliorer la capacité de l'Etat et celle des institutions. Ce développement doit être un projet structurant car la capacité de l'Etat joue un rôle important à tous les stades du développement. Par exemple, cela peut être moyen de tirer parti de la libéralisation : les pays ayant adopté la TVA ont atténué les effets négatifs de la libéralisation des échanges.

Il est important de procéder à une réforme de l'administration publique, en particulier de la transparence. Une modernisation de l'administration fiscale et du processus de collecte conduirait à une augmentation des recettes fiscales. Cette modernisation devrait avoir pour objectifs une meilleure identification des contribuables et le développement de la vérification croisée. Cela assurerait un suivi plus efficace des déclarations mais aussi des recettes collectées par l'administration.

Le développement des institutions doit aussi contribuer à réduire la corruption. Un niveau élevé de corruption détruit l'environnement des affaires et encouragent l'informalité, créant ainsi un cercle vicieux qui compromet les performances fiscales.

Une meilleure conception de la politique fiscale

Les pays en développement doivent procéder à une meilleure conception de leur politique fiscale. La fragmentation du pouvoir de taxation est peu optimale. Compte tenu des possibilités de déductions, de telles configurations aboutissent un à un niveau plus faible d'impôt. Il faut plutôt privilégier l'unicité du pouvoir de taxation surtout si la fragmentation induit une concurrence pour taxer la même base dans la mesure où chaque instance de taxation chercherait à maximiser son propre revenu. La politique fiscale doit avoir un objectif de mobilisation efficiente des impôts. De ce fait, sa conception doit être pensée afin de réduire la fragmentation du pouvoir de taxation. Il est aussi important d'éviter les exonérations d'IS dans la conception des régimes fiscaux.

Il est important de trouver l'équilibre idéal entre l'effort de collecte des recettes fiscales et les ressources provenant des secteurs extractifs.

Un renforcement de la sécurité

L'amélioration de la capacité de l'Etat doit être étroitement accompagnée par un renforcement de la sécurité. L'insécurité empêche non seulement la collecte efficace (ou

la collecte tout court) mais elle réduit l'efficacité des dépenses publiques. La construction des écoles et des hôpitaux ne sert pas à grand-chose, si ces infrastructures sont après détruites lors des conflits. Si elles ne sont pas détruites, le déplacement de la population ou l'augmentation des violences font qu'elles ne sont pas fréquentées.

Des dépenses publiques plus efficaces et plus efficientes.

Les dépenses publiques doivent assurer des services publics de qualités. Les Etats doivent privilégiés les dépenses dans les secteurs productifs comme l'éducation, la santé et les infrastructures publiques. Les dépenses publiques efficaces démontrent l'utilité de l'impôt et peuvent renforcer le civisme fiscal.

Une meilleure mobilisation des recettes fiscales combinée à une utilisation efficiente des ressources publiques élargit l'espace budgétaire et peut être un pas important vers la soutenabilité budgétaire des pays en développement.

General Appendix

Give a man a fish and you feed him for a day; teach a man to fish and you feed him for a lifetime. Anne Isabella Thackeray Ritchie's (1837–1919) novel, *Mrs. Dymond* (1885).

i. Tax effort in Sub-Saharan African countries: Replication and evidence from a new dataset

This paper is a joint work with Emilie Caldeira (CERDI-CNRS), Ali Compaoré (CERDI-CNRS), Mario Mansour (IMF), and Grégoire Rota-Graziosi (CERDI-CNRS). A slightly different version has been accepted by the journal “REVUE D’ECONOMIE DU DEVELOPPEMENT”.

The associated webpage to replicate the results is available at <https://data.cerdi.uca.fr/taxeffort/>.

Abstract

This paper proposes (i) a new database of tax revenue for 42 Sub-Saharan African countries (SSA) over the period 1980-2015, (ii) an estimate of tax effort for these countries, and (iii) some replication analyses of previous tax effort estimations. The database results from statistical information of the African Department of the International Monetary Fund (IMF). In particular, it allows distinguishing tax revenue from the natural resource sector from the other economic sectors. SSA countries collected on average 13.2 percent of GDP in non-resource tax revenue over the studied period and their average estimated tax effort is 0.57. In other words, SSA countries could raise 23.2 percent of GDP in non-resource taxes if they fully used their potential. In line with previous analyses, we find that countries' stage of development measured by per-capita income, financial development, and trade openness are important factors improving tax revenue in the region, while natural resource endowment and the importance of the agriculture sector reduce unambiguously the non-resource tax-to-GDP ratio. Finally, beyond the originality of the database itself and the empirical results, this work participates explicitly to the replication principle given its online development with R software (<https://data.cerdi.uca.fr/taxeffort/>).

Keywords: Tax effort; Sub-Saharan Africa; Stochastic frontier analysis.

JEL Codes: H20; O11; O23.

i.1. Introduction

Since the Addis Ababa Conference in July 2015, Domestic Revenue Mobilization (DRM) became one of the main tools of financing Sustainable Development Goals (SDGs). DRM is now a well-discussed topic to address the issue of economic development (see e.g., Besley and Persson, 2014) and is a privileged tool for donors and international and regional institutions (African Development Bank, International Monetary Fund, World Bank, European Union Commission).

In this paper, we propose (i) an update and complete version of the tax revenue dataset published in Mansour (2014), (ii) an estimate of tax effort for these countries, and (iii) some replication analyses of previous tax effort estimations by Gupta (2007) and Fenechietto and Pessino (2013). The database covers 42 Sub-Saharan African (SSA) countries over the period 1980-2015. It results from statistical information collected in the African Department of the International Monetary Fund (IMF)—most of which is included in public IMF documents. We distinguish tax revenue from the natural resource extractive industry, from those from other economic sectors.

Tax revenue excluding natural resources is on average 13.2 percent of GDP. The average estimated total tax effort is 0.57. In other words, SSA countries could raise on average 23 percent of GDP of non-resource taxes if they fully utilized their potential. We decompose the total tax effort score into time-varying and persistent tax effort and conclude that the total tax effort score is mainly driven by time-varying factors. Moreover, consistent with previous literature, we find that countries' stage of development measured by per-capita income, financial development, and trade openness are important factors improving tax revenue in the region, while natural resource endowment and the importance of the agriculture sector reduce unambiguously the non-resource tax-to-GDP ratio. Regarding the replication exercise, the estimations broadly confirm previous analyses such as Fenechietto and Pessino (2013). However, our verification test failed to replicate the exact results of Gupta (2007) in terms of robust coefficients and significance of the variables, which might be caused from the use of less detailed data than we provide here.

Our analysis contributes to the existing literature by providing a new estimation of SSA countries' total tax efforts and their composition. We decompose tax effort in terms of direct taxation (Corporate Income Tax, CIT, and Personal Income Tax, PIT). In addition, beyond the originality of the database itself and the empirical results, our works participates explicitly to the replication principle given its online application developed with R-Shiny. The need of replicability appears highly relevant for tax effort analysis given the primacy of DRM in the agenda of developing countries, donors, and international organizations. The database is dynamic and is hosted on a webpage that

allows users to interact with the data and generate new analytical results, including quick descriptive statistics and running alternative specifications of regressions.

The rest of the paper is organized as follows: Section i.2 presents the dataset; Section i.3 briefly reviews the literature on the determining factors of tax effort in developing countries; Section i.4 describes the empirical methodology and variables. Section i.5 presents and discusses the results; section i.6 proposes a replication analysis of Gupta (2007) and Fenechietto and Pessino (2013), and section i.7 concludes.

i.2. Tax revenue dataset for Sub-Saharan Africa over 1980-2015

The study of tax policy in developing countries has long been constrained by the availability and the quality of detailed relevant data. Moreover, extractive industries have played and still play a crucial role in the economic development of SSA countries. More than half of these countries are resource dependent, that is natural resources represent 25 percent or more of total country's exports. Tax revenues from this sector are usually large and at high risk of being taken out of the source country through various licit or illicit channels, including generous tax incentives provided in mining or petroleum codes and other laws; aggressive tax planning such as the use of thin capitalization, trade mispricing, or plain tax evasion; and double taxation agreements that do not always protect appropriately source countries' taxation rights.

We provide here an updated version of the tax revenue dataset published in Mansour (2014), which covered the period 1980-2010 for 41 countries (see <https://data.cerdi.uca.fr/taxeffort/>).¹¹⁸ It participates to recent efforts to better apprehend tax revenues in Africa, in particular the revenue statistics in Africa from the OECD, which cover 26 countries in its last release¹¹⁹ and the Government Revenue Dataset initiated by the International Centre for Tax and Development (ICTD) and updated by UNU-WIDER.¹²⁰ There are three advantages that our dataset provides relative to these two alternatives. First coverage for SSA countries is generally broader, and deeper for each of the tax series. Second, the definition of variable is consistent across all countries,¹²¹ Finally, the isolation of resource revenue from non-resource (tax)

¹¹⁸ See <https://ferdi.fr/publications/a-tax-revenue-dataset-for-sub-saharan-africa-1980-2010>

¹¹⁹ See <https://www.oecd.org/ctp/revenue-statistics-in-africa-2617653x.htm>

¹²⁰ See <https://www.wider.unu.edu/project/government-revenue-dataset>

¹²¹ The ICTD database, now Government Revenue Dataset (<https://www.wider.unu.edu/project/government-revenue-dataset>), combines revenue data primarily from OECD revenue statistics, IMF staff reports' statistical tables, and IMF GFS. This produces asymmetries in the definition of resource revenues. For instance, ICTD reports no resource tax revenue for Australia and Canada, and only aggregated corporate income tax (CIT), which include profit taxes from the resource sector if the source is OECD or GFS. These asymmetries are less important in SSA countries since the primary source for ICTD for these countries is IMF staff reports, and Keen and Mansour

revenue allows for a better understanding of the interaction of these two fundamentally different (economically) sources.¹²²

Distinguishing resource from non-resource revenue is highly relevant to understand countries' tax effort. For instance, Bornhorst, Gupta, and Thornton (2009), Crivelli and Gupta (2014), and James (2015) emphasize a crowding-out effect between resource revenue and non-resource tax revenue: an increase of the former reduces the latter. McGuirk (2013) explains this effect through the strategy of the government to remain in power by reducing its accountability or equivalently the tax pressure. Caldeira *et al.* (2020)¹²³ provides an alternative explanation of the negative relationship between resource and non-resource tax revenue in terms of an inter-ministerial tax competition: the Minister in charge of Mining and Petroleum can tax partly the same base than the Minister of Finance. The inter-ministerial tax competition reduces total tax revenue and deteriorates the economic development of these countries by favoring a concentration of the economic activity in the extractive industry.

The dataset covers 9 tax series and 42 SSA countries over the period 1980-2015. The series are: 1. Total Taxes; 2. Trade Taxes; 3. Indirect Taxes; 4. VAT with a decomposition for some countries between domestic VAT, VAT collected at the border, and VAT refunds; 5. Excises; 6. Direct Taxes; 7. Personal Income Tax; 8. Corporate Income Tax with additional information for some countries concerning CIT from extractive industry; 9. Other tax revenues.

The database is built from data that countries report to the IMF in the context of surveillance, using a combination of bottom-up and top-down approach to obtain the highest disaggregation level for the tax and non-tax revenue composition while ensuring as much as possible data accuracy. In order to isolate the impact of resource revenue on the tax effort, the database reports revenue from extractive activities separately and irrespective of the policy tool used to raise them. As such, resource revenues include royalties and other fees, dividends, and bonuses from extractive activities, the government share of production sharing agreements, and (importantly) corporate income taxes. The latter is included because it is similar in design to production sharing, and hence subject to the same extent to volatility in commodity

(2009)—and both report a different concept of resource revenue. For instance, the average resource revenue-to-GDP ratio during 1980-2015 in ICTD is 8.16 percent, which is close to the 8.6 percent in our database. However, the average CIT ratio in ICTD is 1.82 percent over the same period, slightly higher than the 1.7 percent in our database—possibly due to the fact that the CIT revenue for SSA taken from OECD revenue statistics for Africa includes some resource revenue.

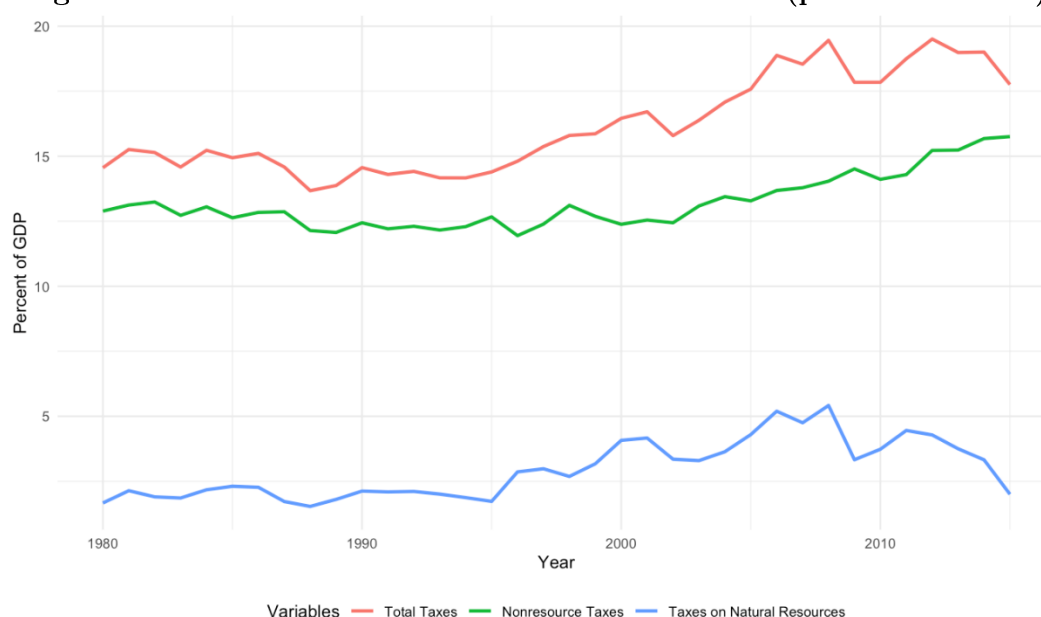
¹²² The OECD statistics do not report resource revenues unless they are accounted for as corporate taxes. This may not be an issue in OECD countries, where oil revenue is derived primarily through the tax system. However, in SSA countries, production sharing agreements and turnover-based royalties are prominent.

