



HAL
open science

Essays in international economics : firm heterogeneity, aggregate productivity and misallocation

Charlotte Sandoz-Dit-Bragard

► **To cite this version:**

Charlotte Sandoz-Dit-Bragard. Essays in international economics : firm heterogeneity, aggregate productivity and misallocation. Economics and Finance. Université Panthéon-Sorbonne - Paris I, 2018. English. NNT : 2018PA01E039 . tel-01997907

HAL Id: tel-01997907

<https://theses.hal.science/tel-01997907v1>

Submitted on 29 Jan 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Essays in International Economics:
Firm Heterogeneity, Aggregate Productivity and
Misallocation

Charlotte Sandoz-dit-Bragard

Thèse pour l'obtention du grade de Docteur
de l'Université Paris 1 Panthéon-Sorbonne en Sciences Économiques
Présentée et soutenue publiquement le 22 octobre 2018

Directeurs de thèse:

Jean Imbs, Directeur de Recherche, CNRS, Professeur, PSE, France

Lionel Fontagné, Professeur, Université Paris 1 Panthéon-Sorbonne PSE, France

Jury:

Flora Bellone (Rapporteur), Professeur, Université Nice Sophia Antipolis, France

Gabriel Felbermayr (Rapporteur), Professeur, Université de Munich, Allemagne

Maria Bas, Professeur, Université Paris 1 Panthéon-Sorbonne & PSE, France

Isabelle Méjean, Professeur, CREST-Ecole Polytechnique, France

Katheline Schubert, Professeur, Université Paris 1 Panthéon-Sorbonne & PSE, France

This dissertation is dedicated to my mother and my brother, Louis,
For their resilience in the face of illness.

Acknowledgments

The writing of the dissertation was a long and difficult journey and I achieved it thanks to all of you. You gave me the strength to be resilient and the capacity to realize one of my dreams.

First, I would like to thank my supervisors, Jean Imbs and Lionel Fontagné, for their guidance. I am really grateful to Lionel Fontagné who has accepted to help me for designing my research project since the first day I have decided to walk this path. Today, I realize how important his role has been all over this intense period and I am very appreciative of his trust in me and his constant support. I would like also to thank him to take on board Jean Imbs who provides me valuable comments and help to achieve my professional project.

Moreover, I would like to thank Guillaume Gaulier and Jean-Charles Bricongne, my professors in master degree who gave me the chance to do an internship at Banque de France and to be involved in a very interesting research project. I am very thankful to Antoine Berthou who was my supervisor during the internship and the PhD fellow position at Banque de France. He followed my work almost day by day and his door was always opened for questions and doubts during 5 years. Thanks to him, I also got the opportunity to meet and work with Kalina Manova. She rapidly becomes an amazing mentor. I am deeply thankful to her for teaching me the importance of discipline and commitment to work and for her encouragement during some challenging moments.

I am very thankful to my wonderful co-authors, Jong Hyun Chung, Piyaporn Sod-sriwiboon and Adil Mohommad, for their availability, generosity and active guidance. I am also indebted to Isabelle Méjean for her insightful comments on my work. I am grateful to Maria Bas, Flora Bellone, Gabriel Felbermayr for commenting on my

work and for enriching my ideas. I am also thankful to Roberta Serafini, Romain Duval, Mathieu Parenti, Claire Lelarge for their time and comments.

My sincere thanks to Banque of France, IMF and ECB and all my managers there for supporting my work. More especially, I thank Soledad Zignogo, Rémy Lecat, Antoine Devulder, Paul Cashin, Sonali Das and Paloma Lopez-Garcia for their generosity in giving me time to focus on my research projects.

For the time I was at Banque de France, I had the enormous chance to be part of the Cifre group. Brendan Vannier, who is a model of positivity, initiated a PhD seminar and a strong team spirit. Giulia Aliprandi made my lunch time unforgettable. Alessandra Pizzo was like a mama with her constant care and concern. Simon Ray with his homemade coffee combined with intense discussion pushed my productivity to the limit, even sometimes closed to tachycardia attacks. Claire Labonne and Miklos Vari were wonderful coaches during the job market. Pauline Bourgeon was always available for sharing experiences and advice.

At PSE, I had the chance to meet Margarita Lopez-Forero who supports me all along my PhD application and after. It was always a pleasure to come to PSE for discussing and sharing experiences with her around a cup of coffee. I am thankful to Elsa Leromain who gave me the strength to stay on board during a storm at the end of the PhD and Sophie Piton who was a fantastic partner on the job market. I also thank all other participants to the GSIE seminar.

Most importantly, writing this dissertation would not have been possible without the unwavering support of my husband, family and friends. Jean-Benoît was always besides me all along this long journey to encourage me and pass obstacles. I thank him for extreme patience, listening skills and positive thinking that gave me courage to start and conclude this dissertation. I am very grateful to my parents for unconditional love and trust in life. The worldwide delivery of their farm

products and apple cakes also contributes to keep my moral up. I especially thank my mother for the number of phone hours and kilometers to follow me everywhere, with a great respect for my own choices. I thank my sister for her love, support and strength. I thank my brothers, Jean, Louis and Maxime, and my sister of law, Laure for enriching conversations we have at Chaumigny. I also thank my non-economist friends, Anne-Florence, Sophie, Cyprien, Thérèse, Laura, Etienne, Camille, Raphaël, Mathilde, Sonia, Alice and the 212 team for parties and fun holidays during these years.

Finally, all this adventure would not have started without my babysitter Denise Boudot. When I was 6 years old, she was the only one able to convince me to do my homework. Thanks to her extreme patience and rigor, I learn the importance of dedication and commitment to perfection.

Contents

| | | |
|----------|---|-----------|
| 1 | Résumé | 1 |
| 2 | Introduction | 17 |
| 3 | Productivity, (Mis)allocation and Trade | 20 |
| 3.1 | Introduction | 20 |
| 3.2 | Theoretical Framework | 27 |
| 3.2.1 | Set Up | 28 |
| 3.2.2 | Firm Productivity and Resource Misallocation | 29 |
| 3.2.3 | Firm Behavior | 31 |
| 3.2.4 | General Equilibrium | 33 |
| 3.2.5 | Welfare | 35 |
| 3.2.6 | From Theory to Empirics | 36 |
| 3.2.7 | Impact of Trade Liberalization | 43 |
| 3.2.8 | Numerical Simulation | 47 |
| 3.2.9 | Discussion | 50 |
| 3.3 | Data | 51 |
| 3.3.1 | CompNet Productivity Data | 51 |
| 3.3.2 | WIOD Trade Data | 53 |
| 3.4 | Trade and Aggregate Productivity: OLS Correlation | 55 |
| 3.4.1 | OLS Specification | 56 |
| 3.4.2 | OLS Results | 58 |
| 3.5 | Impact of Trade on Aggregate Productivity: IV Causation | 60 |
| 3.5.1 | The Endogeneity Problem | 60 |
| 3.5.2 | IV Strategy | 61 |

| | | |
|----------|--|-----------|
| 3.5.3 | Baseline IV Results | 64 |
| 3.5.4 | Sensitivity Analysis | 65 |
| 3.5.5 | Import Competition from China | 67 |
| 3.6 | How Trade Affects Productivity: Interpretation and Mechanisms . . . | 69 |
| 3.6.1 | Firm Selection | 71 |
| 3.6.2 | Productivity Upgrading | 74 |
| 3.6.3 | Imperfect Institutions and Market Frictions | 75 |
| 3.6.4 | Misallocation Measures in the Literature | 79 |
| 3.7 | Conclusion | 80 |
| 3.8 | Tables and Figures | 82 |
| 4 | Input Prices, Allocation of Resources and TFP Growth: Evidence from Chinese Imports in France | 96 |
| 4.1 | Introduction | 96 |
| 4.2 | Theoretical Framework | 100 |
| 4.2.1 | Technology and firm behaviors | 100 |
| 4.2.2 | Sectoral production functions and aggregate TFP | 106 |
| 4.3 | Empirical framework | 109 |
| 4.3.1 | Data description | 109 |
| 4.3.2 | Estimation method of aggregate TFP | 111 |
| 4.3.3 | Heterogeneous impact of Chinese trade shock along firm size distribution: evidence from firm-level wedges | 114 |
| 4.3.4 | TFP growth and Chinese trade shock: OLS correlation | 117 |
| 4.3.5 | Impact of outsourcing in China on French TFP growth: IV causality | 120 |
| 4.3.6 | Robustness checks | 124 |

| | | |
|----------|--|------------|
| 4.4 | Conclusion | 126 |
| 4.5 | Tables and Figures | 128 |
| 5 | Resource Misallocation in India: The Role of Cross-State Labor | |
| | Market Reform and Financial Development | 144 |
| 5.1 | Introduction | 144 |
| 5.2 | Literature Reviews | 146 |
| 5.3 | Measuring Misallocation | 149 |
| 5.4 | Data and Stylized Facts | 153 |
| | 5.4.1 Firm-level balance sheet data | 153 |
| | 5.4.2 State and sector characteristics in India | 155 |
| | 5.4.3 Stylized facts | 156 |
| 5.5 | Econometric Analysis | 158 |
| | 5.5.1 Baseline regression | 158 |
| | 5.5.2 Links between labor market regulations and informality | 160 |
| 5.6 | Empirical Results | 161 |
| | 5.6.1 Regression results | 161 |
| | 5.6.2 Robustness check and scenario analysis | 162 |
| 5.7 | Conclusion | 165 |
| 5.8 | Tables and Figures | 167 |
| 6 | Conclusion | 177 |
| | References | 179 |
| | Appendices | 188 |
| A | Productivity, (Mis)allocation and Trade | 188 |

| | | |
|----------|---|------------|
| B | Input Prices, Allocation of Resources and TFP Growth: Evidence from Chinese Imports in France | 195 |
| B.1 | Exact decomposition of sectoral TFP | 195 |
| B.1.1 | Dispersion of firm-level wedges as measure of sector-level mis-allocation | 196 |
| C | Resource Misallocation in India: The Role of Cross-State Labor Market Reform and Financial Development | 199 |
| C.1 | Alternative Measures of Misallocation | 199 |
| C.1.1 | Variance of TFPR | 199 |
| C.1.2 | TFP gap | 199 |
| C.2 | Labor Market Regulations and Reforms in India | 200 |