¹²³ In chapter 1.

prices. However, resource revenues do not include non-refundable VAT on inputs, which we were not able to identify separately—presumably, this is not very important in aggregate given that extractive companies often seek and obtain an exemption from VAT on input, knowing that VAT refund mechanisms in SSA countries are not very effective.

Figure i.1. displays the evolution of the average tax revenue in Africa, in percent of GDP.¹²⁴ Note that the volatility of commodity prices explains a large share of revenue variations over the period. However, an improvement of non- resource tax revenue is perceptible since 2000: This revenue stagnated around 12.5 percent of GDP from 1980 to 2000 and reached 15 percent by 2015.

Figure i.1. Evolution of revenue in SSA: 1980-2015 (percent of GDP)



Sources: Tax revenue Dataset for SSA and authors' own calculations.

Figure i.2. highlights the tremendous change in the structure of non-resource tax revenue over the studied period. The reduction of tariff duties (equal to trade tax revenue in the dataset) was offset by an increase in the revenue of taxes on goods and services, which results from the introduction of the Value Added Tax (VAT).

¹²⁴ Figures 1, 2 and many others are created from the dedicated website on the page entitled Graphics.

Figure i.2. Variation of average direct, indirect, and trade tax revenue over the period 1980-2015 (percent of GDP).

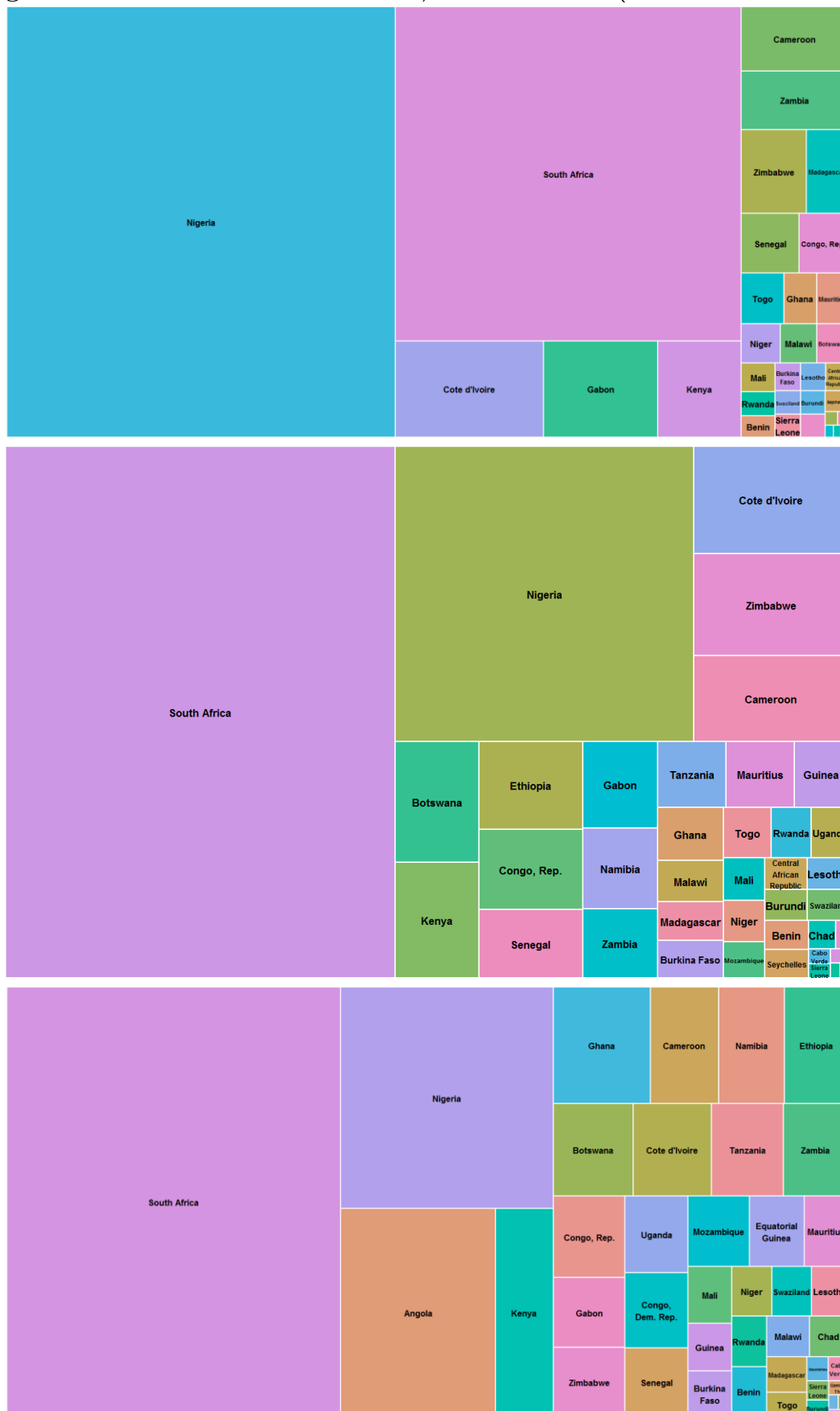


Sources: Tax revenue Dataset for SSA and authors' own calculations.

Figure i.3. shows total tax revenue collected across SSA countries in 1980, 1990 and 2015. Total tax revenue amounted to 91 billion USD (constant 2010 USD) in 1980¹²⁵, 117 billion USD in 1990, and 259 billion USD in 2015. South Africa and Nigeria are the main contributors with respectively 32 percent of total revenue (including resource revenue) in 1980, 39 percent in 1990, and 40 percent in 2015 for South Africa, and 46 percent in 1980, 36.2 percent in 1990 and only 13 percent in 2015 for Nigeria. This highlights the main role of the natural resource sector in aggregate for SSA and the sharp decrease of total tax revenue collected in Nigeria. The variation of total tax revenue over the period 2000-2015 displays contrasting results: while tax revenue decreases by 49 percent in Nigeria, they increase significantly in Mozambique by 615 percent reaching 3.1 billion USD in 2015, in Rwanda by 403 percent (1,2 billion USD), in Chad by 376 percent (1.1 billion USD), and in Ghana by 341 percent (8 billion USD).

¹²⁵ Some countries are missing in 1980.

Figure i.3. Total tax revenue in 1980, 1990 and 2015 (constant 2010 USD).



Sources: Tax revenue Dataset for SSA and authors' own calculations.

i.3. Brief literature review on tax effort

DRM would be more reliable and sustainable source of financing than its domestic alternative (debt, seigniorage) or international financial flows (i.e. remittances, official development assistance and foreign direct investment). Hence, a non-negligible literature has investigated how countries, specifically developing countries, which face important financial constraints, can levy more domestic resource to finance development and wean themselves from aid.

Several empirical analyses study the macroeconomic and institutional driving factors of countries tax-to-GDP ratio. A first generation of empirical works establish that agriculture, mining (resource rent), and share of external debt in total debt are significant determinants of countries tax ratios. Agriculture share, which is still important in least developed economies, is negatively associated with the level of tax revenue (Chelliah *et al.*, 1975; Leuthold, 1991; Tanzi, 1992; Stotsky and WoldeMariam, 1997), while mining and external debt are positively associated with tax revenues (Chelliah *et al.*, 1975; Tait *et al.*, 1979 and Tanzi, 1992).

However, the relationship between natural resource sector and tax revenue remains controversial. Indeed, in line with the resource curse debate, recent studies point out a negative association between resource rent and government tax revenue. For instance, Belinga *et al.* (2017) highlight a crowding-out effect of resource revenue on non-resource revenue for a panel of 30 resource-rich countries over the period 1992-2012. Natural resource boom is associated with less incentive in tax collection.

A second generation of empirical works outlined the pivotal role of inflation, institutional quality, education, political stability, external aid, and financial development in addition to the previous economic factors (Tanzi and Davoodi, 1997, Grigorian and Davoodi, 2007, Gupta, 2007, Gordon and Li, 2009, Clist and Morrissey, 2011, Fenochietto and Pessino, 2013, Feger and Asafu-Adjaye, 2014).

Contrary to these studies, this paper does not assess the determinants of tax revenue ratio. It rather provides a new dataset and focuses on the effort of countries to raise tax revenue. We define tax effort as the extent to which the actual tax revenue collected is from the maximum level of tax revenue given their characteristics. These characteristics correspond to the determinant variables previously studied in the literature, which are mainly: the level of development, trade openness, the size of the agricultural sector, natural resource rent, and financial development. Given these characteristics, we compute for each country potential tax revenue. Tax effort results then from the comparison between potential tax revenue and actual collected tax revenue. Closer they are, the greater is the tax effort. We do not study the details of countries' tax code, nor the organization of their revenue administration or authorities.

Our approach is then purely economic, since it does not rely on countries' tax system¹²⁶ but only on economic characteristics. It allows some international comparisons among countries, which share similar economic features. This analysis could be then complemented by some tax policy and revenue administration diagnostics. Indeed, differences in tax effort across countries may result from some distinctions in existing taxes, their statutory rates, their respective tax bases, tax expenditures, the efficiency of revenue administration (organization, IT technology, the number of tax inspectors, and even their remunerations' modalities).¹²⁷ Other determinants such as tax morale, the ethno-linguistic fragmentation of the countries, political regimes (presidential or parliamentary), inflation rate... are variables, which may be added in our empirical assessment of tax effort.¹²⁸

Tax effort is complementary to tax gap analysis,¹²⁹ which measure the difference between expected revenue and collected one. The tax gap approach is legal and microeconomic, while the tax effort analysis relies only on macroeconomic data. Indeed, the computation of expected revenue differs from potential revenue in the tax effort analysis, since the former requires the use of statutory tax rates, tax base's definition, and eventually some assumptions on the behavior of consumers and producers. The tax gap has usually two components: the policy gap and the compliance or administrative gap. The former, roughly equivalent to the cost of tax expenditures, results directly from a political decision to reduce the tax burden of the investor or the consumer. This policy aims at stimulating investments or at protecting the poorest. For instance, investment or sectorial (Petroleum or Mining) codes may provide tax exemptions or reduce tax rates, which would reduce tax revenues. Similarly, one of the main justifications of VAT exemptions or reduced rates is to protect the poorest consumer. For instance, developing countries use to exempt completely the agricultural sector and some SSA countries exempt even from VAT the importations of some foodstuff such as rice and wheat. The rationale is the assumption of a tax incidence close to one, i.e. such exemptions would reduce the price for households.¹³⁰ The second element of the gap is the administrative or compliance gap. This gap corresponds to

¹²⁶ Gillitzer and Slemrod (2015) define tax system as the combination of tax policy (tax laws) and revenue administration.

¹²⁷ See for instance Caldeira and Rota-Graziosi (2019) for a detailed analysis of relative tax revenue performance between Benin and Togo, which begins with a tax effort analysis of these two countries and is completed by a review of countries' tax systems.

¹²⁸ The devoted website to this paper allows adding any variable and running new estimates of tax efforts (see <https://data.cerdi.uca.fr/taxeffort/>).

¹²⁹ Several countries provide some tax gap analyses. One of the most exhaustive exercise is the VAT Gap work done by the EU commission. The VAT gap amounts to 137 billion Euro in 2017, or equivalently to 11.2 percent of total VAT revenue.

¹³⁰ We do not discuss here the efficiency or the equity of these tax expenditures.

the capacity of tax and customs administration or tax authorities to enforce current tax laws and to the compliance behavior of firms and individuals to pay their taxes.

i.4. Empirical methodology: The Stochastic Frontier Analysis

The literature proposes several approaches to capture countries' tax effort. The usual indicator to compare countries' tax effort is the tax-to-GDP ratio. However, Stotsky and WoldeMariam (1997) point out that this simple approach is inappropriate to measure the taxable capacity since not all taxes are explicitly linked to income and to its distribution. Using panel data on 42 Sub-Saharan African countries, during the period 1990-1995, they propose another measure of tax effort consisting of the ratio of the actual to the predicted tax share in GDP. They find that countries with high tax shares tend to have a relatively high tax effort index, even though some disparities remain across countries. Following a similar approach, Gupta (2007) computes the tax effort for 105 developing countries over 25 years but clearly recognize some shortcomings related to this approach.

Cyan *et al.* (2013) propose a method of estimating tax effort that closely relies on the revenue adequacy approach (see Martinez-Vasquez and McNab, 2000). This method consists in looking at the deviations between what a country would like to raise in tax revenues – as revealed by the structural choice of the level of public expenditures – and its actual tax revenue level. This approach corroborates the empirical evidence that changes in expenditures induce changes in tax levels (see Baicker and Skinner, 2011). Recently, Yohou and Goujon (2017) proposed a Vulnerability-Adjusted Tax Effort Index (VATEI) for a sample of 120 developing countries over 1990-2012. Their approach consists in building the tax effort as the residual of a standard panel regression model (random effects model) of non-resource tax ratio on the economic vulnerabilities and human asset indices, in addition to the usual determinants of tax revenue. This adjusted tax effort index is assumed to measure the willingness and capacity of governments to collect tax beyond the structural factors.

An alternative and increasingly used approach to capture countries' tax effort is the Stochastic Frontier Analysis (SFA) method, which has been followed by: Alfirman (2003), Fenchietto and Pessino (2013), Langford and Ohlenburg (2015), Brun and Diakite (2016). Aigner, *et al.* (1977) and Meeusen and van Den Broeck (1977) developed SFA approach to model firms' production behavior. The rationale is that economic agents cannot exceed an "ideal frontier" of production, which is the optimal level of output given the limited endowment of inputs. In our context, the tax frontier refers to the tax capacity, which is the maximum potential tax revenue, given a country's institutional, demographic, and economic features, while the tax effort is the

actual revenue in relation to the frontier. Hence, the closer a country is to that frontier, the greater is its tax effort.