List of Figures

| | | |
|-----|---|-----|
| 3.1 | Welfare, Misallocation, and OP Covariance | 91 |
| 3.2 | Numerical Simulation | 92 |
| 3.2 | Numerical Simulation (cont.) | 93 |
| 3.3 | Sources of Productivity Growth: Overlapping 3-Year Growth Rates | 94 |
| 3.4 | Trade Exposure Over Time | 95 |
| 4.1 | Evolution of traded intermediate inputs in France | 141 |
| 4.2 | Evolution of imported inputs from China in French customs and WIOD databases | 141 |
| 4.3 | Decomposition of revenue-based aggregate TFP growth | 142 |
| 4.4 | Firm-level productivity and input wedges in 1995, 2001, 2007 and 2012 by firm size | 143 |
| 5.1 | Misallocation in US, India and China | 169 |
| 5.2 | Median TFPR by state | 175 |
| 5.3 | India: Distribution of TFP lost by State | 175 |
| 5.4 | Correlation between misallocation and the size of informal sector | 176 |
| 5.5 | India: Distribution of TFP gap in States with High Informality (in %) | 176 |
| A.1 | Dispersion of firm-level productivity and input wedges in logs (Based 1 in 1995) | 197 |

List of Tables

| | | |
|------|--|-----|
| 3.1 | Numerical Simulation: Productivity Gains from Trade Liberalization | 83 |
| 3.2 | Summary Statistics | 84 |
| 3.3 | Trade and Aggregate Economic Activity: OLS Correlation | 85 |
| 3.4 | Instrumenting Export Demand and Import Competition: IV First Stage | 86 |
| 3.5 | Impact of Trade on Aggregate Productivity: IV Second Stage | 87 |
| 3.6 | Import Competition Ratio and Chinese Import Competition | 88 |
| 3.7 | Mechanisms: Firm Selection and Innovation | 89 |
| 3.8 | Mechanisms: Imperfect Institutions and Market Frictions | 90 |
| 4.1 | Barriers cited by French companies as important or very important for planned but not performed outsourcing abroad | 128 |
| 4.2 | Descriptive Statistics | 129 |
| 4.3 | Cobb-Douglas coefficients in the revenue-based production function | 129 |
| 4.4 | Average allocative efficiency, technical efficiency and annual TFP growth by sector | 130 |
| 4.5 | Summary statistics for the within-sector variation of firm-level characteristics over time | 131 |
| 4.6 | OLS baseline - Aggregate TFP growth and trade margins | 132 |
| 4.7 | OLS baseline - Chinese trade flows in values and decomposition of TFP growth | 133 |
| 4.8 | IV baseline - First stage | 134 |
| 4.9 | IV baseline - Second stage | 135 |
| 4.10 | IV baseline without the initial share of Chinese trade flows - Second stages | 136 |

| | |
|---|-----|
| 4.11 IV baseline without the initial number of firms per year and sector - Second stages | 137 |
| 4.12 IV baseline with initial RD expenditure - Second stages | 138 |
| 4.13 IV baseline with controls for global shocks - Second stages | 139 |
| 4.14 OLS - Alternative trade flows | 140 |
| 5.1 Summary Statistics – ASI database | 167 |
| 5.2 Summary Statistics – State characteristics | 168 |
| 5.3 Dispersion of firm-level TFPR (in logs) in India | 169 |
| 5.4 Misallocation and labor market reforms | 170 |
| 5.5 Median-mean ratio of TFPR, labor market reforms and informality . | 171 |
| 5.6 TFP gap, labor market reforms and informality | 172 |
| 5.7 Covariance between labor and labor productivity as measure of mis- allocation | 173 |
| 5.8 Restricting sample to years 2008 and 2010 | 174 |
| A.1 Summary Statistics | 189 |
| A.2 Trade and Aggregate Productivity Growth: OLS First Differences . . | 191 |
| A.3 Impact of Trade on Aggregate Productivity: Robustness | 192 |
| A.4 Imperfect Institutions and Market Frictions: Robustness | 193 |
| A.5 Impact of Trade on Dispersion of Productivity and Mark-Up | 194 |
| B.1 Sector-level dispersion of wedges and share of imported inputs from China | 198 |

1 Résumé

La motivation principale de cette recherche est de comprendre comment les politiques commerciales, le cadre réglementaire et la qualité des institutions impactent le niveau et la croissance de la productivité agrégée des pays développés et émergents. La productivité est un concept économique important car elle est l'un des principaux déterminants de la croissance du PIB par tête et du niveau de vie d'un pays. Le PIB est la somme des valeurs ajoutées créées à partir des ressources disponibles dans l'économie. Ses trois principaux composants sont le facteur travail, le facteur capital et le progrès technique. Le progrès technique peut être soit un progrès technologique (mise au point de nouveaux produits ou de nouveaux procédés de fabrication), soit un progrès en matière d'organisation (nouvelle méthode de gestion, d'organisation du travail ou nouvelle organisation du système productif dans son ensemble. . .). Soutenu par l'innovation, le progrès technique permet une amélioration de la productivité globale des facteurs de production et dépend du savoir-faire accumulé et de l'adoption de nouvelles technologies au sein des entreprises.

Au niveau macroéconomique, la productivité globale des facteurs (TGF) est définie comme le rapport entre la quantité produite et le volume de ressources mises en œuvre pour l'obtenir. Différentes mesures de productivité existent. Si elle est calculée par rapport à un seul type de ressources (le travail ou le capital), on parle alors de productivité apparente du travail ou du capital. Elle mesure la valeur ajoutée produite par travailleur ou par unité de capital. Si la productivité est calculée à partir de plusieurs facteurs de production, elle est alors le résidu d'une fonction de production et capture ce qui n'est pas expliqué par l'accroissement des facteurs de production. Par exemple, la meilleure utilisation d'un logiciel de programmation peut permettre d'augmenter la production d'une machine-outil, tous les autres facteurs étant

constants par ailleurs.

Depuis le début des années 2000, de nombreux pays développés font face à un ralentissement de la productivité. Cette tendance s'est accentuée après la crise financière de 2008-09. Cette situation est préoccupante car ce ralentissement menace les progrès réalisés en termes d'amélioration du niveau de vie, questionne la soutenabilité des dettes privées et publiques, et la viabilité des systèmes de protection sociale. Ce ralentissement de la croissance de la productivité est expliqué par au moins quatre facteurs : un manque d'investissement des entreprises à la suite de la contraction des crédits lors de la crise financière, une population vieillissante dans la plupart des pays développés, une faible vitesse de la diffusion des technologies entre entreprises et entre pays à cause de rigidités sur les marchés du travail et des biens, et des réactions politiques anti-globalisation.

La présente thèse contribue à ce pan de la littérature en étudiant comment les flux commerciaux et les réformes structurelles impactent la croissance de la productivité agrégée dans le secteur manufacturier en Europe et en Inde. Elle répond principalement à trois questions. Premièrement, l'ouverture commerciale permet-elle d'atteindre un niveau de productivité agrégée plus élevé en Europe ? Deuxièmement, le commerce extérieur bénéficie-t-il disproportionnellement aux entreprises les plus productives au détriment des petites et moyennes entreprises en France ? Troisièmement, les nombreuses réglementations du marché du travail en Inde expliquent-elles le faible niveau de productivité de certains états ? Quel est le rôle du secteur informel ?

L'objectif de ce travail est plus précisément de comprendre l'impact du commerce et des réglementations sur les marchés des biens et du travail sur la productivité agrégée en regardant leurs impacts sur le comportement des entreprises. La productivité agrégée est une moyenne pondérée de la productivité des entreprises. Le

poids capture la taille de l'entreprise qui peut être mesurée par la valeur ajoutée, le nombre d'employés ou le chiffre d'affaires. Toutes ces variables proviennent du bilan des entreprises et elles dépendent du programme de maximisation du profit. Dans un monde en concurrence pure et parfaite, le prix d'un bien est égal au coût marginal de production de l'entreprise et la taille de cette dernière est alors proportionnelle à son niveau de productivité. Cependant, les entreprises font en réalité face à des distorsions de marché qui accroissent de façon hétérogène le niveau des prix par rapport à l'équilibre concurrentiel. Ces distorsions de prix peuvent résulter de politiques commerciales, de réglementations gouvernementales, de la qualité des institutions. . . Elles impactent directement la taille de l'entreprise et change le poids de cette dernière dans la productivité agrégée. La perte de productivité liée à ces distorsions est appelée misallocation car l'allocation des facteurs de production entre entreprises est sous-optimale relativement à un équilibre concurrentiel.

Dans le premier chapitre co-écrit avec Antoine Berthou, John Jong-Chung Chung et Kalina Manova, nous examinons l'impact du commerce extérieur sur la productivité agrégée. Nous montrons théoriquement et numériquement qu'une libéralisation bilatérale ou libéralisation unilatérale des exports augmente le bien-être et la productivité agrégée, alors qu'une libéralisation unilatérale des imports peut les augmenter ou les réduire. Néanmoins, ces trois types de libéralisation ont des effets ambigus en présence de mauvaise allocation des ressources entre entreprises liée à la présence de distorsions de marché. A partir de données sur 14 pays européens et 20 secteurs manufacturiers entre 1998 et 2011, nous mettons empiriquement en évidence que des chocs exogènes sur les exportations ou sur la concurrence à l'importation génèrent d'importants gains de productivité agrégée. En décomposant ces gains, nous trouvons que ces deux activités commerciales augmentent la productivité moyenne des entreprises, mais que l'expansion des exportations réalloue également l'activité vers

les entreprises les plus productives, alors que les importations agissent à l'inverse. Nous proposons deux mécanismes d'ajustement. Premièrement, accroître les exportations ou les importations augmente le niveau minimum de productivité des entreprises actives. Deuxièmement, des institutions et des marchés efficaces amplifient les gains liés aux importations, mais réduisent ceux liés aux exportations. Pour conclure, les effets de la globalisation opèrent via la combinaison d'une sélection accrue des entreprises en termes de productivité et une réallocation des ressources entre entreprises en présence de distortions sur les prix.

Dans le second chapitre, j'examine l'impact de la stratégie d'externalisation des entreprises sur la croissance de la productivité globale des facteurs (PGF). Je montre théoriquement et empiriquement que la baisse des prix des consommations intermédiaires importées par les entreprises accroît la croissance de la productivité agrégée en présence de distortions sur les prix. Dans un modèle de concurrence monopolistique avec des distortions de marché et un coût fixe à l'importation, la baisse du coût marginal des intrants étrangers permet à davantage de firmes dans le milieu / haut de la distribution des productivités d'importer de nouvelles variétés à un coût plus faible. La libéralisation commerciale réduit alors leur coût marginal de production et les rapproche de leur taille optimale, ce qui améliore l'allocation des ressources entre entreprises. A partir des données de firmes françaises des secteur manufacturiers entre 1995 et 2012, je réalise ensuite une décomposition de la productivité totale des facteurs (PGF) and je quantifie les gains liés à l'ouverture commerciale en Chine à partir de son entrée à l'OMC en 2001. Je trouve que l'intensification de l'externalisation de la production des biens intermédiaires en Chine a augmenté la croissance de la productivité en France et que l'ensemble de ces gains est expliqué par une meilleure allocation des ressources entre entreprises présentes d'une année sur l'autre.

Dans le troisième chapitre co-écrit avec Adil Mohommad et Piyaporn Sodsriwiboon, nous analysons l'impact des réformes sur le marché du travail en présence d'un secteur informel sur l'allocation des facteurs de production entre entreprises. Tout d'abord, nous étudions la nature et la magnitude de la misallocation en Inde. Nous trouvons que la mauvaise allocation des ressources entre entreprises est importante et très hétérogène entre les états de ce pays. Ensuite, nous analysons les déterminants de l'efficacité allocative des ressources entre entreprises en comparant les secteurs entre états. Premièrement, les distorsions liées à la stricte réglementation du marché du travail expliquent une part importante de la misallocation, et plus particulièrement dans les états avec un large secteur informel. Deuxièmement, la faible disponibilité des crédits génère des distorsions de prix et une mauvaise allocation des ressources entre entreprises. Pour conclure, des réformes pour davantage de flexibilité sur le marché du travail et une meilleure allocation des crédits entre entreprises réduiraient les distorsions de marché payées par les entreprises et généreraient des gains de productivité et une croissance économique plus forte à long terme en Inde.

Pour conclure, chacun de ces chapitres étudie le lien entre la productivité des entreprises et la productivité agrégée en présence d'hétérogénéité des firmes. Dans un premier temps, je montre théoriquement comment les chocs d'ouverture commerciale et les distorsions de prix modifient la façon dont les firmes maximisent leur profit, ce qui change la composition de la productivité agrégée. Deuxièmement, je quantifie l'impact de ces chocs ou des imperfections de marché sur la productivité agrégée à partir de données individuelles d'entreprises en Europe et en Inde. Permettre aux entreprises les plus productives d'avoir accès au crédit pour financer leurs investissements, à des employés bien formés et à des intrants au meilleur rapport qualité-prix est essentiel pour qu'elles puissent répondre à la demande et croître plus rapidement. Valoriser la croissance des entreprises les plus productives est essentiel pour soutenir

la croissance économique dans un monde de plus en plus globalisé où la concurrence est accrue.

Présentation de la thèse

Productivité, (Mis)allocation et commerce : Chapitre 1

La croissance du commerce mondial est plus rapide que celle du PIB mondial depuis le début des années 1970, et a même été jusqu'à deux fois plus rapide entre 1985 et 2007. Une question d'un grand intérêt politique est comment la globalisation a affecté la productivité agrégée et le bien-être, et de savoir comment son impact diffère d'un pays à l'autre en fonction du niveau de développement économique. Dans les économies avancées, la concurrence accrue des pays à bas salaire a nourri les débats sur les gains au commerce avec une préoccupation accrue concernant l'emploi domestique et les inégalités, mais aussi au vue de la spectaculaire expansion commerciale de la Chine après son accession à l'OMC en 2001. Dans les pays en développement, les réformes commerciales n'ont pas toujours engendré les retours attendus, conduisant les décideurs politiques à questionner les mérites d'une libéralisation commerciale si le pays a des fondamentaux macroéconomiques faibles et une transformation structurelle lente.

La théorie économique fournit une justification claire pour la libéralisation commerciale: elle permet une organisation plus efficiente de la production entre pays, secteurs et entreprises, ce qui génère des gains de productivité et de bien-être. Plus particulièrement, les modèles de commerce avec firmes hétérogènes mettent en avant l'importance de 3 canaux de gains au commerce : la sélection des entreprises, la réallocation des activités entre entreprises et les gains de productivité intra-firme (Melitz (2003); Lileeva et Trefler (2010)). En parallèle, la recherche actuelle en macroéconomie et croissance ont mis en avant que les frictions institutionnelles et de

marché déforment l'allocation des ressources productives entre firmes et donc réduit la productivité agrégée (Hsieh et Klenow (2010)). Cependant, la façon dont ces frictions modifient les gains au commerce reste encore mal comprise.

Ce papier étudie l'impact du commerce international sur la productivité agrégée. Nous montrons théoriquement et numériquement qu'une libéralisation bilatérale ou unilatérale des exports augmente la productivité agrégée et le bien-être, alors qu'une libéralisation unilatérale des imports peut les augmenter ou les réduire. Cependant, ces trois types de libéralisation commerciale ont des effets ambigus en présence de distorsions de marché.

Notre première contribution est théorique. Nous étudions l'impact d'une libéralisation commerciale dans un modèle de commerce classique avec des firmes hétérogènes et potentiellement une mauvaise allocation des ressources due à des distorsions de marché. De plus, nous simulons le modèle afin d'évaluer qualitativement et quantitativement ses prédictions. Nous mettons en avant deux principaux résultats.

Premièrement, en l'absence de misallocation, une réduction bilatérale des coûts au commerce ou une réduction unilatérale des coûts à l'export augmentent clairement la productivité agrégée et le bien-être, comme dans Melitz (2003); Melitz et Redding (2014). D'une part, ces réformes augmentent le niveau minimum de productivité à partir duquel les entreprises domestiques peuvent opérer et réduit la marge extensive en forçant les entreprises les moins productives à sortir du marché. D'autre part, elles réallouent et concentrent l'activité vers les entreprises les plus productives et augmentent la marge intensive. En revanche, une réduction unilatérale des coûts à l'importation a des conséquences ambiguës puisqu'elle augmente la compétitivité sur les marchés domestiques et étrangers, ce qui a des effets opposés sur le seuil minimum de productivité pour les entreprises domestiques.

Deuxièmement, en présence de distorsions, l'impact des libéralisations bilatérales

et unilatérales sur la productivité et le bien-être devient ambigu et non monotonique du degré de misallocation. Des distorsions plus ou moins importantes peuvent amplifier, réduire ou inverser les gains au commerce. Implicitement, ces distorsions sont liées à des imperfections institutionnelles qui causent des frictions sur les marchés. Ainsi, la globalisation a des effets ambigus parce que les économies avec des distorsions sont dans un équilibre de second ordre et les réformes commerciales peuvent réduire ou amplifier l'effet de ces distorsions.

Notre seconde contribution est méthodologique et permet de faire le lien entre les parties théoriques et empiriques. Nous démontrons comment les concepts clés du modèle correspondent aux variables empiriques observées, et comment les mécanismes théoriques peuvent être testés à partir des données disponibles. Ensuite, nous décomposons la productivité agrégée mesurée en deux composants qui sont la moyenne non-pondérée de la productivité des entreprises et la covariance entre le niveau d'emploi et de productivité de la firme, comme dans Olley et Pakes (1996).

Notre troisième contribution est empirique. À partir du cadre théorique, nous évaluons l'impact du commerce international sur la productivité agrégée et les mécanismes par lequel il opère. Nous utilisons une nouvelle base de données créée par le Competitiveness Research Network à la BCE contenant la productivité du travail agrégée pour 14 pays européens et 20 secteurs manufacturiers. Ces données sont uniques car elles fournissent des données agrégées de productivité, mais aussi de multiples indicateurs de la distribution sous-jacente des entreprises. Ainsi il est possible pour la première fois de décomposer la productivité agrégée pour un large panel de pays et de secteurs. Nos mesures de référence de l'ouverture commerciale des pays sont les exportations et les importations brutes par secteur provenant de la base de données World Input-Output Database.

Nous mettons en évidence quatre résultats empiriques. Premièrement, l'expansion des exportations et des importations augmente significativement la productivité agrégée. Deuxièmement, les gains de productivité de l'exportation ou de l'importation de biens sont réalisés via différents canaux. La croissance des exportations entraîne une augmentation de la productivité moyenne des entreprises et une réallocation du travail vers les entreprises les plus productives, le dernier canal expliquant 23%-39% de l'effet total. En revanche, tous les gains de productivité liés à la hausse des importations résultent uniquement d'une amélioration de la productivité moyenne des entreprises, avec 17%-36% de ces gains réduits par un déplacement de l'activité vers les entreprises les moins productives. Finalement, l'analyse théorique indique que ces trois résultats ne peuvent être rationalisés que dans un cadre avec de la misallocation entravant les effets de la globalisation.

Pour conclure, ces résultats révèlent une interaction complexe entre l'hétérogénéité des firmes et l'efficacité de l'allocation des ressources qui détermine l'amplitude des gains au commerce. En particulier, ils montrent que la capacité des économies à répondre à des chocs de commerce est différente selon le degré de misallocation.

Importations de Biens Intermédiaires et Croissance de la Productivité Agrégée en France: Chapitre 2

L'intégration d'un pays dans la chaîne globale de valeurs ajoutées est un important facteur de compétitivité et impacte directement sa productivité. Avoir accès à des biens intermédiaires étrangers permet aux entreprises domestiques d'acheter des biens moins chers ou de meilleure qualité relativement aux variétés domestiques, ce qui modifie leur fonction de production et les rend plus productives. Par exemple, les entreprises françaises ont intensivement sous-traité leur production en Chine au

début des années 2000 pour avoir accès à des composants moins chers. Elles ont ainsi gagné des parts de marché en France et à l'étranger en réduisant leur coût de production. Ces entreprises, qui sont par ailleurs les plus productives, pèsent davantage dans la moyenne pondérée grâce à la hausse de leurs ventes et contribue positivement à la croissance de la productivité en France.

L'objectif de ce papier est de comprendre comment les stratégies de sous-traitance des entreprises modifient la croissance de la productivité agrégée et l'allocation des ressources entre entreprises. Plus précisément, je montre comment l'ouverture commerciale de la Chine au début des années 2000 a permis une hausse de la croissance de la productivité en France en permettant à un plus grand nombre d'entreprises d'avoir accès à des biens intermédiaires moins chers.

Tout d'abord, plus de la moitié des biens importés en France sont des biens intermédiaires entre 1995 et 2013 et une partie grandissante l'est en provenance de la Chine. Les biens chinois représentent environ 2% du total des biens intermédiaires importés en 1999, contre 7% en 2011. De plus, les importations de biens intermédiaires croissent en moyenne de 3% par an, contre 15% pour les biens provenant de la Chine¹. Alors que le coût unitaire des biens intermédiaires importés depuis la Chine chute relativement à celui des autres pays producteurs entre 2000 et 2003, le nombre d'entreprises qui importent de ce pays doublent entre 2001 et 2007. L'entrée de la Chine à l'OMC en 2001 a accru sa compétitivité et a considérablement modifié la composition des flux commerciaux de la France.