The stochastic frontier approach encompasses parametric and non-parametric models. Data Envelopment Analysis (Charnes *et al.*, 1997) and the Free Disposal Hull (Deprins, Simar, and Tulkens, 1984) are the two main and increasingly popular methods used for non-parametric stochastic frontier models. These methods use linear optimization programs to construct the efficiency curve. They display the advantage that no restrictive assumptions on the production function are necessary (except the standard convexity assumption). However, they remain sensitive to random variations in data and measurement errors. Any variation between production units is therefore likely to be interpreted as inefficiency. Furthermore, the inefficiencies estimated by these models are very sensitive to variations in the sample, to the heterogeneity between the units and to the presence of outliers (See Hjalmarsson *et al.* 1996 for more discussion).

Regarding parametric models in panel data analysis, they are single output-based and categorized into five groups: (i) time-invariant technical inefficiency models (Pitt and Lee, 1981; Schmidt and Sickles, 1984); (ii) time-varying technical inefficiency models Cornwell *et al.* (1990), Kumbhakar (1990), Battese and Coelli (1992), Lee and Schmidt (1993), and Kumbhakar and Wang (2005); (iii) models that separate firm heterogeneity from inefficiency (Greene, 2005; Wang and Ho, 2010); (iv) models distinguishing persistent and time-varying inefficiency (Kumbhakar and Heshmati, 1995); (v) and finally models separating firm effects, persistent inefficiency, and time-varying inefficiency (Colombi *et al.*, 2014;. Kumbhakar *et al.*, 2014; Filippini and Greene, 2016). In panel data, such models offer the possibility for richer specifications, deal with stochastic noise, and allow testing hypotheses (Hjalmarsson *et al.* 1996; Odeck, 2007).

We follow a parametric approach to estimate the tax effort since we focus on a single output: the total non-resource tax-to-GDP ratio.¹³¹ More precisely, we use the model that separates the error into four components: Generalized True Random Effects model (GTRE). This model was introduced by Colombi *et al.* (2014), Kumbahkar *et al.* (2014), and Tsionas and Kumbahkar (2014). It presents several advantages: (i) it takes into account random shocks; (ii) it is robust to the presence of heterogeneity within the panel; (iii) it allows distinguishing country heterogeneity, and persistent and time-varying factors affecting countries' tax effort. Persistent (i.e. structural) factors are for instance colonial history, culture, geography, the economic structure of the country, which have long-lasting influence on the tax effort. The time-varying factors are both country- and time-specific. They include tax policy, tax administration performance,

¹³¹ We exclude natural resource revenue; which variations are mainly driven by commodities' prices.

natural resources discoveries, and commodity price cycles. For example, countries might improve their tax administration performance by clamping down on tax evasion, training their tax officers, or using more sophisticated tax tools. Also, countries' tax effort might change following discovery of natural resources or a boom in commodity prices. Different methods are proposed in the literature to estimate the parameters of the GTRE model: Colombi *et al.* (2014) use a maximum likelihood estimator (MLE); Kumbahakar *et al.* (2014) propose a multi-step procedure; Tsionas and Kumbahakar (2014) develop a Bayesian approach; Filipini and Greene (2016) use a simulated maximum likelihood approach.

We estimate the following model:

$$\tau_{i,t} = \alpha + f(X_{i,t}, \beta) + \mu_i + \nu_{i,t} - \eta_i - \varphi_{i,t} \quad (\text{eq. i.1.})$$

The dependent variable, $\tau_{i,t}$, represents the logarithm of the total non-resource tax-to-GDP, the subscripts i and t denote respectively country and time dimensions and $X_{i,t}$ is a vector of covariates explaining countries tax ratio. $\eta_i > 0$ and $\varphi_{i,t} > 0$ are the persistent and time-varying inefficiencies respectively, while μ_i and $\nu_{i,t}$ represent the random effects and the stochastic noise respectively.¹³²

Starting from hypotheses on the distribution of the four errors, the MLE approach of Colombi *et al.* (2014) makes it possible to obtain a form of the log-likelihood. Indeed, assuming that $\nu_{i,t}$ is independent and identically distributed (iid) with a normal distribution and $\varphi_{i,t}$ is iid with a half-normal distribution, the error $\varepsilon_{i,t} = \nu_{i,t} - \varphi_{i,t}$ has an asymmetric normal distribution with parameters $\lambda = \sigma_\nu / \sigma_\varphi$ and $\sigma = \sigma_\nu^2 + \sigma_\varphi^2$. Similarly, the error $\psi_i = \mu_i - \eta_i$ has an asymmetric normal distribution with parameters $\lambda = \sigma_\mu / \sigma_\eta$ and $\sigma = \sigma_\mu^2 + \sigma_\eta^2$. The two-term error $\varepsilon_{i,t} = \varepsilon_{i,t} + \psi_i$ is the sum of two asymmetric normal distributions and then admits a known density. It is therefore possible to define the function of the log-likelihood and to deduce from it the MLE of the parameters. However, the complexity of the likelihood function, which, in his form, involves T_i integrations, makes very hard the implementation in practice.¹³³ Hence, Filippini and Greene (2016) proposes a computation method based on Butler and Moffitt (1982) formulation to simplify the log-likelihood function and subsequently estimates the MLE using a simulation-based optimization. With the same assumptions on the parameters as before, the idea is to obtain the conditional density $f(\varepsilon_i / \psi_i)$, which is defined on ψ_i . Unlike to the previous case, the manipulation, then, involves

¹³² We use the logarithm of non-resource tax-to-GDP as dependent. The predictor variables, except the real GDP per capita, are scaled to unit *i.e.* in percent of GDP and not in logarithm. By doing so, we do not assume implicitly the functional form linking the output to the inputs. The log-log form is the most used in the stochastic frontier literature. Note that our results remain robust to the use of the log-log form.

¹³³ For these authors a direct optimization of the log-likelihood of the model appears complex.

only one integration. In order to simplify the implementation of the estimation, we use the multi-step procedure of Kumbhakar *et al.* (2014).¹³⁴ The model based on equation i.1 is estimated in three stages:

In stage 1, a standard random-effect regression is used to estimate $\hat{\beta}$ and predicts the values of $\varepsilon_{i,t}$ and ψ_i . We estimate the following equation:

$$\tau_{i,t} = \alpha^* + f(X_{i,t}, \beta) + \varepsilon_{i,t} + \psi_i \quad (\text{eq. i.2.})$$

Where $\alpha^* = \alpha - E(\eta_i) - E(\varphi_{i,t})$, $\psi_i = \mu_i - \eta_i + E(\eta_i)$, $\varepsilon_{i,t} = v_{i,t} - \varphi_{i,t} + E(\varphi_{i,t})$, $E(\eta_i) = \sqrt{\frac{2}{\pi\sigma_\eta}}$, and $E(\varphi_{i,t}) = \sqrt{\frac{2}{\pi\sigma_\varphi}}$.

In stage 2, by performing a standard stochastic frontier technique, the time-varying tax inefficiency $\varphi_{i,t}$ is estimated using the predicted values of $\varepsilon_{i,t}$ from the first stage. Following Battese and Coelli (1988), this procedure gives the prediction of the time-varying tax effort $\exp(-\varphi_{i,t}|\varepsilon_{i,t})$.

In stage 3, we estimate the persistent tax inefficiency component, denoted by η_i by performing a stochastic frontier model as in the previous stage. The persistent tax effort is then defined by $\exp(-\eta_i)$.

Finally, the overall tax effort is obtained by the product of the time-varying tax effort and the persistent tax effort.

Considering the relevant literature on the determinants of domestic resource mobilization, we identify the following driving factors of government tax revenue and consider them as inputs $X_{i,t}$:

- The level of development: Countries' tax capacity depends on their level of economic development assessed through the level of real GDP per capita. High income countries should raise more tax revenue than developing countries, since they have more efficient tax administration, better institutions, and a higher demand for public goods and services (see Lotz and Morss, 1967; Pessino and Fenechietto, 2010; Crivelli and Gupta, 2014).
- Trade openness: Trade liberalization policies implemented in most developing countries starting in the early 1970s and stretching well into the 1990s have substantially increased trade volume in these countries. Therefore, trade openness expressed as total trade (value of imports and exports) as a share of GDP is expected to positively influence tax revenue through households' consumption and domestic corporate profits. This reinforces the role of customs administration in

¹³⁴ See Kumbhakar *et al.* (2015) for the estimation procedure.

collecting taxes, both the external tariff and domestic taxes, on imported goods (see Stotsky and WoldeMariam, 1997; Pessino and Fenechietto, 2010; Gnanngnon and Brun, 2018 among others).

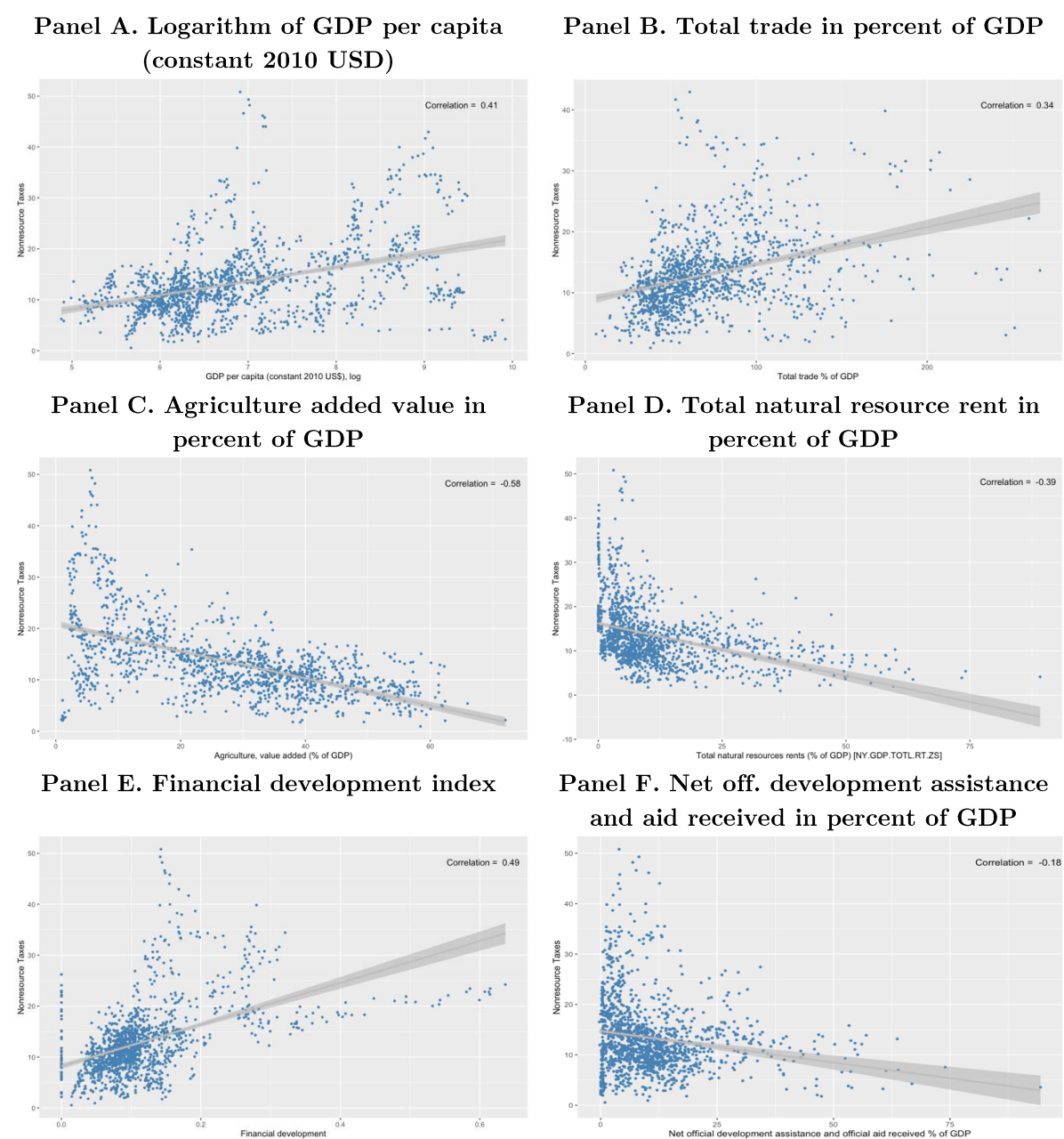
- Agriculture value-added as a percent of GDP: Agriculture is often largely tax exempt in SSA countries from income taxes and other production taxes, and is frequently either tax exempt or out-of-scope of VAT. The arguments in favor of this treatment are that the sector is dominated by small and medium-size farmers that are scattered across geography, and hence hard to tax; and even if tax can be effectively levied, such farmers cannot be significant contributors to tax revenues.¹³⁵
- Natural resource rent as a percent of GDP: The negative effect of natural resource rent on tax revenue is widely evidenced in the literature. Natural resource endowment is associated with lower tax revenue (Sachs and Warner, 2001; Eltony, 2002; Belinga *et al.*, 2007). During commodity prices upswings, governments in resources-rich countries have less incentive to mobilize other tax revenues; resource rent crowds-out tax revenue (Bornhorst *et al.*, 2009, Crivelli and Gupta, 2014, James, 2015) or an inter-ministerial tax competition occurs (Caldeira *et al.*, 2020).
- Financial development: Financial development may favor higher tax collection (see Gordon and Li, 2009). Combined with improved access to credit, it allows individuals and companies to finance profitable projects and improve the national information system on economic activities—hence, favor tax collection. On the other hand, in a presence of ineffective financial system, firms could successfully evade tax payment by conducting business in cash, which is harder for tax administrations to monitor.
- Aid received: There is no consensus on the effect of aid on taxes. In a review of several papers studying the relationship between taxation and aid, Morrissey (2015, p.102) stated “the safest conclusion is that we do not have a robust evidence”. The study of the relationship raises questions of accountability of governments, good governance and most importantly the repayment contract that comes with aid.