Néanmoins, toutes les entreprises françaises n'ont pas bénéficié dans la même mesure de ce choc à cause d'une différence de productivité et de frictions sur les marchés internationaux. Pour importer des variétés étrangères, les entreprises doivent payer un coût fixe. Ce coût fixe contraint les entreprises les moins productives à

¹Source: Base de données WIOD et calcul de l'auteur

trouver des fournisseurs domestiques, ainsi elles ont accès un nombre de variétés plus faible. De plus, des frictions sur les marchés internationaux peuvent amplifier ce phénomène et empêcher certaines entreprises suffisamment productives d'importer des produits étrangers. Par exemple, une enquête de l'INSEE de Fontagné et d'Isanto (2013) a montré que la peur des employés et des syndicats est une des principales raisons de l'abandon de projet d'externalisation d'une partie de la production. Les autres barrières citées sont les barrières administratives et légales ainsi que l'incertitude sur la qualité des biens et des services à l'étranger. Ces frictions restreignent le potentiel de croissance de ces entreprises en leur faisant perdre des parts de marché et génèrent une mauvaise allocation des parts de marché entre entreprises, appelée "misallocation". Cette misallocation pèse négativement sur la croissance de la productivité agrégée qui est une moyenne pondérée de la productivité des entreprises.

Dans ce papier, je montre comment un choc commercial qui réduit le coût marginal des biens intermédiaires produits à l'étranger augmente la croissance de la productivité agrégée. Pour cela, j'étudie l'impact de l'entrée de la Chine à l'OMC sur la croissance de la Productivité Globale des Facteurs (PGF) en France entre 1995 et 2012. Ce choc commercial est exogène à l'économie française au cours de cette période, ce qui permet d'identifier un lien de causalité entre la hausse des importations et la croissance de la productivité.

La première contribution est théorique. J'introduis des biens intermédiaires dans un modèle avec des firmes hétérogènes et des distorsions sur les prix des biens et des facteurs de production. Les entreprises déterminent le montant optimal de production en maximisant leur profit qui est la somme de leurs ventes moins le coût des facteurs de production. Elles utilisent trois types de facteurs de production : du travail, du capital et des biens intermédiaires achetés domestiquement ou à l'étranger.

En plus de leur niveau de productivité, la part de marché des entreprises dépend de deux ingrédients : des distorsions sur le prix des biens et des facteurs de production et du coût fixe pour importer des biens intermédiaires produits à l'étranger.

Premièrement, les entreprises doivent payer un coût fixe pour importer des biens produits à l'étranger. En effet, trouver un fournisseur à l'étranger requiert un investissement initial pour faire de la prospection et établir une relation de confiance avec un partenaire dans un environnement légal, réglementaire et culturel différent. Ce coût est proportionnel au nombre de fournisseurs à l'étranger après maximisation du profit de l'entreprise. Plus le nombre de fournisseurs est grand, plus l'entreprise intègre dans son système de production un nombre élevé de biens intermédiaires au meilleur rapport qualité-prix, ce qui augmente la productivité marginale des biens intermédiaires et les parts de marché de l'entreprise.

Deuxièmement, les entreprises font face à des distorsions sur le prix des biens qu'elles produisent ou sur le prix des facteurs de production qu'elles consomment. Ces distorsions sont exogènes à l'entreprise et peuvent être, par exemple, dues à des barrières douanières ou législatives, ou encore à des subventions. Ces dernières augmentent ou réduisent disproportionnellement la part de marché des entreprises indépendamment de leur productivité, ce qui aboutit à une mauvaise allocation des ressources entre entreprises du point de vue du planificateur social.

Finalement, un choc d'ouverture commerciale qui diminue le coût marginal des variétés produites à l'étranger permet à un plus grand nombre d'entreprises relativement productives d'avoir accès à un plus grand panier des biens intermédiaires. En effet, ces entreprises peuvent être initialement contraintes à cause de la présence de frictions sur les marchés à l'étranger et du coût fixe à l'importation. A la suite de ce choc, ces dernières étendent leur part de marché pour se rapprocher de leur taille optimale qui est proportionnelle à leur niveau de productivité.

La seconde contribution est méthodologique et établit le lien entre la partie théorique et empirique. Je propose une nouvelle décomposition de la croissance de la productivité (PGF) agrégée afin de quantifier les gains de PGF liés à la réallocation des parts de marché entre les entreprises à la suite de l'ouverture commerciale de la Chine. Je réécris la décomposition d'Osotimehin (2016) avec un troisième facteur de production : des biens intermédiaires. La croissance de la PGF est le résultat de la variation de la productivité intra-firme (appelé efficacité technique) et de la variation de la taille relative des entreprises (appelé efficacité allocative). Cette décomposition est innovante car elle définit le degré d'efficacité allocative qui est définie en fonction de l'allocation optimale des parts de marché du point de vue du planificateur social. L'allocation est dite optimale quand la productivité marginale des entreprises est égalisée au sein du secteur et que la taille des entreprises est strictement proportionnelle à son niveau de productivité. Dans ce cadre, une réduction du coût marginal de biens produits à l'étranger, comme lors de l'ouverture commerciale de la Chine, permet une réallocation des parts de marché vers les entreprises relativement plus productives qui sont initialement contraintes par les frictions sur les marchés et le coût fixe à l'import. A la suite de ce choc, ces entreprises se rapprochent de leur taille optimale et augmente leur part de marché dans le secteur. Cet ajustement hétérogène de la taille relative des entreprises, à la suite d'un choc commercial, améliore l'efficacité allocative au sein des secteurs et contribue positivement à la croissance de la PGF agrégée.

La troisième contribution est empirique. Je quantifie l'impact de l'ouverture commerciale de la Chine sur la croissance de la productivité agrégée et de l'efficacité allocative en France. Je calcule la décomposition de la croissance de la productivité agrégée à partir des données d'entreprises françaises dans les secteurs manufacturiers entre 1995 et 2013. Je trouve qu'une hausse de 1% des importations de biens

intermédiaires depuis la Chine stimule en moyenne de 0.038% la croissance de la productivité annuelle. L'impact de cette ouverture commerciale est considérable, surtout que la Chine représente seulement 2% des biens intermédiaires des entreprises françaises en 1999 et qu'ils croissent à un rythme soutenu d'environ 10% par an depuis le début des années 2000. De plus, l'ensemble de ces gains de productivité est expliqué par une amélioration de l'efficacité allocative des parts de marché entre les entreprises. L'augmentation du nombre d'entreprises important des biens intermédiaires en provenance de la Chine est le principal canal via lequel le choc opère, ce qui confirme les mécanismes décrits dans la partie théorique. Pour conclure, l'entrée de la Chine à l'OMC a considérablement bouleversé l'organisation de la chaîne mondiale de valeur ajoutée en permettant à un plus grand nombre d'entreprises d'avoir accès à des biens intermédiaires avec un coût marginal plus faible. La France est également concernée et ce choc a positivement contribué à la croissance de sa productivité agrégée entre 1995 and 2012.

Mauvaise Allocation des Ressources et Réformes sur le marché du Travail dans les états en Inde: Chapitre 3

Encourager le développement économique à long terme et améliorer le niveau de vie constituent les principaux défis des pays en développement. Les dernières études montrent que la productivité est le principal facteur qui explique les différences entre pays en termes de PIB par habitant (Jones (2016), Restuccia et Rogerson (2017)). Les gains de productivité sont donc essentiels pour que les pays en développement puissent favoriser et accélérer leur développement économique. Les caractéristiques institutionnelles et les politiques gouvernementales peuvent avoir des effets importants sur cette dernière, car elles impactent le processus décisionnel des entreprises en

matière de production, d'investissement et d'allocation de leurs ressources limitées. En modifiant les variables qui servent à la maximisation du profit des entreprises, elles distordent l'allocation des parts de marché entre entreprises, ce que l'on appelle la mauvaise allocation, et entravent la croissance au niveau macroéconomique. Ces politiques peuvent être des obstacles à l'entrée et à la sortie des marchés, des limites sur la capacité de production de l'entreprise, ou des politiques fiscales et des subventions, etc. En Inde, il apparaît que l'ampleur de la mauvaise allocation de la main d'œuvre et du capital est assez importante et est probablement due à des politiques et à d'autres obstacles structurels créant des distorsions de prix entre les entreprises. Hsieh et Klenow (2009) ont montré que si l'Inde avait le niveau d'efficacité des États-Unis, elle pourrait réaliser des gains de productivité d'environ 40-60% dans le secteur manufacturier.

L'objectif de ce chapitre est d'étudier l'impact des réformes du marché du travail et de la disponibilité du crédit sur la *misallocation* dans les États indiens. Nous utilisons un modèle de concurrence monopolistique pour montrer comment les distorsions institutionnelles et de marché modifient la répartition des ressources entre les entreprises. Ensuite, nous définissons une nouvelle mesure de *misallocation*. Comme nous supposons que la productivité et les distorsions de prix au niveau de l'entreprise suivent une loi de distribution jointe log-normale, le ratio médiane-moyen de la productivité (TFPR) mesure l'étendue de la mauvaise allocation pour chaque état et secteur.

A partir d'une enquête contenant les bilans des entreprises indiennes pour les années 2003/04, 2006/07, 2008/09 et 2010/11, nous établissons empiriquement quatre principaux résultats. Premièrement, conformément à la littérature existante, la *misallocation* en Inde est relativement importante par rapport aux États - Unis et a augmenté dans les années 2000. Deuxièmement, dans l'ensemble des États indiens,

l'ampleur de la mauvaise allocation est considérable et il existe une hétérogénéité significative. Troisièmement, l'analyse économétrique suggère que les réformes visant à accroître la flexibilité du marché du travail contribuent à réduire la misallocation, surtout dans les États avec un large secteur informel. Enfin, les données suggèrent que les crédits ne sont pas toujours bien alloués entre les entreprises et une hausse du stock de crédits a tendance à être associés à un degré plus élevé de misallocation, sauf dans les secteurs fortement tributaires du financement externe. Ce dernier fait écho à des conclusions similaires (par exemple, Durantou et al (2015)), qui trouvent des preuves d'inefficacité dans la répartition des ressources financières en Inde.

2 Introduction

Productivity is a key economic concept as it is one of the main determinants of GDP per capita and living standard of a country. Productivity is defined as the ratio between the quantity produced and the amount of resources used to obtain it. It is a residual of a production function and it captures what is not explained by the increase of production factors used. For example, a better use of programming software can increase the output of a machine tool, all other factors being constant.

Since the early 2000s, many developed and developing countries are facing a slowdown in productivity. This trend is even more pronounced after the 2008-09 financial crisis. This is worrying as it threatens recent improvements of living standard, and both questions the sustainability of private and public debts and the viability of social protection systems. At least four factors explain the slowdown: a lack of business investment as a result of the credit crunch during the financial crisis, an aging population in most developed countries, a low speed in technologies diffusion between companies and between countries due to rigidities in the goods and labor markets and a slowdown in international trade flows.

The aim of this research is to understand how trade policies, regulatory framework and institution quality impact productivity at the level of both firm and country. This dissertation answers four main questions. Did trade openness help to achieve a higher level of aggregate productivity in Europe? How did outsourcing strategy in China of French firms contribute to aggregate productivity growth in France? To what extent do strict labor market regulations in India explain low productivity levels in some regions? And what is the role of the informal sector?

In the first chapter, in collaboration with Antoine Berthou, John Jong-Hyun Chung and Kalina Manova, we examine the impact of international trade on aggre-

gate productivity. We show theoretically and numerically that bilateral and unilateral export liberalization increase aggregate welfare and productivity, while unilateral import liberalization can either raise or reduce them. However, all three trade reforms have ambiguous effects in the presence of resource misallocation. Using a unique dataset on 14 European countries and 20 manufacturing industries from 1998 to 2011, we empirically establish that exogenous shocks to both export demand and import competition generate large gains in aggregate productivity. Decomposing these gains, we find that both trade activities increase average firm productivity, but export expansion also reallocates activity towards more productive firms, while import penetration acts in reverse. We provide evidence for two adjustment mechanisms. First, both export and import exposure raise the minimum productivity among active firms. Second, efficient institutions, flexible factor and product markets amplify the productivity gains from import competition, but dampen those from export expansion. We conclude that the effects of globalization operate through a combination of productivity-enhancing firm selection and reallocation across firms in the presence of resource misallocation.

In the second chapter, I study the impact of firm outsourcing strategy abroad on French aggregate TFP growth. I show theoretically and empirically that decreasing marginal cost of imported intermediate inputs foster aggregate productivity growth in presence of price distortions and fixed entry costs for importing foreign varieties. In a monopolistic competition model with heterogeneous firms, firm-level market share depends on two elements: (i) its productivity and its ability to pay the fixed cost to import varieties with the best price-quality ratio, (ii) exogenous distortions on the prices of inputs. After a trade liberalization, declining marginal cost of foreign inputs allow more firms in the mid-to-top productivity distribution to outsource new varieties at lower cost. It reduces their marginal cost of production and fosters sector-

level allocative efficiency of resources and TFP growth if they are initially constraint by market frictions. Using a comprehensive dataset of French firms between 1999 and 2012, I then implement a TFP decomposition and quantify gains in France from trade liberalization in China. I find that increasing sourcing of intermediate goods in China significantly raises French TFP growth through input-output linkages. The gains are fully explained by higher allocative efficiency.

In the third chapter, in collaboration with Adil Mohommad and Piyaporn Sod-sriwiboon, we analyze micro-level data for Indian manufacturing firms and identifies the nature, magnitude, and sources of misallocation. We show that the magnitude of resource misallocation in India is relatively large and heterogeneous across Indian states. We find that labor market rigidities in states with high informality, and availability of credit, are among the key drivers of misallocation in India. Our finding suggests that removing structural rigidities in the labor market and improving credit allocation would reduce distortions and contribute to productivity gains and long-term growth in India.

In the fourth and concluding chapter, I present a summary of our findings and directions for future work in the area of productivity, trade and structural reforms.

3 Productivity, (Mis)allocation and Trade

3.1 Introduction

World trade has steadily grown faster than world GDP since the early 1970s, and it expanded twice as quickly between 1985 and 2007.² Of great policy interest is how globalization affects aggregate productivity and welfare, and how its impact differs across countries at different levels of economic development. In advanced economies, increased competition from low-wage countries has exacerbated public debates about the gains from trade, in the face of rising concerns about domestic employment and inequality and China's dramatic trade expansion after joining the WTO in 2001. In developing countries, trade reforms have not always yielded all or only the desired benefits, leading policy makers to question the merits of trade openness in light of weak macroeconomic fundamentals and slow structural transformation.

Economics theory provides a clear rationale for trade liberalization: it enables a more efficient organization of production across countries, sectors and firms, which generates aggregate productivity growth and welfare gains. In particular, heterogeneous-firm trade models emphasize the importance of firm selection, the reallocation of activity across firms, and within-firm productivity upgrading as key channels mediating these gains (e.g. Melitz, 2003, Lileeva and Trefler, 2010). At the same time, recent macroeconomics and growth research highlights that institutional and market frictions distort the allocation of productive resources across firms and thereby reduce aggregate productivity (e.g. Hsieh and Klenow, 2009). However, how such frictions modify the gains from trade remains poorly understood.

This paper investigates the impact of international trade on aggregate produc-

²See Chapter 2 of the World Economic Outlook published by the International Monetary Fund (Ahn, 2016).

tivity. We show theoretically and numerically that bilateral and unilateral export liberalization increase aggregate productivity and welfare, while unilateral import liberalization can either raise or reduce them. However, all three trade reforms have ambiguous effects in the presence of resource misallocation. Using unique new data on 14 European countries and 20 manufacturing industries during 1998-2011, we empirically establish that exogenous shocks to both export demand and import competition generate large gains in aggregate productivity. Decomposing these gains, we find that both trade activities increase average firm productivity, but export expansion also reallocates activity towards more productive firms, while import penetration acts in reverse. To unpack the adjustment mechanisms, we show that both export and import exposure raise the minimum productivity among active firms. We also document that efficient institutions, factor and product markets amplify the productivity gains from import competition, but dampen those from export expansion. We conclude that the effects of globalization operate through a combination of improved firm selection and reallocation across firms in the presence of resource misallocation.

Our first contribution is theoretical. We examine the impact of trade liberalization in a standard heterogeneous-firm trade model with potential resource misallocation. We also numerically simulate the model to assess its qualitative and quantitative predictions. We emphasize two main results.

First, in the absence of misallocation, reductions in bilateral trade costs and in unilateral export costs unambiguously raise aggregate productivity and welfare, as in Melitz (2003) and Melitz and Redding (2014a). On the extensive margin, such reforms raise the productivity threshold above which domestic firms can operate. On the intensive margin, they shift activity from less towards more productive firms. By contrast, unilateral import reforms have ambiguous consequences because they increase market competitiveness both in the liberalizing country and in its trade

partner, with opposite effects on the productivity cut-off at home. This results in welfare and productivity gains when wages are flexible, but leads to Metzler-paradox losses when wages are fixed in an outside sector, as in Demidova and Rodriguez-Clare (2013) and Bagwell and Lee (2016).

Second, with resource misallocation, the impact of both bilateral and unilateral trade liberalization on aggregate productivity and welfare becomes ambiguous. Moreover, this impact is not monotonic in the degree of misallocation, such that more severe distortions may amplify, dampen or reverse the gains from globalization. In the model, firms receive two exogenous draws, productivity φ and distortion η . Distortions η create a wedge between the social and the private marginal cost of production, and generate an inefficient allocation of production resources and market shares across firms that is based on distorted productivity $\underline{\varphi} = \varphi\eta$ rather than true productivity φ . Implicitly, this misallocation arises only due to institutional imperfections that cause frictions in the markets for factor inputs or output products, and is not driven by variable mark-ups as in Dhingra and Morrow (2016). Globalization has ambiguous productivity and welfare effects because distorted economies operate in a second-best equilibrium and trade reforms can worsen or improve allocative efficiency.

Our second contribution is methodological and provides an important bridge between theory and empirics. We demonstrate how key theoretical concepts in the model map to empirically observable variables, and how theoretical mechanisms can be assessed with available data. We first show that firm productivity measured by real value added per worker is monotonic in theoretical firm productivity, conditional on export status. We then demonstrate that welfare is generally not monotonic in measured aggregate productivity, defined as employment-weighted average firm productivity. However, the two are exactly proportional in the special case of no

misallocation and free entry with Pareto-distributed productivity. They also move together in a wide segment of the parameter space away from this special case, but only as long as there is no misallocation.

We next decompose measured aggregate productivity into the measured unweighted average firm productivity and the measured covariance of firms' productivity and employment share, as in Olley and Pakes (1996). While it may be intuitive that the latter captures allocative efficiency, we show that it is not a sufficient statistic for the model parameters governing misallocation or for the resultant extent of resource misallocation. But crucially, the OP decomposition is nevertheless informative: Numerical simulations indicate that trade reforms can move the two OP components of aggregate productivity in opposite directions if and only if there is resource misallocation.

Our third contribution is empirical. Guided by the theoretical framework, we empirically assess the effect of international trade on aggregate productivity and the mechanisms through which this effect operates. We use rich new data assembled by the Competitive Research Network at the ECB on aggregate labor productivity for 14 European countries and 20 manufacturing industries during 1998-2011. These data are unique in capturing not only aggregate outcomes, but also multiple moments of the underlying distribution across firms. This makes it possible to implement the OP decomposition in a large cross-country, cross-sector panel for the first time.

Our baseline measures of countries' trade exposure are their gross exports and imports by sector from the World Input-Output Database. Since these trade outcomes are endogenous, we exploit a 2SLS IV strategy to identify the causal impact of plausibly exogenous shocks to export demand and import competition. This strategy uses the variation in the initial composition of countries' trade flows, and capitalizes on two WIOD features: the distinction between gross and value-added trade flows,

and information on the sector of final use for each trade flow. We instrument for export demand with a Bartik-style weighted average of absorption across a country's export destinations, by sector. We instrument for import supply with import tariffs and a Bartik-style weighted average of value-added exports for final consumption across a country's import origins, by sector. We provide consistent results when we alternatively consider (instrumented) import competition specifically from China, and confirm the stability of our findings to a series of robustness exercises.

We establish four empirical results. First, both export expansion and import penetration significantly increase aggregate productivity. Our estimates imply that a 20% rise in export demand would boost overall productivity by 7.6%-8.2% depending on the specification, while a comparable change in import competition would generate productivity gains in the 1%-10% range.

Second, the productivity gains from export and import activity are mediated through different channels. Export growth induces higher average firm productivity and a reallocation of economic activity towards more productive firms, with the latter contributing 23%-39% of the total effect. By contrast, all of the benefits from import competition result from improved average firm productivity, with 17%-36% of these gains in fact negated by a shift in activity towards less productive firms.

Third, both export and import exposure raise the minimum productivity among active firms, consistent with international trade improving aggregate productivity by triggering exit from the left tail of the distribution. However, firm selection accounts for only about half of the total productivity gains.

Finally, the theoretical analysis indicates that these three empirical patterns can only be rationalized with resource misallocation moderating the impact of globalization. In line with this conclusion, we document that efficient institutions, factor and product markets amplify the productivity gains from import competition, but

dampen those from export expansion. We measure overall institutional quality with rule of law, and exploit indices for labor market flexibility, creditor rights' protection and product market regulation to proxy institutional frictions in input and output markets.

These findings reveal the complex interaction between firm heterogeneity and resource misallocation that determine the aggregate welfare and productivity impact of trade liberalization. In particular, they point to asymmetries in the ability of distorted economies to respond to and gain from positive shocks to domestic firms such as growing export demand and negative shocks such as tighter import competition.