In addition to these variables, the devoted website to this paper allows adding any variable and running new estimates of tax efforts.

Table i.4. and Table i.5. provide descriptive statistics and more details on variables definition and source. Figure 1.4. displays scatter plot of total non-resource tax revenue for each of the explanatory variables. These graphs tend to confirm the expected relationships.

¹³⁵ The improvement in technologies for farming, including in SSA, and the increase of large farming firms over the past two decades, weaken such arguments. Nevertheless, countries have been very slow in rethinking the taxation of agriculture.

Figure i.4. Correlation between total non-resource tax revenue and explanatory variables



Sources: Tax revenue Dataset for SSA, World Development Indicators, Svirydzhenka (2016), and authors' own calculations.

i.5. Results

Table i.1. displays the three-stage estimation results¹³⁶. Dependent variables in column [1] to column [4] are respectively total non-resource tax revenue, total income taxes, corporate income tax, and personal income tax. In line with previous studies (Stotsky and WoldeMariam, 1997; Gordon and Li, 2009; Pessino and Fenochietto, 2010; Crivelli and Gupta, 2014) all the variables have the expected sign and are statistically

¹³⁶ We excluded Zimbabwe from the sample in all regressions.

significant. The coefficients associated with the level of development (Log of GDP per capita) and trade openness are positive and significant at the one-percent level. More precisely, a one percentage increase in per-capita GDP is associated with an increase in the total tax revenue by 0.003 percentage points. Similarly, an increase of one percent in total trade-to-GDP ratio is associated with a rise in DRM of 0.2 percent. Agriculture and natural resources sectors harm tax revenue collection. The coefficients associated with these variables are all negative and statistically significant and are consistent with previous analyses (Stotsky and WoldeMariam, 1997; Sachs and Warner, 2001; Eltony, 2002; Belinga *et al.*, 2017). These results also hold mostly for tax revenue subcomponents (columns [2]-[4]).

For the rest of the analysis (stages 2 and 3), we consider the total non-resource tax revenue as the dependent variable (column [1]). Panel A and Panel B of Table i.1. report the second and third stages. We then deduce the time-varying and persistent tax effort scores and compute the total tax effort (Panel C). The higher is the tax effort score, the closer is the country to the “frontier”. Table i.6. presents the summary of tax effort for columns [2]-[4].

The full sample average stands at 0.817 and 0.698 for time-varying and persistent tax effort, respectively over 1980-2015. The average total tax effort score is equal to 0.572,¹³⁷ suggesting that SSA countries mobilize 57 percent of their tax potential. In other words, given their economic features, SSA countries would raise on average 23.16 percent of GDP of non-resource taxes if they fully used their tax potential, rather than the actual 13.22 percent.¹³⁸ Furthermore, it is worth underscoring that time-varying factors account for only 36 percent of the total tax effort.¹³⁹ Thus, SSA countries would gain significant additional tax revenue by addressing issues related to time-varying factors. In the sample, the minimum tax effort score is 0.057 (Equatorial Guinea in 2011) and the maximum is 0.847 (Burundi in 1998). Note that the tax effort has improved slightly over the period (Figure i.5)—from 0.57 during 1980-1989 to 0.58 during the most recent period. An important result is that the number of countries that have improved their tax effort over time is significantly higher than those for which the tax effort has declined (Figure i.6).

¹³⁷ Recall that the total tax effort is obtained by the product of the time-varying tax effort and the persistent tax effort.

¹³⁸ On average, total non-resource taxes stand at 13.2% in SSA countries over the period. See table A2.

¹³⁹ Since the total tax effort is obtained by a product of the time-varying tax effort and the persistent tax effort components, taking the natural logarithm (Log-linearization) allows us to compute the percentage of each component in the total score.

Table i.1: The three-stage estimation results

Variables	[1]	[2]	[3]	[4]
	NRTAX	Direct	CIT	PIT
Log GDP per cap. (Cst. 2010 USD) ₍₋₁₎	0.265*** (0.0301)	0.407*** (0.0450)	0.331*** (0.0596)	0.410*** (0.0695)
Total trade (%GDP) ₍₋₁₎	0.002*** (0.0004)	0.005*** (0.0006)	0.008*** (0.0010)	0.004*** (0.0011)
Agriculture value added (%GDP) ₍₋₁₎	-0.003** (0.0014)	-0.007*** (0.0021)	0.002 (0.0029)	-0.022*** (0.0033)
Total natural resource rent (%GDP) ₍₋₁₎	-0.002* (0.0014)	-0.002 (0.0020)	-0.001 (0.0029)	-0.008** (0.0035)
Constant	0.579** (0.2299)	-1.832*** (0.3435)	-2.622*** (0.4537)	-2.265*** (0.5285)
Observations	1165	1,165	1,086	1,081
R-squared	0.163	0.240	0.142	0.183
Number of countries	39	39	38	38

Panel A: Stage 2 - estimation of the time-varying tax inefficiency (stochastic frontier)

			Number of obs.	1165	
			Wald chi2(1)	317.84	
Log likelihood = 104.87			Prob > chi2	0.0000	
	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
frontier (one)	0.215	0.012	17.830	0.000	0.191 0.239
usigmas (_cons)	-2.597	0.106	-24.520	0.000	-2.804 -2.389
vsigma (_cons)	-3.759	0.100	-37.690	0.000	-3.954 -3.563

Panel B: Stage 3 - estimation of the persistent tax inefficiency (stochastic frontier)

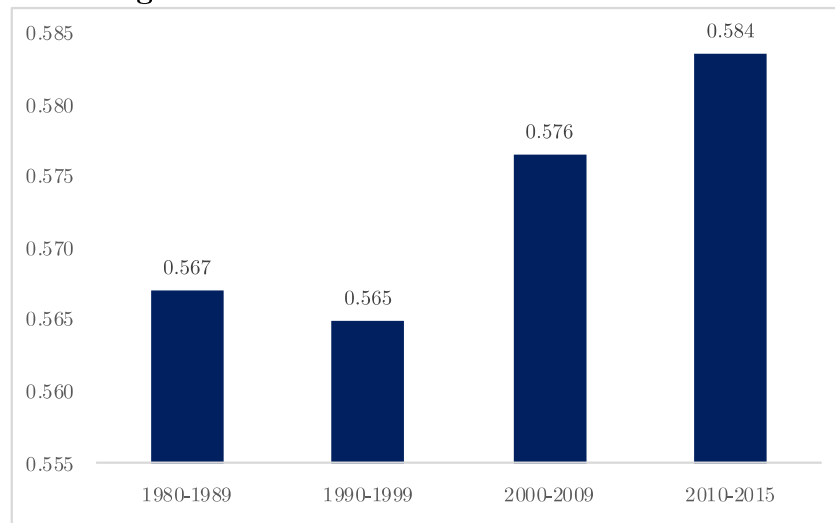
			Number of obs.	1165	
			Wald chi2(1)	1400.00	
Log likelihood = -371.66			Prob > chi2	0.0000	
	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
frontier (one)	0.446	0.012	37.420	0.000	0.423 0.470
usigmas (_cons)	-1.275	0.060	-21.340	0.000	-1.392 -1.158
vsigma (_cons)	-3.790	0.116	-32.630	0.000	-4.018 -3.563

Panel C: Summary of tax effort estimation results

	Obs.	Mean	Std. Dev.	Min	Max
Time-varying tax effort	1165	0.817	0.092	0.318	0.967
Persistent tax effort	1165	0.698	0.167	0.101	0.942
Total tax effort	1165	0.572	0.153	0.057	0.847

Notes: Significance: *** p<0.01, ** p<0.05, * p<0.1; Standard errors in parentheses. NRTAX: Total non-resource tax revenue; Direct: Total income tax revenue; CIT: Corporate income tax revenue; PIT: Personal income tax revenue.

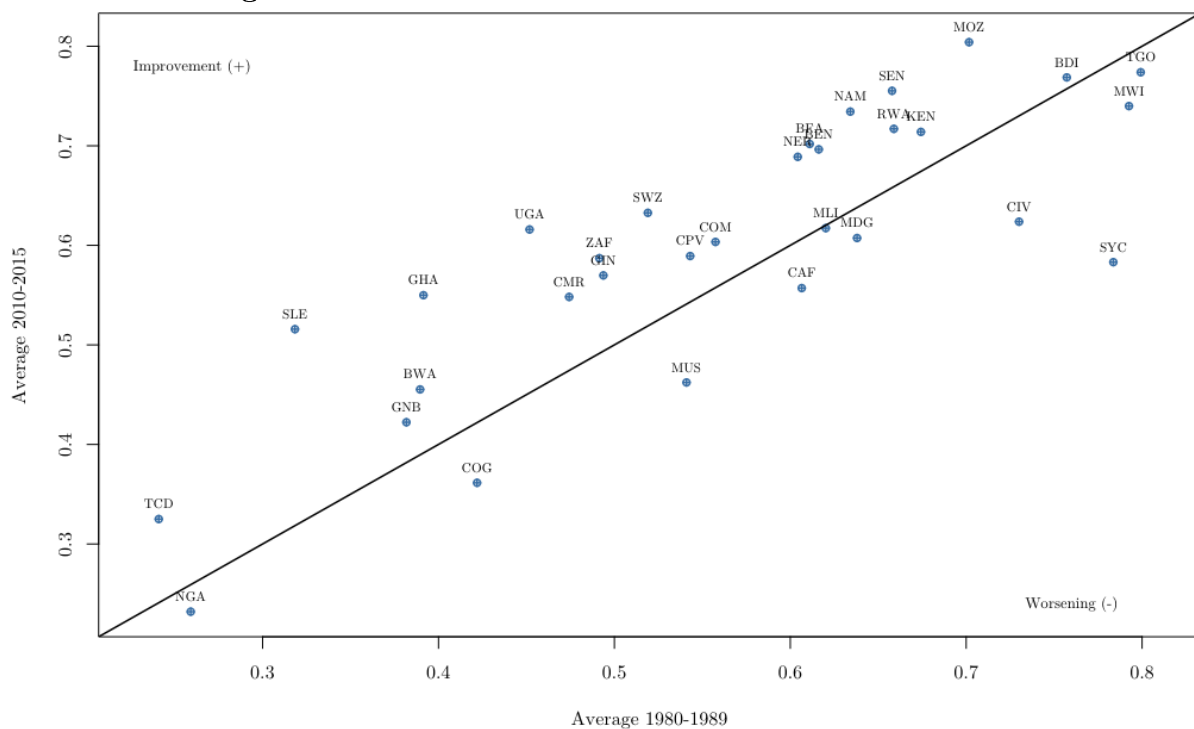
Figure i.5. Evolution of tax effort over time



Sources: Tax revenue Dataset for SSA and authors' own calculations.

Figure i.6. shows the evolution of countries tax effort. Most of SSA countries¹⁴⁰ have improved their tax effort over time, particularly in Uganda, Sierra Leone, and Senegal.

Figure i.6. Evolution of countries tax effort over time



Sources: Tax revenue Dataset for SSA and authors' own calculations.

¹⁴⁰ We display the analysis for 29 countries given the availability of the data for the whole period in particular in 1980.

Table i.2. provides a country ranking over different sub-periods (1980-1989, 1990-1999, 2000-2009, and 2010-2015) based on total tax effort scores. Focusing on the last sub-period (i.e. 2010-2015), it emerges that Mozambique, Togo, Burundi, Senegal, and Gambia are top performers with a tax effort score of 0.804, 0.774, 0.769, and 0.755, and 0.742 respectively, while the five poor performers over the sub-period are Congo Republic (0.361), Chad (0.325), Gabon (0.319), Nigeria (0.232) and Equatorial Guinea (0.071). The non-resource tax to GDP has a decreasing trend in Equatorial Guinea, Congo Republic and Gabon. These countries rely a lot and increasingly on revenue from natural resources. As for Nigeria and Chad, they have generally a non-resource tax below 7 percent of GDP over the period 1980-2015.

The poverty level in Mozambique and Burundi explains paradoxically their performance in terms of tax effort. Table i.1. highlights the crucial role of GDP per capita to determine the tax revenue to GDP ratio. The coefficient of this variable is not only highly significant, but its level is more important. Togo (as Benin) has a substantial transit activity with Nigeria. Given the Nigerian trade policy to foster domestic production especially (for instance, rice and wax fabrics) or for other considerations (such as environmental and security reason for second-hand cars), some goods subject to high tariff rates are imported in Togo and then smuggled to Nigeria. These importations raise revenue in particular in terms of tariffs and VAT (even if these goods are not consumed in Togo).

Natural resource endowment, especially oil, reduces significantly the computed tax effort (see Panel A of Figure i.7.). The worst performers are resource-rich SSA countries (Nigeria, Equatorial Guinea) given the crowding out effect (Bornhorst *et al.*, 2009, Crivelli and Gupta, 2014, James, 2015) or the inter-ministerial tax competition weakening the institution in charge of tax policy (Caldeira *et al.*, 2020).

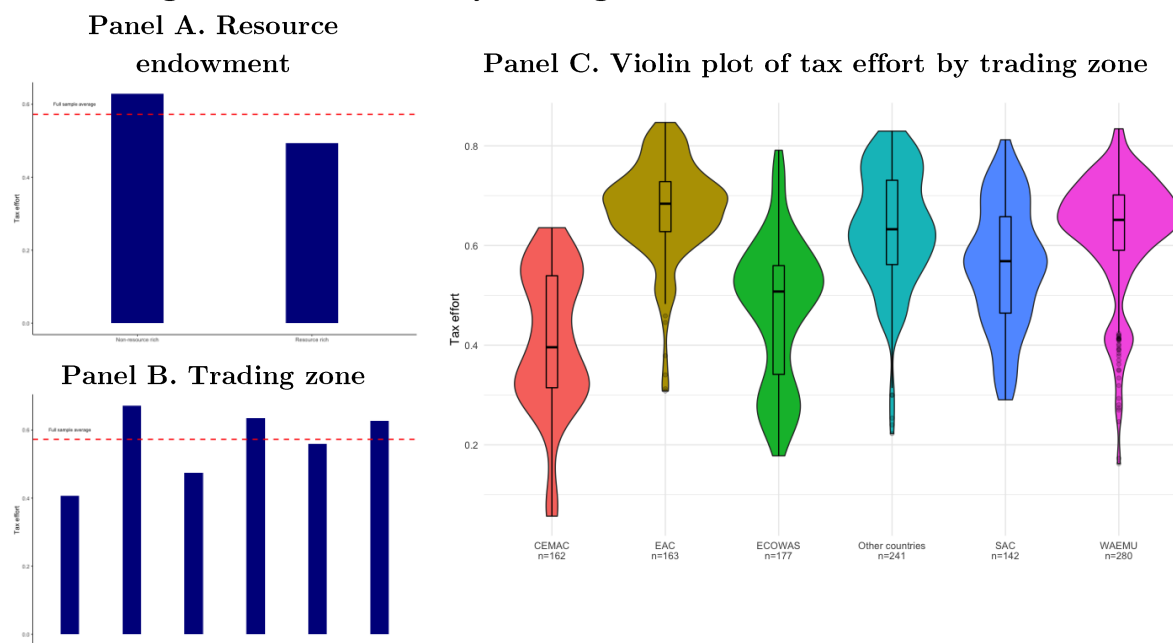
Table i.2: Full sample tax effort-based ranking (baseline specification)

Country	1980-1989		1990-1999		2000-2009		2010-2015		
	TE	Rank	TE	Rank	TE	Rank	TE	Rank	Average tax ratio
Angola	-	-	0.265	34	0.279	36	-	-	8.20
Benin	0.616	14	0.627	12	0.691	8	0.696	12	14.67
Botswana	0.390	28	0.361	30	0.411	30	0.455	31	20.96
Burkina Faso	0.611	15	0.660	10	0.689	9	0.702	11	13.15
Burundi	0.757	5	0.806	1	0.792	1	0.769	3	13.40
Cabo Verde	0.543	19	0.605	16	0.619	19	0.589	22	18.71
Cameroon	0.474	24	0.482	25	0.532	26	0.548	28	12.74
Central African Republic	0.607	16	0.560	21	0.569	23	0.557	26	7.79
Chad	0.241	32	0.312	31	0.314	32	0.325	34	5.99
Comoros	0.557	18	0.605	15	0.593	21	0.603	21	11.47
Congo, Dem. Rep.	-	-	-	-	-	-	-	-	9.14
Congo, Rep.	0.422	26	0.375	29	0.307	34	0.361	33	10.87
Cote d'Ivoire	0.730	6	0.682	9	0.645	13	0.624	15	14.02
Equatorial Guinea	-	-	-	-	0.082	37	0.071	37	2.79
Ethiopia	-	-	-	-	-	-	0.724	8	12.01
Gabon	-	-	-	-	0.310	33	0.319	35	11.58
Gambia, The	-	-	-	-	0.735	3	0.742	5	14.93
Ghana	0.391	27	0.480	26	0.534	25	0.550	27	14.82
Guinea	0.494	22	0.422	28	0.521	27	0.570	25	13.38
Guinea-Bissau	0.382	29	0.303	32	0.380	31	0.422	32	8.15
Kenya	0.674	8	0.704	6	0.702	7	0.714	10	15.61
Lesotho	0.808	1	-	-	-	-	-	-	40.97
Madagascar	0.638	11	0.574	19	0.626	18	0.607	19	9.80
Malawi	0.793	3	0.752	3	0.686	10	0.740	6	14.02
Mali	0.620	13	0.585	17	0.634	17	0.617	17	10.85
Mauritius	0.541	20	0.492	24	0.461	29	0.462	30	18.28
Mozambique	0.702	7	0.685	8	0.663	12	0.804	1	19.95
Namibia	0.634	12	0.717	5	0.708	5	0.734	7	31.13
Niger	0.604	17	0.546	22	0.640	14	0.689	13	12.59
Nigeria	0.259	31	0.269	33	0.298	35	0.232	36	4.87
Rwanda	0.659	9	0.623	14	0.703	6	0.717	9	13.70
Sao Tome and Principe	-	-	-	-	-	-	-	-	15.40
Senegal	0.658	10	0.689	7	0.739	2	0.755	4	19.04
Seychelles	0.784	4	0.767	2	0.635	16	0.583	24	30.93
Sierra Leone	0.318	30	0.448	27	0.517	28	0.516	29	9.33
South Africa	0.491	23	0.573	20	0.585	22	0.587	23	22.83
Swaziland	0.519	21	0.542	23	0.606	20	0.633	14	25.53
Tanzania	-	-	0.649	11	0.558	24	0.605	20	10.82
Togo	0.799	2	0.625	13	0.729	4	0.774	2	15.90
Uganda	0.452	25	0.578	18	0.638	15	0.616	18	11.28
Zambia	-	-	0.719	4	0.671	11	0.623	16	14.58

Sources: Tax revenue Dataset for SSA and authors' own calculations.

As an illustration of the potentiality of the devoted website, we explore also the tax effort behavior across African trading zone, on average (Panel B of Figure i.7) and looking at the heterogeneity across trade unions (Panel C of Figure i.7). We find that Eastern African Community (EAC) is the top performing bloc while Central African States Community (rich in oil) is the poorest performer.

Figure i.7. Tax effort by trading zone and resource endowment



Sources: Tax revenue Dataset for SSA and authors' own calculations.

For robustness purpose, specifically to deal with the omitted variables bias, we control successively for financial development and development aid and assistance. The three-stage estimation results are respectively reported in Table i.7. and Table i.9. For each variable, the summary of tax effort for tax subcomponents – columns [2]-[4] – is reported in Table i.8. and Table i.10., respectively.

Focusing on non-resource tax, the average total effort does not change when controlling for financial development: the average tax effort remains 0.572. The top performers in the sub-period 2010-2015 remain Mozambique, Togo, Senegal¹⁴¹, Burundi, and The Gambia. The average tax effort score for subcomponents are slightly higher (+0.01) than those from the baseline results.

Controlling for revenue coming from development aid and assistance results in a slight change in the average tax effort: the average tax effort varies from 0.572 to 0.570. The top performers over the sub-period 2010-2015 are Mozambique, Burundi, Togo, Senegal, and Namibia¹⁴². The average effort to collect direct tax increases driven by an

¹⁴¹ Note that Senegal comes one place higher.

¹⁴² Namibia replaces The Gambia as the fifth in ranking.

increase in effort to collect personal income tax and a decrease in effort to collect corporate income tax.

To test the sensibility of our results to the change of production technology between the non-resource tax and its determinants, we use the log-log functional form. The average tax effort varies from 0.572 to 0.571 for the baseline estimation (c.f. Table i.1. and Table i.11). The average tax efforts are 0.581 and 0.566 when using the log-log specification and controlling for financial development and official assistance and aid respectively (see Table i.11).

To further test the robustness of our results, we compute tax effort using some second general stochastic frontier models¹⁴³. We first estimate tax effort using the model of Battese and Coelli (1992). The average tax effort is 0.573 for when using the same variables as in the baseline.

The average tax effort is 0.626 and 0.576 when controlling respectively for financial development and development assistance and aid. Using the model of Kumbhakar (1990), the average tax effort is respectively 0.493, 0.626 and 0.587 respectively for the baseline, with financial development and with official assistance and aid.

i.6. Replication

Our analysis participates explicitly to the replication effort, which ensures the reliability of produced works. Over recent years, there has been a growing interest in replication particularly in economic research.¹⁴⁴ Following Hamermesch (2007) and Clemens (2017) approach, we undertake a replication of the papers of Gupta (2007) and Fenechietto and Pessino (2013). This replication approach consists in three stages: verification, reproduction, and robustness. Verification means the use of the same sample, population, and empirical specification,¹⁴⁵ while reproduction uses the same econometric model on different samples from the same population.¹⁴⁶ Robustness¹⁴⁷

¹⁴³ Second generation models have their limitation in measuring inefficiency, hence our choice of Generalized True Random Effects model. While they allow for time varying inefficiency, hence improvement over time, the intercept is the same across all countries. Unfortunately, in the presence of time-invariant unobservable factors, they are subject to misspecification bias. Moreover, they are not fitted to deal with heterogeneity between countries. For more discussion, see Wang (2002), Green (2005), and Belotti and Ilardi (2018).

¹⁴⁴ For instance, the top five Reviews in Economics, for a paper to be accepted and published, request the inputs including dataset and program of the paper for replication purpose (Sukhtankar, 2017) and the American Economic Review particularly has dedicated a whole volume to replication. In addition, Anderson and Kichkha (2017)], after a discussion of the three main methods of research synthesis (i.e. traditional literature surveys, meta-analysis and replication), *argue that only pure replication does not contain substantial judgement*.

¹⁴⁵ Hamermesch (2007) calls this procedure pure reproduction.

¹⁴⁶ For Hamermesch (2007), this is called a statistical replication.

¹⁴⁷ Called Scientific replications by Hamermesch (2007).

consists either in running the same specification on different samples and populations, either in applying different econometric specifications on the same sample and population. In our replication exercise,¹⁴⁸ we estimate the same specification for the same sample (same countries and period) as in the original paper for the verification. The reproduction consists in running the same specification on the same sample of countries but including all the available observations for the variables used in the author(s)'s specification(s). Finally, for the robustness, we expand the sample and the time period by using all the countries and years on which data are available to test the author(s)'s specification(s). It is worth mentioning that some differences with respect to the original paper on variables characteristics (i.e. mean, standard deviation, minimum and maximum) emerge even though the sources are the same. This could be due to changes and adjustments in dataset over time. These differences could be also related to some minor treatments by the authors during the dataset compilation, which are not reported in the paper. Furthermore, in the case we do not find a variable from the same source as the author, we take one from another source, if applicable. Otherwise, if the variable is not used in the baseline specification, we do not run the regression for that given specification.

i.6.1. Replication of Gupta (2007)

The author estimates countries' revenue potential for a panel of 105 developing countries for the period 1980-2004 using central government revenue dataset. The estimates explained the ratio of central government revenue (excluding grants) to GDP as a function of a set of structural variables (i.e. the log of per capita GDP, the share of agriculture in GDP, the ratio of imports to GDP, share of aid and debt in GDP) and institutional and policy variables (corruption, law and order, government stability, political stability and economic stability). An important limit of this paper is the inclusion of natural resources revenue into tax revenue. Gupta (2007) uses various methods of panel data estimation including Fixed Effect (FE), Random Effects (RE), Common Correlation Coefficient (CCC), Panel Specific Correlation (PSC), and Dynamic Panel Specification (DPS). The results show that the per capita GDP, trade openness, and the share of agriculture in GDP are statistically significant and strong determinants of countries revenue performance. In addition, certain forms of foreign aid improve revenue performance while external debt does not. Regarding politico-institutional factors, the author found that political and economic stability affect positively revenue performance, and corruption significantly and negatively affects

¹⁴⁸ Our replication process is applied based on the following conditions: First, the paper must be an empirical investigation of countries' tax effort (i.e. employing econometric specification) with an actual computation of tax effort. Second, it must be an international comparison of tax effort among countries. In addition, we choose not to replicate number of seminal papers on tax effort prior to the 1990s such as Bahl, (1971, 1972), Chelliah (1971), Chelliah, Baas, and Kelly (1975), Leuthold (1991), Lotz and Morss (1970), Tait, Grätz, and Eichengreen (1979).

revenue performance. The author also emphasizes that countries' tax revenue performance depends on their tax structure. More precisely, countries that depend on indirect taxation as their main source of tax revenue, tend to perform less than countries raising more from direct taxation.

We replicate the key specifications despite a few issues with some variables (economic stability, political stability, and average tariff). The verification test failed to replicate the exact results as in the paper in terms of coefficient and significance of the variables. We have more significant variables than in the original paper (see Table i.12 and Table i.13).¹⁴⁹ Moreover, the robustness exercise yields smaller coefficients for all the variables than in the paper, suggesting a smaller effect when non-resources tax is used instead of central government revenue, and when the sample is expanded to all available countries and years (c.f. Table i.14. and Table i.15.).

i.6.2. Replication of Fenochietto and Pessino (2013)

Fenochietto and Pessino (2013) estimated countries tax capacity and tax effort using Stochastic Frontier Analysis for 113 countries. They first estimated the tax capacity for 96 non-natural resources dependent countries and then on the whole sample using tax and pension contributions revenue collected by central and sub national governments as percent of GDP from the IMF WEO. The authors considered a set of structural and institutional variables (level of development, inflation, education, trade, income inequality, corruption, and the ease of tax collection) explaining countries' tax capacity and estimated tax effort using Battese and Coelli (1992) Half Normal (HN) and Truncated Normal (TN) models incorporating heterogeneity. They also relied on Mundlak (1978) Random Effects Model (REM) to deal with the 'unobserved' heterogeneity.

The verification test for this paper produced almost the same results: the sign and the magnitude are close. As in the paper, the coefficients for non-resource countries are slightly lower than those for all countries (First two columns of Table i.16. and Table i.17.).

For the robustness analysis, in addition to broadening the sample to all available countries and year while replacing the dependent variable with the ICTD non-resource tax, we also estimate the parameters of Stochastic Frontier (SF) tax function for ICTD non-resource tax while limiting the analysis to the non-resource dependent countries defined in the paper. The robustness results show stable coefficients for all the

¹⁴⁹ Although we replicated all the forms of panel data estimations, we present the results for the common correlation coefficient and the panel specific correlation estimations. The reason is that the author expressed his preference for these results in the paper (see Gupta, 2007 p.26).

variables. Nevertheless, the logarithm of the GDP per capita and the logarithm of the GDP per capita square do not have the expected sign or are not significant. We went further in robustness analysis, by relaxing the non-linear relationship assumption between tax revenue and GDP per capita. Thus, we dropped the logarithm of the GDP per capita squared from the specification. Results in last two columns of Table i.16. and Table i.17. show that once we relax the nonlinear relationship assumption, all the variables get the expected sign.

i.7. Conclusion

This analysis offers a new dataset of tax revenue, which updates and completes the dataset published in Mansour (2014). We collect statistical information from the African Department of the International Monetary Fund (IMF), most of which is publicly available. We cover 42 SSA countries over the period 1980-2015 distinguishing resource revenue from non-resource (tax) revenue. This work participates to recent efforts to better apprehend tax revenues in Sub-Saharan Africa, in particular the revenue statistics in Africa from the OECD, which cover 26 countries in its last release and the Government Revenue Dataset initiated by the International Centre for Tax and Development (ICTD) and updated by UNU-WIDER.