Our primary contribution is to characterize and quantify the productivity gains from trade while distinguishing between export and import exposure and assessing the adjustments to average firm productivity and resource allocation across firms. We thus speak to a vibrant theoretical trade literature on the role of firm heterogeneity for the welfare gains from globalization and inform the empirical validity of the mechanisms it highlights (e.g. Arkolakis et al. (2012), Melitz and Redding (2014a)). Prior empirical work has typically analyzed one-sided trade liberalization episodes in specific countries, often exploiting micro-level data. By contrast, we provide systematic cross-country evidence which nevertheless allows us to examine the firm dimension, establish causality, and directly compare the impact of export and import expansion.

We find evidence consistent with several mechanisms identified in previous studies. For example, Pavcnik (2002) explores the aggregate productivity gains from trade reforms in Chile in the late 1970s. Using a decomposition similar to ours, she concludes that about 2/3 of the gains resulted from improvements in the OP covariance term. On the other hand, Harrison et al. (2013) find that most of the

productivity benefits from trade liberalization in India during 1990-2010 came from changes in the average productivity of surviving firms. In the case of the US, Bernard et al. (2006) show that following a decline in trade barriers, liberalized sectors experienced faster productivity growth both because the least productive firms exited and because more productive firms expanded operations. Adjustments within surviving firms have also been documented in response to trade reforms, such as production technology upgrading (Lileeva and Trefler, 2010; Bustos, 2011; Bloom et al., 2016), product quality upgrading (Amiti and Konings, 2007; Amiti and Khandelwal, 2013; Martin and Méjean, 2014), reallocations across multiple products (Bernard et al., 2011; Mayer et al., 2014; Manova and Yu, 2016), and product scope expansion (Goldberg et al., 2010; Khandelwal et al., 2013).

Our second contribution is to analyze the implications of resource misallocation for the adjustment to and welfare gains from trade. A burgeoning literature in macroeconomics shows that market frictions can distort the allocation of resources across firms and lower aggregate productivity (Hsieh and Klenow, 2009; Epifani and Gancia; Bartelsman et al., 2013; Gopinath et al., 2017; Edmond et al., 2015; Foster et al., 2008), and Foster et al. (2015, 2016). At the same time, a growing body of work documents the detrimental impact of financial and labor market frictions on international trade activity (Chor and Manova, 2012; Manova, 2013; Foley and Manova, 2015; Helpman et al., 2010). We draw on insights from these two strands of research to inform the fundamental question of welfare gains from trade in the presence of imperfect resource allocation. Our findings relate to several concurrent studies in this vein. Ben Yahmed and Dougherty (2017) find that the impact of import competition on firm productivity depends on the degree of product market regulation, while Alfaro and Chen (2017) conclude that greater competition from multinational firms fosters productivity-enhancing reallocations of activity among

domestic firms. Ding, Jiang and Sun (2016) document that import competition reduces productivity dispersion in China due to the exit of less productive firms.

The rest of the paper is organized as follows. Section 2 theoretically and numerically examines the impact of globalization on aggregate productivity. Section 3 introduces the CompNet and WIOD data. Section 4 presents the baseline OLS estimates, while Section 5 develops the IV estimation strategy and reports the main IV results. Section 6 explores the mechanisms through which international trade operates. The last section concludes.

3.2 Theoretical Framework

We examine the impact of international trade on aggregate welfare and productivity in a general-equilibrium model with firm heterogeneity in productivity as in Melitz (2003) and Chaney (2008) and potential resource misallocation as in Bartelsman et al. (2013). We formalize the main theoretical results and provide intuition for the underlying mechanisms in this section, and relegate detailed proofs to Appendix A.

Our goal is threefold. First, we highlight that in the absence of resource misallocation, bilateral and unilateral export liberalizations always raise aggregate welfare and productivity, while unilateral import liberalization can have ambiguous effects. Second, we show that all three types of globalization have ambiguous consequences in the presense of misallocation. Third, we characterize the relationship between the concepts of welfare and productivity in the model and measures of firm and aggregate productivity in the data to provide a bridge between theory and empirics.

3.2.1 Set Up

Consider a world with two potentially asymmetric countries $i = 1, 2$.³ In each country, a measure L_i of consumers inelastically supply a unit of labor, such that aggregate expenditure is $E_i = w_i L_i$ due to free firm entry into production. The utility of the representative consumer U_i is a Cobb-Douglas function of consumption of a homogeneous good H_i and a CES aggregate over consumption of available differentiated varieties $z \in \Omega_i$ with elasticity of substitution $\sigma \equiv 1/(1 - \alpha) > 1$:

$$U_i = H_i^{1-\beta} Q_i^\beta, \quad Q_i = \left[\int_{z \in \Omega_i} q_i(z)^\alpha dz \right]^{1/\alpha}. \quad (3.1)$$

Demand $q_i(z)$ for variety z with price $p_i(z)$ in country i is thus $q_i(z) = \beta E_i P_i^{\sigma-1} p_i(z)^{-\sigma}$, where βE_i is total expenditure on differentiated goods and $P_i = \left[\int_{z \in \Omega_i} p_i(z)^{1-\sigma} dz \right]^{1/(1-\sigma)}$ is an ideal price index.

The homogeneous good is freely tradeable and produced under CRS technology that converts one unit of labor into one unit of output. It proves important to distinguish between two cases. When β is sufficiently low, both countries produce the homogeneous good, such that it serves as a numeraire that fixes worldwide wages to unity, $w_i = 1$. We will refer to this case simply as $\beta < 1$. When $\beta = 1$ by contrast, only differentiated goods are consumed, and wages are endogenously determined in equilibrium.

In each country, a continuum of monopolistically competitive firms produce horizontally differentiated goods that they can sell at home and potentially export

³The model can be easily extended to a world with N asymmetric countries. In the global equilibrium, the equilibrium conditions below would hold for each country. From the perspective of country i , the impact of import or export liberalization in i that is symmetric with respect to all other countries would be independent of N ; the impact of bilateral reforms with trade partner j would be qualitatively the same but moderated by j 's relative market size.

abroad. Firms must pay a sunk entry cost $w_i f_i^E$,⁴ and should they commence production, fixed operation costs $w_i f_{ii}$ and constant marginal costs as specified below. Exporting from i to j requires fixed overhead costs $w_i f_{ij}$ and iceberg trade costs such that τ_{ij} units of a product need to be shipped for 1 unit to arrive, where $\tau_{ii} = 1$ and $\tau_{ij} > 1$ if $i \neq j$. We allow for $\tau_{ij} \neq \tau_{ji}$, and will analyze symmetric and asymmetric reductions in τ_{ij} to assess the impact of different trade reforms.

3.2.2 Firm Productivity and Resource Misallocation

In the absence of misallocation, firms in country i draw productivity φ upon entry from a known Pareto distribution $G_i(\varphi) = 1 - (\varphi_i^m/\varphi)^\theta$, where $\theta > \sigma - 1$ and $\varphi_i^m > 0$. This fixes firms' constant marginal cost to w_i/φ . In the presence of resource misallocation by contrast, firms draw both productivity φ and distortion η from a known joint distribution $H_i(\varphi, \eta)$. Firms' marginal cost is now determined by their *distorted productivity* $\underline{\varphi} = \varphi\eta$ and equals $w_i/\underline{\varphi} = w_i/(\varphi\eta)$. For comparability with the case of no misallocation, we assume that $\underline{\varphi}$ is Pareto distributed with scale parameter $\underline{\varphi}_i^m$ and shape parameter θ .

Conceptually, η captures any distortion that creates a wedge between the social marginal cost of an input bundle and the private marginal cost to the firm. Formally, this implies a firm-specific wedge in the first-order condition for profit maximization, as in Hsieh and Klenow (2009) and Bartelsman et al. (2013). Such a wedge may result from frictions in capital or labor markets or generally weak contractual institutions that support inefficient practices like corruption and nepotism.⁵ Distortions η will

⁴We consider a variant of the model with an exogenous mass of firms in Appendix B.

⁵Examples include the allocation of MFA export quota rights in China based on firms' state ownership and political connections, labor regulations that depend on firms' employment level, or credit provision based on personal or political connections due to weak contract enforcement (e.g. Khandelwal et al. (2013); Midrigan and Xu (2014)).

lead to deviations from the first-best allocation of productive resources across firms: If a firm can access "too much" labor, this would be equivalent to a subsidy of $\eta > 1$. Conversely, capacity constraints would correspond to a tax of $\eta < 1$.

Modeling resource misallocation in this way has several appealing features. First, introducing distortions on the input side is isomorphic to allowing for distortions in output markets instead, such as firm-specific sales taxes.⁶ Our theoretical formulation thus ensures tractability without loss of generality. In the empirical analysis, we correspondingly exploit different measures of broad institutional quality, capital and labor market frictions, and restrictive product market regulations. Second, in our model misallocation describes the inefficient allocation of production resources and consequently market shares across firms in the differentiated industry, as well as across sectors when $\beta < 1$. Since the combination of CES preferences and monopolistic competition will imply constant mark-ups, no additional misallocation arises from variable mark-ups across firms as in Dhingra and Morrow (2016).

Finally, the functional form for firms' marginal costs permits a transparent comparison of firm and economy-wide outcomes with and without misallocation. Under misallocation, firm selection, production and export activity depend on φ and η only through distorted productivity $\underline{\varphi} = \varphi\eta$, while optimal resource allocation in the first best depends on φ alone. Thus two parameters regulate the degree of misallocation: the dispersion of the distortion draw, σ_η , and the correlation between the distortion and productivity draws, $\rho(\varphi, \eta)$.⁷ Misallocation occurs if and only if $\sigma_\eta > 0$, but its

⁶For example, one can specify the distortion on the revenue side such that firm profits equal $\pi_{ij}(\varphi, \eta) = \eta p_{ij} q_{ij} - w_i l_{ij}$.

⁷For example, with asymmetric information and imperfect contract enforcement in credit markets, creditors may base loan decisions on a noisy signal of firm productivity, such that $0 < \rho(\varphi, \eta) < 1$. Alternatively, if more productive firms optimally higher more skilled workers to produce higher-quality goods, labor market frictions may be especially costly in the specialized market for skilled workers, such that $\rho(\varphi, \eta) < 0$.

severity need not vary monotonically in the $\sigma_\eta - \rho(\varphi, \eta)$ space.⁸

3.2.3 Firm Behavior

We first characterize firms' optimal behavior in the absence of resource misallocation. Producers choose their sales price $p_{ij}(\varphi)$ and quantity $q_{ij}(\varphi)$ to maximize profits $\pi_{ij}(\varphi)$ separately in each market j they serve. The problem of a firm with productivity φ and its first-best outcomes are thus:

$$\max_{p,q} \pi_{ij}(\varphi) = p_{ij}(\varphi)q_{ij}(\varphi) - w_i\tau_{ij}q_{ij}(\varphi)/\varphi - w_if_{ij} \quad \text{s.t.} \quad q_{ij}(\varphi) = \beta E_j P_j^{\sigma-1} p_{ij}(\varphi) \quad (3.2)$$

$$p_{ij}(\varphi) = \frac{w_i\tau_{ij}}{\alpha\varphi}, \quad q_{ij}(\varphi) = \beta E_j P_j^{\sigma-1} \left(\frac{\alpha\varphi}{w_i\tau_{ij}} \right)^\sigma, \quad (3.3)$$

$$l_{ij}(\varphi) = f_{ij} + \frac{\tau_{ij}q_{ij}(\varphi)}{\varphi}, \quad c_{ij}(\varphi) = w_i \left(f_{ij} + \frac{\tau_{ij}q_{ij}(\varphi)}{\varphi} \right) = \alpha r_{ij}(\varphi) + w_if_{ij}, \quad (3.4)$$

$$r_{ij}(\varphi) = \beta E_j \left(\frac{\alpha P_j \varphi}{w_i\tau_{ij}} \right)^{\sigma-1}, \quad \pi_{ij}(\varphi) = \frac{r_{ij}(\varphi)}{\sigma} - w_if_{ij}. \quad (3.5)$$

where $l_{ij}(\varphi)$, $c_{ij}(\varphi)$ and $r_{ij}(\varphi)$ are the employment, costs and revenues associated with sales in j .