We provide an estimate of tax effort adopting the Stochastic Frontier Analysis approach. First, we confirm the impact of previously studied factors on countries' DRM capacity such as level of development, financial development, trade openness, natural resource rent, and the size of the agriculture sector. The two latter factors have a negative effect on the domestic revenue mobilization capacity. We estimate on average the total tax effort to be 0.58. Given that non-resource tax revenue amounts to 13.2 percent of GDP, potential tax revenue would be on average 22.75 percent of GDP. Mozambique, Burundi, Togo, Senegal, and Gambia are top performers with a tax effort score above 0.75, while the five lowest performers are resource-rich countries such as Congo Republic (0.366), Chad (0.333), Gabon (0.327), Nigeria (0.243) and Equatorial Guinea (0.073). The poverty level in Mozambique and Burundi explains paradoxically their performance in terms of tax effort. Finally, we did some replication analyses of previous works on tax effort, in particular Gupta (2007) and Fenechietto and Pessino (2013). We fail to replicate the results of Gupta (2007) in terms of robust coefficients and significance of the variables. Some explanatory variables are missing. However, we confirm broadly the analysis of Fenechietto and Pessino (2013).

We acknowledge that our results in terms of tax effort are subject to some caveats. First, additional explanatory variables, in particular regarding political regimes, may be taken into account in the estimation, which could then modify the ranking of countries. Secondly, empirical tools evolve regularly especially the SFA methodology.

Third, the estimate of GDP in Africa is particularly weak and heterogeneous across countries. SSA countries regularly update their base year necessary to the computation of GDP with significant changes.¹⁵⁰ That is the reasons why we build a devoted website under R-Shiny linked to this paper. This website allows the reader not only to download our dataset, but also to replicate our empirical analysis and run their own regressions with additional variables.

¹⁵⁰ For instance, Ghana revised upward its total GDP by more than 60% in November 2010.

i.8. References

- Aigner, Dennis, CA Knox Lovell, and Peter Schmidt (1977). “Formulation and Estimation of Stochastic Frontier Production Function Models.” *Journal of Econometrics* 6 (1): 21–37.
- Alfirman, Luky. (2003). “Estimating Stochastic Frontier Tax Potential: Can Indonesian Local Governments Increase Tax Revenues under Decentralization?” Center for Economic Analysis, Department of Economics, University of Colorado.
- Anderson, Richard G. and Areerat Kichkha (2017). “Replication, Meta-Analysis, and Research Synthesis in Economics.” *American Economic Review* 107 (5): 56–59.
- Bahl, Roy W. (1971). “A Regression Approach to Tax Effort and Tax Ratio Analysis.” *Staff Papers* 18 (3): 570–612.
- . (1972). “A Representative Tax System Approach to Measuring Tax Effort in Developing Countries.” *Staff Papers* 19 (1): 87–124.
- Baicker, Katherine and Jonathan Skinner. (2011). “Health Care Spending Growth and the Future of US Tax Rates.” *Tax Policy and the Economy* 25 (1): 39–68.
- Battese, George E. and Tim J Coelli. (1988). “Prediction of Firm-Level Technical Efficiencies with a Generalized Frontier Production Function and Panel Data.” *Journal of Econometrics* 38 (3): 387–99.
- . (1992). “Frontier Production Functions, Technical Efficiency and Panel Data: With Application to Paddy Farmers in India.” *Journal of Productivity Analysis* 3 (1): 153–69.
- Beling, Vincent, Maximillien Kaffo Melou, and Jean-Pascal Nganou. (2017). “Does Oil Revenue Crowd Out Other Tax Revenues? Policy Lessons for Uganda.” The World Bank.
- Bellotti, Federico and Giuseppe Ilardi (2018). “Consistent inference in fixed-effects stochastic frontier models”. In: *Journal of Econometrics* 202 (2): 161–177.
- Besley, Timothy and Torsten Persson. (2014). “Why Do Developing Countries Tax so Little?” *Journal of Economic Perspectives* 28 (4): 99–120.
- Bornhorst, Fabian, Sanjeev. Gupta, and John Thornton. (2009). “Natural Resource Endowments and the Domestic Revenue Effort,” *European Journal of Political Economy*, 25(4): 439-446.

- Brun, Jean-François and Maimouna Diakite. (2016). “Tax Potential and Tax Effort: An Empirical Estimation for Non-Resource Tax Revenue and VAT’s Revenue.” *Études et Documents 2016/10*, CERDI, France.
- Butler, John S. and Robert Moffitt. (1982). “A Computationally Efficient Quadrature Procedure for the One-Factor Multinomial Probit Model.” *Econometrica: Journal of the Econometric Society*, 761–764.
- Caldeira, Emilie and Grégoire Rota-Graziosi, (2019), “Tax effort in Benin: How can tax gaps be reduced?” with Emilie Caldeira, in F. Bourgignon, R. Houssa, J.-P. Platteau and P. Reding, (eds) *Benin Institutional Diagnostic*, Economic Development & Institutions, Chapter 6.
- Caldeira, Emilie, Ali Compaore, Alou A. Dama, and Grégoire Rota-Graziosi, (2020), “Inter-ministerial Tax Competition: The Case of Resource-Rich Developing Countries,” Working Paper, CERDI, forthcoming.
- Charnes, Abraham, William Cooper, Arie Y Lewin, and Lawrence M. Seiford. (1997). “Data Envelopment Analysis Theory, Methodology and Applications.” *Journal of the Operational Research Society* 48(3):332–333.
- Chelliah, Raja J. (1971). “Trends in Taxation in Developing Countries.” *Staff Papers* 18 (2): 254–331.
- Chelliah, Raja J., Hessel J. Baas, and Margaret R. Kelly. (1975). “Tax Ratios and Tax Effort in Developing Countries, 1969-71.” *Staff Papers* 22 (1): 187–205.
- Clemens, Michael A. (2017). “The Meaning of Failed Replications: A Review and Proposal.” *Journal of Economic Surveys* 31 (1): 326–342.
- Clist, Paul and Oliver Morrissey. (2011). “Aid and Tax Revenue: Signs of a Positive Effect since the 1980s.” *Journal of International Development* 23 (2): 165–180.
- Colombi, Roberto, Subal C. Kumbhakar, Gianmaria Martini, and Giorgio Vittadini. (2014). “Closed-Skew Normality in Stochastic Frontiers with Individual Effects and Long/Short-Run Efficiency.” *Journal of Productivity Analysis* 42 (2): 123–136.
- Cornwell, Christopher, Peter Schmidt, and Robin C Sickles. (1990). “Production Frontiers with Cross-Sectional and Time-Series Variation in Efficiency Levels.” *Journal of Econometrics* 46 (1–2): 185–200.
- Crivelli, Ernesto and Sanjeev Gupta. (2014). “Resource Blessing, Revenue Curse? Domestic Revenue Effort in Resource-Rich Countries.” *European Journal of*

Political Economy 35: 88–101.

- Cyan, Musharraf, Jorge Martinez-Vazquez, and Violeta Vulovic. (2013). “Measuring Tax Effort: Does the Estimation Approach Matter and Should Effort Be Linked to Expenditure Goals?” International Center for Public Policy Working Paper 13-08, Andrew Young School of Policy Studies, Georgia State University.
- Deprins, Dominique, Leopold Simar, and Henry Tulkens. (1984). “Measuring Labor-Efficiency in Post Offices.”, in *The Performance of Public Enterprises: Concepts and Measurement*, Amsterdam, 1984, 243-267.
- Eltony, Nagy. (2001). “The Determinants of Tax Effort in Arab Countries.” API-Working Paper Series 0207, Arab Planning Institute - Kuwait, Information Center.
- Feger, Thuto and John Asafu-Adjaye. (2014). “Tax Effort Performance in Sub-Sahara Africa and the Role of Colonialism.” *Economic Modelling* 38: 163–174.
- Fenochietto, Ricardo and Carola Pessino. (2013). “Understanding Countries’ Tax Effort.” 13–244. International Monetary Fund.
- Filippini, Massimo, and William Greene. (2016). “Persistent and Transient Productive Inefficiency: A Maximum Simulated Likelihood Approach.” *Journal of Productivity Analysis* 45 (2): 187–196.
- Gordon, Roger and Wei Li. (2009). “Tax Structures in Developing Countries: Many Puzzles and a Possible Explanation.” *Journal of public economics* 93 (7–8): 855–866.
- Greene, William. (2005). “Reconsidering Heterogeneity in Panel Data Estimators of the Stochastic Frontier Model.” *Journal of Econometrics* 126 (2): 269–303.
- Grigorian, David A. and Hamid R. Davoodi. (2007). “Tax Potential vs. Tax Effort: A Cross-Country Analysis of Armenia’s Stubbornly Low Tax Collection.” 7–106. International Monetary Fund.
- Gupta, Abhijit Sen. (2007). “Determinants of Tax Revenue Efforts in Developing Countries.” 7–184. International Monetary Fund.
- Hamermesh, Daniel S. (2007). “Replication in Economics.” *Canadian Journal of Economics/Revue Canadienne d’économique* 40 (3): 715–733.
- Hjalmarsson, Lennart, Subal C.Kumbhakar, and Almas Heshmati. (1996). “DEA, DFA and SFA: A Comparison.” *Journal of Productivity Analysis* 7 (2–3): 303–327.

- Kumbhakar, Subal C. (1990). “Production Frontiers, Panel Data, and Time-Varying Technical Inefficiency.” *Journal of Econometrics* 46 (1–2): 201–211.
- Kumbhakar, Subal C. and Almas Heshmati. (1995). “Efficiency Measurement in Swedish Dairy Farms: An Application of Rotating Panel Data, 1976–88.” *American Journal of Agricultural Economics* 77 (3): 660–674.
- Kumbhakar, Subal C., Gudbrand Lien, and J. Brian Hardaker. (2014). “Technical Efficiency in Competing Panel Data Models: A Study of Norwegian Grain Farming.” *Journal of Productivity Analysis* 41 (2): 321–337.
- Kumbhakar, Subal C. and Hung-Jen Wang. (2005). “Estimation of Growth Convergence Using a Stochastic Production Frontier Approach.” *Economics Letters* 88 (3): 300–305.
- Kumbhakar, Subal C., Hung-Jen Wang, and Alan P. Horncastle. (2015). “A Practitioner’s Guide to Stochastic Frontier Analysis Using Stata.” Cambridge University Press.
- Langford, Ben and Tim Ohlenburg. (2015). “Tax Revenue Potential and Effort.” International Growth Centre Working Paper. 2015.
- Leuthold, Jane H. (1991). “Tax Shares in Developing Economies a Panel Study.” *Journal of Development Economics* 35 (1): 173–185.
- Lotz, Joergen R. and Elliott R. Morss. (1967). “Measuring ‘Tax Effort’ in Developing Countries.” *Staff Papers* 14 (3): 478–499.
- . (1970). “A Theory of Tax Level Determinants for Developing Countries.” *Economic Development and Cultural Change* 18 (3): 328–341.
- Mansour, Mario. (2014). “A Tax Revenue Dataset for Sub-Saharan Africa: 1980-2010.” *Revue D’Économie Du Développement, Forthcoming*.
- McGuirk, Eoin, (2013), “The illusory Leader: Natural Resources, Taxation, and Accountability,” *Public Choice*, 154, 285-313.
- Meeusen, Wim and Julien van Den Broeck. (1977). “Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error.” *International Economic Review*, 435–444.
- Morrissey, Oliver. (2015). Aid and Government Fiscal Behavior: Assessing Recent Evidence. *World Development* 69, 98–105.

- Mundlak, Yair. (1978). “On the Pooling of Time Series and Cross Section Data.” *Econometrica: Journal of the Econometric Society*, 69–85.
- Odeck, James. (2007). “Measuring Technical Efficiency and Productivity Growth: A Comparison of SFA and DEA on Norwegian Grain Production Data.” *Applied Economics* 39 (20): 2617–2630.
- Pessino, Carola and Ricardo Fenochietto. (2010). “Determining Countries’ Tax Effort.” *Hacienda Pública Española/Revista de Economía Pública*, 65–87.
- Pitt, Mark M. and Lung-Fei Lee. (1981). “The Measurement and Sources of Technical Inefficiency in the Indonesian Weaving Industry.” *Journal of Development Economics* 9 (1): 43–64.
- Sachs, Jeffrey D. and Andrew M. Warner. (2001). “The Curse of Natural Resources.” *European Economic Review* 45 (4–6): 827–838.
- Schmidt, Peter and Robin C Sickles. (1984). “Production Frontiers and Panel Data.” *Journal of Business & Economic Statistics* 2 (4): 367–374.
- Stotsky, Janet Gale and Asegedech WoldeMariam. (1997). “Tax Effort in Sub-Saharan Africa.” 97–107. International Monetary Fund.
- Sukhtankar, Sandip. (2017). “Replications in Development Economics.” *American Economic Review* 107 (5): 32–36.
- Svirydzenka, Katsiaryna. (2016). “Introducing a New Broad-based Index of Financial Development.” IMF Working Paper, WP/16/05.
- Tait, Alan A., Wilfrid L.M Grätz, and Barry J. Eichengreen. (1979). “International Comparisons of Taxation for Selected Developing Countries, 1972-76.” *Staff Papers* 26 (1): 123–156.
- Tanzi, Vito. 1992. “Structural Factors and Tax Revenue in Developing Countries: A Decade of Evidence,” In *Open economies: Structural Adjustment and Agriculture*, Ian Goldin, and L. Alan Winters (Eds.), Cambridge: Cambridge University Press, 267-281.
- Tanzi, Vito and Hamid R. Davoodi. (1998). “Corruption, Public Investment, and Growth.” In *The Welfare State, Public Investment, and Growth*, 41–60. Springer.
- Tsionas, Efthymios G. and Subal C. Kumbhakar. (2014). “Firm Heterogeneity, Persistent and Transient Technical Inefficiency: A Generalized True Random-

Effects Model.” *Journal of Applied Econometrics* 29 (1): 110–132.

Yohou, Hermann Djedje and Michaël Goujon. (2017). “Reassessing Tax Effort in Developing Countries: A Proposal of a Vulnerability-Adjusted Tax Effort Index (VATEI).” Working Papers P186, FERDI.

Wang, Hung-Jen (2002). “Heteroscedasticity and non-monotonic efficiency effects of a stochastic frontier model”. In: *Journal of Productivity Analysis* 18(3): 241–253.

Wang, Hung-Jen and Chia-Wen Ho. (2010). “Estimating Fixed-Effect Panel Stochastic Frontier Models by Model Transformation.” *Journal of Econometrics* 157 (2): 286–296.

i.9. Appendix

i.9.1. Appendix: Data, descriptive statistics, and robustness

Table i.3: Country list

Angola, Benin, Botswana, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo, Dem. Rep., Congo, Rep., Côte d'Ivoire, Equatorial Guinea, Ethiopia, Gabon, Gambia, The, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Swaziland, São Tomé and Príncipe, Tanzania, Togo, Uganda, Zambia, Zimbabwe

Table i.4: Data sources and definition

Variables	Definition	Sources
Total non-resource tax (% GDP)	Total tax revenues excluding resource rent	Tax revenue dataset, Mansour (2019)
Corporate income tax (% GDP)	Tax imposed on corporate income in countries that have a corporate tax	
Total direct taxes (% GDP)	Taxes on all income sources (i.e. business profits, wages, portfolio income, income from real property, capital gains, etc.)	
Personal income taxes (% GDP)	Taxes on individual income	
Total resource rent (% GDP)	Sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents over GDP.	World Development Indicators, World Bank
GDP PC (constant 2010 US \$)	Sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products	
Total Trade (% GDP)	Volume of imports and exports over GDP	
Agriculture, value added (% GDP)	Net output of forestry, hunting, and fishing, as well as cultivation of crops and livestock production after adding up all outputs and subtracting intermediate inputs, divided by GDP	
Gini index	Index measuring the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution	
Net official development assistance and official aid received (% GDP)	Net official development assistance is disbursement flows (net of repayment of principal). Net official aid refers to aid flows (net of repayments).	
Financial development index	Aggregate of nine indices that summarize how developed financial institutions and financial markets are in terms of their depth, access, and efficiency.	

Table i.5: Descriptive statistics

Variables	Obs.	Mean	Std. Dev.	Min	Max
Total Taxes	1473	16.19	8.97	0.57	53.33
Total non-resource taxes (% GDP)	1473	13.22	7.09	0.55	50.81
Total income taxes	1473	3.89	2.74	0.18	18.69
Corporate Income Tax	1373	1.64	1.24	0.00	9.06
Personal Income Tax	1368	1.84	1.79	0.00	13.33
GDP per capita (constant 2010 US\$)	1474	1892.50	2780.36	131.65	20333.94
Total trade (% of GDP)	1323	71.3	36.48	6.32	265.98
Agriculture, value added (% of GDP)	1345	27.42	15.70	0.89	72.03
Total natural resources rents (% of GDP)	1431	11.61	11.92	0.00	89.17
Financial development (% of GDP)	1435	0.11	0.08	0.00	0.64
Net official development assistance and official aid received (% of GDP)	1448	10.79	10.49	-0.25	94.44

Table i.6: Summary of tax effort estimation results - Baseline estimation [2]-[4]

Dependent	Tax effort components	Obs.	Mean	SD	Min	Max
Direct	Time-varying tax effort	1165	0.756	0.109	0.223	0.936
	Persistent tax effort	1165	0.620	0.157	0.064	0.866
	Total tax effort	1165	0.470	0.139	0.031	0.755
CIT	Time-varying tax effort	1086	0.701	0.114	0.092	0.919
	Persistent tax effort	1086	0.443	0.221	0.045	1.000
	Total tax effort	1086	0.311	0.165	0.019	0.834
PIT	Time-varying tax effort	1081	0.648	0.148	0.031	0.940
	Persistent tax effort	1081	0.539	0.182	0.035	0.834
	Total tax effort	1081	0.350	0.142	0.006	0.676

Table i.7: The three-stage estimation results controlling for financial development

Variables	[1] NRTAX	[2] Direct	[3] CIT	[4] PIT
Log GDP per cap. (Cst. 2010 USD) ₍₋₁₎	0.228*** (0.0309)	0.337*** (0.0459)	0.288*** (0.0617)	0.339*** (0.0716)
Total trade (%GDP) ₍₋₁₎	0.001*** (0.0004)	0.004*** (0.0006)	0.008*** (0.0010)	0.004*** (0.0011)
Agriculture value added (%GDP) ₍₋₁₎	-0.003** (0.0014)	-0.007*** (0.0021)	0.002 (0.0029)	-0.021*** (0.0033)
Total natural resource rent (%GDP) ₍₋₁₎	-0.001 (0.0014)	-0.000 (0.0021)	-0.000 (0.0029)	-0.007* (0.0035)
Financial development ₍₋₁₎	0.776*** (0.1821)	1.259*** (0.2718)	0.666 (0.4225)	1.070** (0.4803)
Constant	0.739*** (0.2303)	-1.500*** (0.3418)	-2.411*** (0.4534)	-1.912*** (0.5273)
Observations	1165	1165	1,086	1,081
R-squared	0.170	0.245	0.140	0.181
Number of countries	39	39	38	38

Panel A: Stage 2 - estimation of the time-varying tax inefficiency (stochastic frontier)

				Number of obs.	1165
				Wald chi2(1)	318.74
Log likelihood = 111.52				Prob > chi2	0.0000
	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
frontier (one)	0.214	0.012	17.850	0.000	0.191 0.238
usigmas (_cons)	-2.605	0.106	-24.640	0.000	-2.813 -2.398
vsigma (_cons)	-3.773	0.100	-37.740	0.000	-3.969 -3.577

Panel B: Stage 3 - estimation of the persistent tax inefficiency (stochastic frontier)

				Number of obs.	1165
				Wald chi2(1)	1568.67
Log likelihood = -339.46				Prob > chi2	0.0000
	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
frontier (one)	0.445	0.011	39.610	0.000	0.423 0.467
usigmas (_cons)	-1.278	0.058	-22.180	0.000	-1.391 -1.165
vsigma (_cons)	-4.016	0.125	-32.070	0.000	-4.261 -3.770

Panel C: Summary of tax effort estimation results

	Obs.	Mean	Std. Dev.	Min	Max
Time-varying tax effort	1165	0.818	0.091	0.322	0.968
Persistent tax effort	1165	0.698	0.171	0.108	0.946
Total tax effort	1165	0.572	0.156	0.061	0.848

Notes: Significance: *** p<0.01, ** p<0.05, * p<0.1; Standard errors in parentheses. NRTAX: Total non-resource tax revenue; Direct: Total income tax revenue; CIT: Corporate income tax revenue; PIT: Personal income tax revenue.

Table i.8: Summary of tax effort estimation results – Robustness controlling for financial development [2]-[4]

Dependent	Tax effort components	Obs.	Mean	SD	Min	Max
Direct	Time-varying tax effort	1165	0.757	0.108	0.209	0.941
	Persistent tax effort	1165	0.637	0.152	0.080	0.874
	Total tax effort	1165	0.483	0.136	0.038	0.766
CIT	Time-varying tax effort	1086	0.700	0.115	0.088	0.919
	Persistent tax effort	1086	0.456	0.217	0.054	1.000
	Total tax effort	1086	0.320	0.164	0.019	0.840
PIT	Time-varying tax effort	1081	0.646	0.149	0.030	0.941
	Persistent tax effort	1081	0.555	0.177	0.045	0.838
	Total tax effort	1081	0.360	0.141	0.006	0.676

Table i.9: The three-stage estimation results controlling for official development assistance and aid

Variables	[1]	[2]	[3]	[4]
	NRTAX	Direct	CIT	PIT
Log GDP per cap. (Cst. 2010 USD) ⁽⁻¹⁾	0.253*** (0.0325)	0.367*** (0.0483)	0.280*** (0.0643)	0.324*** (0.0755)
Total trade (%GDP) ⁽⁻¹⁾	0.002*** (0.0004)	0.005*** (0.0006)	0.009*** (0.0010)	0.004*** (0.0012)
Agriculture value added (%GDP) ⁽⁻¹⁾	-0.003** (0.0014)	-0.007*** (0.0021)	0.001 (0.0030)	-0.022*** (0.0034)
Total natural resource rent (%GDP) ⁽⁻¹⁾	-0.002 (0.0014)	-0.001 (0.0020)	-0.000 (0.0029)	-0.006* (0.0035)
Net off. Dev. assistance and off. aid received (%GDP) ⁽⁻¹⁾	-0.001 (0.0011)	-0.006*** (0.0017)	-0.008*** (0.0025)	-0.009*** (0.0027)
Constant	0.669*** (0.2491)	-1.539*** (0.3696)	-2.209*** (0.4939)	-1.603*** (0.5760)
Observations	1137	1137	1062	1057
R-squared	0.159	0.251	0.155	0.175
Number of countries	39	39	38	38

Panel A: Stage 2 - estimation of the time-varying tax inefficiency (stochastic frontier)

				Number of obs.	1137
				Wald chi2(1)	305.96
Log likelihood = 106.30				Prob > chi2	0.0000
	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
frontier (one)	0.213	0.012	17.490	0.000	0.189 0.237
usigmas (_cons)	-2.617	0.108	-24.270	0.000	-2.828 -2.406
vsigma (_cons)	-3.752	0.099	-37.750	0.000	-3.947 -3.557

Panel B: Stage 3 - estimation of the persistent tax inefficiency (stochastic frontier)

				Number of obs.	1137
				Wald chi2(1)	1387.37
Log likelihood = -376.46				Prob > chi2	0.0000
	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
frontier (one)	0.451	0.012	37.250	0.000	0.427 0.475
usigmas (_cons)	-1.233	0.060	-20.640	0.000	-1.350 -1.116
vsigma (_cons)	-3.819	0.120	-31.760	0.000	-4.055 -3.583

Panel C: Summary of tax effort estimation results

	Obs.	Mean	Std. Dev.	Min	Max
Time-varying tax effort	1137	0.819	0.090	0.319	0.967
Persistent tax effort	1137	0.694	0.170	0.099	0.941
Total tax effort	1137	0.570	0.155	0.056	0.842

Notes: Significance: *** p<0.01, ** p<0.05, * p<0.1; Standard errors in parentheses. NRTAX: Total non-resource tax revenue; Direct: Total income tax revenue; CIT: Corporate income tax revenue; PIT: Personal income tax revenue.

Table i.10: Summary of tax effort estimation results – Robustness controlling for official development assistance and aid [2]-[4]

Dependent	Tax effort components	Obs.	Mean	SD	Min	Max
Direct	Time-varying tax effort	1137	0.763	0.104	0.232	0.935
	Persistent tax effort	1137	0.619	0.155	0.066	0.863
	Total tax effort	1137	0.474	0.137	0.033	0.758
CIT	Time-varying tax effort	1062	0.699	0.115	0.089	0.917
	Persistent tax effort	1062	0.419	0.214	0.042	1.000
	Total tax effort	1062	0.294	0.160	0.018	0.823
PIT	Time-varying tax effort	1057	0.647	0.148	0.030	0.940
	Persistent tax effort	1057	0.554	0.172	0.045	0.829
	Total tax effort	1057	0.360	0.138	0.006	0.655

Table i.11: The three-stage estimation results: baseline, controlling for financial development and official development assistance and aid – Log-log specification

Variables	[1]		[2]		[3]	
	NRTAX					
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Log GDP per cap. (Cst. 2010 USD) ⁽⁻¹⁾	0.329***	(0.0350)	0.287***	(0.0349)	0.358***	(0.0370)
Total trade (%GDP) ⁽⁻¹⁾	0.279***	(0.0289)	0.282***	(0.0294)	0.296***	(0.0301)
Agriculture value added (%GDP) ⁽¹⁾	0.068**	(0.0339)	0.098***	(0.0335)	0.098***	(0.0349)
Total natural resource rent (%GDP) ⁽⁻¹⁾	-0.006	(0.0148)	-0.000	(0.0151)	0.004	(0.0149)
Financial development ⁽⁻¹⁾			0.204***	(0.0292)		
Net off. Dev. assistance and off. aid received (%GDP) ⁽⁻¹⁾					-0.001	(0.0112)
Constant	-1.222***	(0.3231)	-0.580*	(0.3404)	-1.600***	(0.3393)
Observations	1155		1126		1125	
R-squared	0.229		0.261		0.238	
Number of countries	39		39		39	

Panel A: Stage 2 - estimation of the time-varying tax inefficiency (stochastic frontier)

				Number of obs.	[1]	[2]	[3]
	[1]	[2]	[3]		Wald chi2(1)	226.97	254.58
Log likelihood	141.42	169.20	149.50	Prob > chi2	0.0000	0.0000	0.0000
	[1]		[2]		[3]		
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
frontier (one)	0.192***	(0.0127)	0.194***	(0.0121)	0.1896***	(0.0126)	
usigmas (_cons)	-2.828***	(0.1254)	-2.812***	(0.1184)	-2.852***	(0.1258)	
vsigma (_cons)	-3.680***	(0.0943)	-3.794***	(0.0981)	-3.6974***	(0.0940)	

Panel B: Stage 3 - estimation of the persistent tax inefficiency (stochastic frontier)