Since profits are monotonically increasing in productivity, firms in country i sell in country j only if their productivity exceeds threshold φ_{ij}^* . The domestic and export cut-offs are implicitly defined by:

$$r_{ii}(\varphi_{ii}^*) = \sigma w_i f_{ii}, \quad r_{ij}(\varphi_{ij}^*) = \sigma w_i f_{ij}. \quad (3.6)$$

We assume as standard that the parameter space guarantees $\varphi_{ij}^* > \varphi_{ii}^*$ for any $\tau_{ij} >$

1. Along with consumer love of variety and fixed operation costs f_{ii} , this implies

⁸We consider numerical simulations for the case of joint log-normal distribution $G_i(\varphi, \eta)$, which is fully characterized by $\rho(\varphi, \eta) < 1$ and σ_η . Higher-order moments may also matter under alternative distributional assumptions.

selection into exporting, such that no firm exports without also selling at home. In turn, firms commence production upon entry only if their productivity draw is above φ_{ii}^* , and exit otherwise.

Following the same solution concept, we next determine firms' constrained-optimal behavior in the case of misallocation. The profit-maximizing problem of a firm with distorted productivity $\underline{\varphi} = \varphi\eta$ generates the following second-best outcomes:

$$\max_{p,q} \pi_{ij}(\varphi, \eta) = p_{ij}(\varphi, \eta)q_{ij}(\varphi, \eta) - w_i\tau_{ij}q_{ij}(\varphi, \eta)/\varphi\eta - w_i f_{ij} \quad \text{s.t.} \quad q_{ij}(\varphi, \eta) = \beta E_j P_j^{\sigma-1} p_{ij}(\varphi, \eta)^{-\sigma} \quad (3.7)$$

$$p_{ij}(\varphi, \eta) = \frac{w_i\tau_{ij}}{\alpha\varphi\eta}, \quad q_{ij}(\varphi, \eta) = \beta E_j P_j^{\sigma-1} \left(\frac{\alpha\varphi\eta}{w_i\tau_{ij}} \right)^\sigma, \quad (3.8)$$

$$l_{ij}(\varphi, \eta) = f_{ij} + \frac{\tau_{ij}q_{ij}(\varphi, \eta)}{\varphi}, \quad c_{ij}(\varphi, \eta) = w_i \left(f_{ij} + \frac{\tau_{ij}q_{ij}(\varphi, \eta)}{\varphi\eta} \right), \quad (3.9)$$

$$r_{ij}(\varphi, \eta) = \beta E_j \left(\frac{\alpha P_j \varphi \eta}{w_i \tau_{ij}} \right)^{\sigma-1}, \quad \pi_{ij}(\varphi, \eta) = \frac{r_{ij}(\varphi, \eta)}{\sigma} - w_i f_{ij}. \quad (3.10)$$

While it would be socially optimal to allocate input factors and output sales based on true firm productivity φ , in the market equilibrium this allocation is instead pinned down by distorted productivity $\underline{\varphi}$. Along the intensive margin, firms with low (high) distortion draws η produce and earn less (more) than in the first best, while charging consumers higher (lower) prices than efficient. Along the extensive margin, a highly productive firm might be forced to exit if it endures prohibitively high distortive taxes, while a less productive firm might be able to operate or export if it benefits from especially high subsidies. In particular, firms now produce for the domestic and foreign market as long as their distorted productivity exceeds cut-offs

$\underline{\varphi}_{ii}^*$ and $\underline{\varphi}_{ij}^*$, respectively:

$$r_{ii}(\underline{\varphi}_{ii}^*) = \sigma w_i f_{ii}, \quad r_{ij}(\underline{\varphi}_{ij}^*) = \sigma w_i f_{ij}. \quad (3.11)$$

3.2.4 General Equilibrium

The general equilibrium is characterized by equilibrium conditions that ensure free entry, labor market clearing, income-expenditure balance, and international trade balance in each country.

Consider first the case of no misallocation. With free entry, ex-ante expected profits must be zero:

$${}_j\mathbf{E} [\pi_{ij}(\varphi)\mathbf{I}(\varphi \geq \varphi_{ij}^*)] = w_i f_i^E \iff \quad (3.12)$$

$$f_{ii} \int_{\varphi_{ii}^*}^{\infty} \left[\left(\frac{\varphi}{\varphi_{ii}^*} \right)^{\sigma-1} - 1 \right] dG_i(\varphi) + f_{ij} \int_{\varphi_{ij}^*}^{\infty} \left[\left(\frac{\varphi}{\varphi_{ij}^*} \right)^{\sigma-1} - 1 \right] dG_i(\varphi) = f_i^E. \quad (3.13)$$

where $\mathbf{E}[\cdot]$ is the expectation operator and $\mathbf{I}(\cdot)$ is the indicator function.

A key implication of the free-entry condition is that the productivity cut-offs in country i for production and exporting must always move in opposite directions following trade reforms that affect τ_{ij} or τ_{ji} . Intuitively, any force that lowers φ_{ij}^* tends to increase expected export profits conditional on production. For free entry to continue to hold, threshold φ_{ii}^* must therefore rise, such that the probability of survival conditional on entry falls and overall expected profits from entry remain unchanged.

When $\beta < 1$, wages are fixed and pinned down in the homogeneous-good sector. When $\beta = 1$, by contrast, wages are flexible and determined by labor market clearing

in the differentiated-good sector:

$$L_i =_j M_i \mathbf{E} [l_{ij}(\varphi) \mathbf{I}(\varphi \geq \varphi_{ij}^*)] + M_i f_i^E, \quad (3.14)$$

where M_i is the mass of entering firms in country i .

In equilibrium, aggregate consumer income E_j must equal aggregate expenditure in the economy. With free entry, aggregate corporate profits net of entry costs are 0, such that total income corresponds to the total wage bill. Consumers' utility maximization implies the following income-expenditure balance:

$$\beta E_j = \beta w_j L_j =_i R_{ij} =_i M_i \mathbf{E} [r_{ij}(\varphi) \mathbf{I}(\varphi \geq \varphi_{ij}^*)], \quad (3.15)$$

where R_{ij} is aggregate spending by consumers in country j on differentiated varieties from country i .^{9,10}

Consider next the case of resource misallocation. The free entry and labor market clearing conditions are analogous to those above after replacing productivity φ with distorted productivity $\underline{\varphi} = \varphi\eta$. The income-expenditure balance, however, has to be amended to account for the implicit dead-weight loss of misallocation. While firm (φ, η) incurs production costs $c_{ij}(\varphi, \eta) = w_i \left(f_{ij} + \frac{\tau_{ij} q_{ij}(\varphi, \eta)}{\varphi\eta} \right)$, the associated payment received by workers is $c'_{ij}(\varphi, \eta) = w_i \left(f_{ij} + \frac{\tau_{ij} q_{ij}(\varphi, \eta)}{\varphi} \right)$. The gap $c_{ij}(\varphi, \eta) - c'_{ij}(\varphi, \eta)$ is the social cost of distortionary firm-specific taxes or subsidies on labor costs, which we assume is covered through lump-sum taxation of consumers in i . The new

⁹When $\beta = 1$, general equilibrium requires an additional condition for balanced trade in the differentiated-goods sector that implicitly links productivity thresholds and relative wages across countries: $_i R_{ik} =_j R_{kj}$.

¹⁰With an exogenous mass of firms, the free entry condition is moot, and the labor market clearing condition reduces to $L_i =_j M_i \mathbf{E} [l_{ij}(\varphi) \mathbf{I}(\varphi \geq \varphi_{ij}^*)]$. Since aggregate corporate profits Π_j are no longer 0, the income-expenditure condition becomes $\beta E_j = \beta(w_j L_j + \Pi_j)$. This condition also directly guarantees balanced trade when $\beta = 1$. See Appendix B.

equilibrium conditions become:

$${}_j\mathbf{E} \left[\pi_{ij}(\varphi, \eta) \mathbf{I}(\varphi\eta \geq \underline{\varphi}_{ij}^*) \right] = w_i f_i^E, \quad (3.16)$$

$$L_i = {}_j M_i \mathbf{E} \left[l_{ij}(\varphi, \eta) \mathbf{I}(\varphi\eta \geq \underline{\varphi}_{ij}^*) \right] + M_i f_i^E, \quad (3.17)$$

$$\beta E_j = \beta(w_j L_j - T_j) = {}_i R_{ij} = {}_i M_i \mathbf{E} \left[r_{ij}(\varphi, \eta) \mathbf{I}(\varphi\eta \geq \underline{\varphi}_{ij}^*) \right], \quad (3.18)$$

$$T_i = {}_j M_i \mathbf{E} \left[[c_{ij}(\varphi, \eta) - c'_{ij}(\varphi, \eta)] \mathbf{I}(\varphi\eta \geq \underline{\varphi}_{ij}^*) \right]. \quad (3.19)$$

3.2.5 Welfare

Welfare in country i is given by real consumption per capita and can be expressed as:

$$W_i = \left\{ \begin{array}{ll} (1 - \beta)^{1-\beta} \beta^\beta \frac{w_i}{P_i^\beta} \chi_i & \text{if } \beta < 1 \\ \frac{w_i}{P_i} \chi_i & \text{if } \beta = 1 \end{array} \right\} \text{ where } \chi_i = \frac{E_i}{w_i L_i} = \frac{w_i L_i - T_i}{w_i L_i}. \quad (3.20)$$

Up to a constant, welfare is thus proportional to the real wage, w_i/P_i^β , and the ratio of disposable income to gross income, χ_i . In the absence of misallocation, all income accrues to worker-consumers, such that $E_i = w_i L_i$ and $\chi_i = 1$. In the presence of misallocation, by contrast, some income is not available to consumers due to the dead-weight loss of distortions, such that $E_i = w_i L_i - T_i$.¹¹

One can show that the real wage, and therefore also welfare, is a function only of model parameters (market size L_i , fixed production costs f_{ii} , and demand elasticities β and σ) and two endogenous equilibrium outcomes: the (distorted) productivity cut-

¹¹With an exogenous mass of firms instead of free entry, aggregate firm profits are positive. Assuming as standard that consumers hold a diversified domestic firm portfolio, firm profits accrue to consumers and are part of their disposable income.

off for domestic production, φ_{ii}^* or $\underline{\varphi}_{ii}^*$, and the ratio of disposable to gross income, χ_i . This is summarized by the following lemma and proportionality condition:¹²

$$W_i \propto \left\{ \begin{array}{ll} \left(\frac{L_i}{\sigma f_{ii}} \right)^{\frac{\beta}{\sigma-1}} (\varphi_{ii}^*)^\beta & \text{without misallocation} \\ \left(\frac{L_i}{\sigma f_{ii}} \right)^{\frac{\beta}{\sigma-1}} (\chi_i)^{\frac{\beta+\sigma-1}{\sigma-1}} (\underline{\varphi}_{ii}^*)^\beta & \text{with misallocation} \end{array} \right\}. \quad (3.21)$$

Lemma 1 *Without misallocation, welfare increases with the domestic productivity cut-off, $\frac{dW_i}{d\varphi_{ii}^*} > 0$. With misallocation, welfare increases with the distorted domestic productivity cut-off, $\frac{dW_i}{d\underline{\varphi}_{ii}^*} > 0$, and with the share of disposable income in gross income, $\frac{dW_i}{d\chi_i} > 0$.*

With efficient resource allocation, a higher productivity cut-off φ_{ii}^* implies a shift in economic activity towards more productive firms, which intuitively tends to lower the aggregate price index and increase consumers' real income. With misallocation, distortions affect welfare through the reduction in disposable income χ_i and through the sub-optimal selection of active firms based on distorted productivity $\underline{\varphi}$ rather than true productivity φ . A direct implication of Lemma 1 is that the welfare impact of trade liberalization depends on how a reduction in τ_{ij} affects φ_{ii}^* , $\underline{\varphi}_{ii}^*$, and χ_i .

3.2.6 From Theory to Empirics

A key challenge in empirically evaluating the gains from trade is that the theoretical concepts of productivity and welfare are not directly observed in the data. In this section, we show that measurement error and resource misallocation result in important disconnect between these theoretical objects and their measured counterparts

¹²The exact expressions for W_i include an additional constant term: α when $\beta = 1$ and $(1 - \beta)^{1-\beta} \beta^\beta \alpha^\beta$ when $\beta < 1$.

that the literature typically ignores. This will closely guide our empirical design and interpretation.

3.2.6.1 Theoretical vs. measured firm productivity

The theoretical concept of firm productivity φ is quantity-based (TFPQ), while empirical measures $\Phi_i(\varphi)$ are generally revenue-based (e.g. TFPR or labor productivity). We now show that the observed real value added per worker is an attractive choice for $\Phi_i(\varphi)$, and we therefore use it in the empirical analysis.

Observed value added corresponds to the theoretical notion of total firm revenues $r_i(\varphi)$ from domestic sales and any exports, where $r_i(\varphi) = \sum_j r_{ij}(\varphi)\mathbf{I}(\varphi \geq \varphi_{ij}^*)$. Observed employment represents the total units of labor $l_i(\varphi)$ that a firm hires to produce for home and abroad, $l_i(\varphi) = \sum_j l_{ij}(\varphi)\mathbf{I}(\varphi \geq \varphi_{ij}^*)$. Denoting labor used towards fixed overhead and export costs as $f_i(\varphi) = \sum_j f_{ij}\mathbf{I}(\varphi \geq \varphi_{ij}^*)$ and normalizing by the consumer price index P_i , measured firm productivity becomes:

$$\Phi_i(\varphi) = \frac{r_i(\varphi)}{P_i l_i(\varphi)} = \frac{w_i}{\alpha P_i} \left[1 - \frac{f_i(\varphi)}{l_i(\varphi)} \right]. \quad (3.22)$$

One can show that conditional on export status, measured firm productivity increases monotonically with theoretical firm productivity, $\Phi'_i(\varphi|\varphi < \varphi_{ij}^*) > 0$ and $\Phi'_i(\varphi|\varphi \geq \varphi_{ij}^*) > 0$. Note first that the ratio of sales to variable employment, $r_i(\varphi)/[l_i(\varphi) - f_i(\varphi)]$, is invariant across firms with constant mark-ups, but this does not hold for sales to total employment, $r_i(\varphi)/l_i(\varphi)$, because of economies of scale. However, the measured productivity of firm φ based on domestic sales should it not export exceeds its measured productivity based on global sales should it export, $r_{ii}(\varphi)/l_{ii}(\varphi) > r_i(\varphi)/l_i(\varphi)$. This is due to a downward shift in the function $\Phi_i(\varphi)$ at the export productivity cut-off φ_{ij}^* , because firms incur fixed export costs such that

$r_{ii}(\varphi_{ij}^*)/l_{ii}(\varphi_{ij}^*) > r_{ij}(\varphi_{ij}^*)/l_{ij}(\varphi_{ij}^*)$. Finally, observe that measured firm productivity increases with the real wage, w_i/P_i , and implicitly depends on the productivity thresholds, φ_{ii}^* and φ_{ij}^* .

In the case of misallocation, there is an analogous relationship between theoretical and observed distorted productivity, $\underline{\varphi} = \varphi\eta$ and $\underline{\Phi}_i(\varphi, \eta)$:

$$\underline{\Phi}_i(\varphi, \eta) = \frac{r_i(\varphi, \eta)}{P_i l_i(\varphi, \eta)} = \frac{w_i}{\alpha P_i \eta} \left[1 - \frac{f_i(\varphi, \eta)}{l_i(\varphi, \eta)} \right]. \quad (3.23)$$

3.2.6.2 Measured aggregate productivity and OP decomposition

Define measured aggregate productivity $\tilde{\Phi}_i$ as the employment-weighted average of measured firm productivity:

$$\tilde{\Phi}_i \equiv \int_{\varphi_{ii}^*}^{\infty} \theta_i(\varphi) \Phi_i(\varphi) \frac{dG_i(\varphi)}{1 - G_i(\varphi_{ii}^*)}, \quad (3.24)$$

where $\theta_i(\varphi) = l_i(\varphi) / \left[\int_{\varphi_{ii}^*}^{\infty} l_i(\varphi) \frac{dG_i(\varphi)}{1 - G_i(\varphi_{ii}^*)} \right]$ is firm φ 's share of aggregate employment.¹³ Note that the denominator in this employment share excludes labor used towards the sunk entry costs, which is unobserved in the data.

As an accounting identity, aggregate measured productivity $\tilde{\Phi}_i$ can be decomposed into the unweighted average measured productivity across firms, $\bar{\Phi}_i$, and the covariance between firms' measured productivity and share of economic activity, $\ddot{\Phi}_i$, known as the OP gap (Olley and Pakes, 1996):

$$\tilde{\Phi}_i = \bar{\Phi}_i + \ddot{\Phi}_i = \int_{\varphi_{ii}^*}^{\infty} \Phi_i(\varphi) \frac{dG_i(\varphi)}{1 - G_i(\varphi_{ii}^*)} + \int_{\varphi_{ii}^*}^{\infty} [\Phi_i(\varphi) - \bar{\Phi}_i] [\theta_i(\varphi) - \bar{\theta}_i] \frac{dG_i(\varphi)}{1 - G_i(\varphi_{ii}^*)}. \quad (3.25)$$

¹³In the data, the firm weights are defined such that they sum to 1 across firms. Here, $\theta_i(\varphi)$ is defined such that it averages 1 across firms. This ensures that the residual in the OP decomposition is the covariance of $\Phi_i(\varphi)$ and $\theta_i(\varphi)$.

The OP decomposition reveals the mechanisms through which adjustments across and within firms shape aggregate measured productivity $\tilde{\Phi}_i$. Changes in $\bar{\Phi}_i$ reflect two effects of firm selection: exit/entry into production which modifies the set of active firms, and exit/entry into production and into exporting which preserves the set of firms but impacts measured firm productivity. Changes in $\ddot{\Phi}_i$ identify reallocations of economic activity across firms with different productivity levels through changes in their employment share and, implicitly, in their output and sales.

The OP decomposition remains valid in the case of misallocation, when $\underline{\varphi}$, $\underline{\varphi}_{ii}^*$, $\underline{\Phi}_i(\varphi, \eta)$, and $H_i(\varphi, \eta)$ replace φ , φ_{ii}^* , $\Phi_i(\varphi)$, and $G_i(\varphi)$ in (3.25). Note that the covariance terms is positive in a frictionless economy because both $\Phi_i(\varphi)$ and $\theta_i(\varphi)$ are (conditionally) increasing in φ , but it can be positive or negative in the presence of distortions.

3.2.6.3 OP covariance vs. misallocation

The productivity covariance $\ddot{\Phi}_i$ is related to allocative efficiency in the sense that more productive firms would capture a bigger share of production resources and output sales in the absence of misallocation. While it may be tempting to therefore interpret a rise in $\ddot{\Phi}_i$ as an improvement in allocative efficiency, however, this is in fact not a general result.

Theoretically, one can show that the optimal allocation of resources across firms depends on the economic environment (i.e. demand structure, cost structure, market structure, and productivity distribution). This means that no unique value for $\ddot{\Phi}_i$ signals perfect allocative efficiency in an absolute sense. Even when the optimal covariance $\ddot{\Phi}_i^*$ is known for a given economic environment, both values below and above it would indicate distortions relative to the first best. Moreover, the absolute difference $|\ddot{\Phi}_i^* - \ddot{\Phi}_i|$ need not be proportional to or even monotonic in the degree of

misallocation and the welfare loss associated with it.

Given this theoretical ambiguity, we numerically explore the association between welfare, the covariance, and the parameters governing misallocation. We simulate the model using standard parameters from the literature (see Section 2.8). We consider a joint log-normal distribution for the productivity and distortion draws $G_i(\varphi, \eta)$ with $\mu_\varphi = \mu_\eta = 1$, $\sigma_\varphi = 1$, and various degrees of distortion dispersion $\sigma_\eta \in [0.05, 0.3]$, and productivity-distortion correlation $\rho(\varphi, \eta) \in [-0.4, 0.4]$. Note that this parameterization produces Pareto-distributed distorted productivity $\underline{\varphi} = \varphi\eta$, and admits no closed-form solutions for W or $\ddot{\Phi}_i$ as functions of σ_η and $\rho(\varphi, \eta)$.

Figure 1A illustrates that the productivity-size covariance can be negative, zero