				Number of obs.	[1]	[2]	[3]
	[1]	[2]	[3]		Wald chi2(1)	1511.43	1382.52
Log likelihood	-452.54	-385.76	-473.43	Prob > chi2	0.0000	0.0000	0.0000
	[1]		[2]		[3]		
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
frontier (one)	0.478***	(0.0123)	0.447***	(0.0120)	0.488***	(0.0125)	
usigmas (_cons)	-1.125***	(0.0581)	-1.240***	(0.0597)	-1.056***	(0.0580)	
vsigma (_cons)	-3.661***	(0.1092)	-3.710***	(0.1089)	-3.638***	(0.1098)	

Panel C: Summary of tax effort estimation results

		Obs.	Mean	Std. Dev.	Min	Max
[1]	Time-varying tax effort	1155	0.834	0.078	0.379	0.965
	Persistent tax effort	1155	0.683	0.175	0.090	0.940
	Total tax effort	1155	0.571	0.158	0.056	0.865
[2]	Time-varying tax effort	1126	0.833	0.082	0.365	0.965
	Persistent tax effort	1126	0.696	0.169	0.113	0.941
	Total tax effort	1126	0.581	0.154	0.070	0.866
[3]	Time-varying tax effort	1125	0.836	0.078	0.382	0.963
	Persistent tax effort	1125	0.676	0.179	0.085	0.939
	Total tax effort	1125	0.566	0.161	0.054	0.866

i.9.2. Appendix: Replications of Gupta (2007)

Table i.12: Replication results of Gupta (2007) – Common Correlation Coefficients (Verification)

	I	II	III	IV	VII	VIII	IX	X
Log of Per capita GDP	3.624*** (0.398)	3.874*** (0.363)	3.080*** (0.401)	3.360*** (1.103)				
Agriculture share					-0.208*** (0.0362)	-0.181*** (0.0382)	-0.125*** (0.0352)	-0.243*** (0.0754)
Import share		0.0330 (0.0213)	0.112*** (0.0207)	0.0484* (0.0260)		0.0338** (0.0158)	0.0821*** (0.0212)	0.0741** (0.0310)
Aid share			-0.00778 (0.0252)	0.0371 (0.0645)			-0.00711 (0.0442)	0.0419 (0.0771)
Debt share			0.00512 (0.00332)	0.0308* (0.0164)			-0.0111** (0.00485)	0.00927 (0.0153)
Government stability				0.231 (0.173)				0.297* (0.170)
Corruption				-0.305 (0.553)				-0.433 (0.539)
Law and order				0.348 (0.352)				0.476 (0.321)
Tax on goods and services				0.337** (0.169)				0.0674 (0.181)
Tax on income, profit and capital gain				0.521*** (0.171)				0.441** (0.179)
Tax on trade				1.151*** (0.199)				0.852*** (0.191)
Constant	-8.578*** (3.270)	-12.16*** (2.907)	-9.976*** (3.014)	-21.63* (11.09)	25.51*** (0.678)	23.50*** (0.843)	20.82*** (1.039)	12.97*** (2.104)
Observations	954	926	595	120	1,046	1,022	677	118
R-squared	0.419	0.443	0.534	0.662	0.312	0.311	0.364	0.614
Number of countries	93	89	62	20	85	83	59	19

*** p<0.01, ** p<0.05, * p<0.1 Standard errors in parentheses

Table i.13: Replication results of Gupta (2007) – Panel Specific Correlation Coefficients (Verification)

	I	II	III	IV	VII	VIII	IX	X
Log of Per capita GDP	3.668*** (0.365)	4.304*** (0.354)	3.259*** (0.395)	3.543*** (1.216)				
Agriculture share					-0.215*** (0.0301)	-0.188*** (0.0343)	-0.174*** (0.0313)	-0.299*** (0.0686)
Import share		0.0306 (0.0220)	0.128*** (0.0209)	0.0268 (0.0230)		0.0153 (0.0163)	0.0624** (0.0297)	0.0436 (0.0267)
Aid share			-0.0169 (0.0244)	0.0338 (0.0626)			-0.00306 (0.0500)	0.0792 (0.0669)
Debt share			0.00674* (0.00352)	0.0404*** (0.0151)			-0.00510 (0.00578)	0.0121 (0.0156)
Government stability				0.275 (0.181)				0.348** (0.159)
Corruption				-0.297 (0.463)				-0.353 (0.384)
Law and order				0.173 (0.328)				0.403 (0.350)
Tax on goods and services				0.577*** (0.143)				0.309* (0.168)
Tax on income, profit and capital gain				0.571*** (0.166)				0.309* (0.166)
Tax on trade				1.135*** (0.217)				0.690*** (0.186)
Constant	-8.602*** (2.993)	-15.32*** (2.636)	-12.04*** (2.829)	-24.46** (11.11)	26.21*** (0.660)	25.12*** (0.860)	23.07*** (1.340)	14.33*** (2.159)
Observations	954	926	595	120	1,046	1,022	677	118
R-squared	0.678	0.685	0.773	0.801	0.606	0.594	0.602	0.860
Number of countries	93	89	62	20	85	83	59	19

*** p<0.01, ** p<0.05, * p<0.1 Standard errors in parentheses

Table i.14: Replication results of Gupta (2007) – Common Correlation Coefficients (Robustness)

	I	II	III	IV	VII	VIII	IX	X
Log of Per capita GDP	2.330*** (0.207)	2.409*** (0.206)	1.993*** (0.197)	0.0881* (0.0485)				
Agriculture share					-0.169*** (0.0117)	-0.162*** (0.0120)	-0.103*** (0.0122)	-0.00172 (0.00275)
Import share		0.0166*** (0.00453)	0.0537*** (0.00691)	0.00266** (0.00122)		0.0280*** (0.00430)	0.0555*** (0.00670)	0.00315** (0.00132)
Aid share			-0.0206** (0.00829)	-0.00231 (0.00159)			-0.0218** (0.00973)	-0.00264 (0.00179)
Debt share			-0.00464*** (0.00143)	6.78e-05 (0.000302)			-0.00450** (0.00194)	1.76e-05 (0.000411)
Government stability				0.00737 (0.0124)				0.00693 (0.0116)
Corruption				-0.0110 (0.0348)				-0.0248 (0.0344)
Law and order				-0.0305 (0.0356)				-0.0313 (0.0331)
Tax on goods and services				1.045*** (0.0156)				1.039*** (0.0159)
Tax on income, profit and capital gain				0.969*** (0.0175)				0.983*** (0.0166)
Tax on trade				1.015*** (0.0174)				1.015*** (0.0169)
Constant	-3.919** (1.735)	-5.465*** (1.710)	-3.817** (1.576)	-0.226 (0.338)	19.15*** (0.374)	17.67*** (0.405)	14.32*** (0.431)	0.515*** (0.189)
Observations	3,874	3,729	2,317	1,256	4,195	4,073	2,552	1,321
R-squared	0.321	0.337	0.348	0.953	0.307	0.324	0.341	0.956
Number of countries	187	183	116	73	181	177	112	71

*** p<0.01, ** p<0.05, * p<0.1 Standard errors in parentheses

Table i.15: Replication results of Gupta (2007) – Panel Specific Correlation Coefficients (Robustness)

	I	II	III	IV	VII	VIII	IX	X
Log of Per capita GDP	2.027*** (0.169)	2.097*** (0.159)	1.984*** (0.197)	0.00538 (0.0509)				
Agriculture share					-0.154*** (0.0117)	-0.145*** (0.0126)	-0.106*** (0.0130)	-0.00234 (0.00262)
Import share		0.0202*** (0.00423)	0.0612*** (0.00712)	0.00529*** (0.00116)		0.0326*** (0.00486)	0.0622*** (0.00730)	0.00510*** (0.00128)
Aid share			-0.0198** (0.00912)	-0.00344** (0.00168)			-0.0237** (0.0103)	-0.00340* (0.00190)
Debt share			-0.00383*** (0.00133)	-0.000193 (0.000346)			-0.00518*** (0.00191)	-8.41e-07 (0.000430)
Government stability				0.00524 (0.0110)				0.00243 (0.0102)
Corruption				-0.0272 (0.0328)				-0.0332 (0.0322)
Law and order				-0.0471 (0.0354)				-0.0378 (0.0332)
Tax on goods and services				1.056*** (0.0132)				1.042*** (0.0146)
Tax on income, profit and capital gain				0.985*** (0.0186)				0.999*** (0.0176)
Tax on trade				1.009*** (0.0197)				1.020*** (0.0182)
Constant	-1.206 (1.382)	-2.878** (1.289)	-3.451** (1.504)	0.352 (0.373)	18.69*** (0.352)	16.87*** (0.447)	14.40*** (0.488)	0.431*** (0.154)
Observations	3,874	3,729	2,317	1,256	4,195	4,073	2,552	1,321
R-squared	0.613	0.620	0.633	0.984	0.559	0.541	0.555	0.984
Number of countries	187	183	116	73	181	177	112	71

*** p<0.01, ** p<0.05, * p<0.1 Standard errors in parentheses

i.9.3. Appendix: Replications of Fenchietto and Pessino (2013)

Table i.16: Parameter of the SF tax function for Non-resource dependent countries

	Verification		Robustness			
	BC Half Normal	BC Truncated Normal	BC Half Normal	BC Truncated Normal	BC Half Normal	BC Truncated Normal
Log of per capita GDP	0.523** (0.203)	0.534*** (0.206)	-7.745* (4.680)	10.66** (5.161)	5.883*** (0.450)	2.494*** (0.490)
Agri. added value (% GDP)	-0.005*** (0.002)	-0.005*** (0.002)	-0.03 (0.04)	-0.03 (0.04)	0.017 (0.036)	-0.057 (0.038)
Pub. expenditure in Edu. (%GDP)	0.031*** (0.006)	0.031*** (0.006)	1.268*** (0.136)	0.809*** (0.142)	1.184*** (0.134)	0.888*** (0.134)
Trade	0.0006** (0.0002)	0.0006** (0.0002)	0.04*** (0.007)	0.005 (0.007)	0.037*** (0.007)	0.008 (0.006)
GINI index	-0.008*** (0.001)	-0.008*** (0.001)	-0.140*** (0.025)	-0.125*** (0.028)	-0.159*** (0.026)	-0.128*** (0.028)
Log of per capita GDP squared	-0.022** (0.011)	-0.023** (0.011)	0.772*** (0.264)	-0.463 (0.290)		
Constant	0.966 (0.961)	0.925 (0.968)	32.35 (20.23)	-16.60 (23.33)	-24.63*** (5.035)	23.90 (0)
Sigma	-1.880*** (0.185)	-2.066*** (0.455)	4.273*** (0.220)	2.983*** (0.180)	4.575*** (0.205)	2.868*** (0.151)
Gamma	3.558*** (0.204)	3.367*** (0.475)	3.196*** (0.243)	1.840*** (0.226)	3.514*** (0.224)	1.678*** (0.192)
Mu	(omitted)	0.0892 (0.184)	(omitted)	20.25*** (5.366)	(omitted)	25.09*** (5.152)
Eta	-0.004* (0.002)	-0.004** (0.002)	-0.024*** (0.003)	-0.002 (0.001)	-0.019*** (0.002)	-0.002 (0.0008)
Observations	533	533	561	561	561	561
Number of countries	68	68	70	70	70	70
sigma2	0.153	0.127	71.73	19.75	97.01	17.60
gamma	0.972	0.967	0.961	0.863	0.971	0.843
sigma_u	0.385	0.350	8.301	4.129	9.706	3.851
sigma_v	0.065	0.065	1.679	1.645	1.675	1.664

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses

Table i.17: Parameter of the SF tax function for Non-resource dependent and resources dependent countries

	Verification		Robustness			
	BC Half Normal	BC Truncated Normal	BC Half Normal	BC Truncated Normal	BC Half Normal	BC Truncated Normal
Log of per capita GDP	0.599*** (0.193)	0.615*** (0.197)	-9.203* (4.740)	7.646 (4.732)	5.454*** (0.441)	2.188*** (0.493)
Agri. added value (% GDP)	-0.005*** (0.002)	-0.005*** (0.002)	-0.071** (0.034)	-0.0758** (0.036)	-0.029 (0.032)	-0.093*** (0.033)
Pub. expenditure in Edu. (%GDP)	0.035*** (0.006)	0.034*** (0.006)	1.310*** (0.137)	0.838*** (0.132)	1.215*** (0.134)	0.857*** (0.130)
Trade	0.0007*** (0.0002)	0.0007*** (0.0003)	0.028*** (0.007)	0.002 (0.006)	0.023*** (0.007)	0.002 (0.006)
GINI index	-0.008*** (0.001)	-0.008*** (0.001)	-0.130*** (0.024)	-0.096*** (0.026)	-0.144*** (0.026)	-0.097*** (0.026)
Log of per capita GDP squared	-0.026*** (0.010)	-0.027*** (0.011)	0.829*** (0.267)	-0.306 (0.266)		
Constant	0.592 (0.909)	0.536 (0.923)	41.10** (20.47)	-3.334 (20.87)	-20.41*** (4.878)	20.64*** (6.686)
Sigma	-1.888*** (0.181)	-2.171*** (0.417)	4.332*** (0.205)	3.161*** (0.146)	4.647*** (0.187)	3.127*** (0.136)
Gamma	3.487*** (0.200)	3.196*** (0.437)	2.938*** (0.232)	1.723*** (0.188)	3.279*** (0.209)	1.677*** (0.174)
Mu	(omitted)	0.132 (0.158)	(omitted)	20.66*** (2.212)	(omitted)	20.52*** (3.569)
Eta	-0.003 (0.002)	-0.003 (0.002)	-0.018*** (0.003)	-0.0007 (0.001)	-0.014*** (0.002)	-0.009 (0.001)
Observations	566	566	681	681	681	681
Number of countries	73	73	95	95	95	95
sigma2	0.151	0.114	76.13	23.59	104.3	22.82
gamma	0.970	0.961	0.950	0.849	0.964	0.842
sigma_u	0.383	0.331	8.503	4.474	10.03	4.384
sigma_v	0.067	0.067	1.957	1.890	1.946	1.896

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses

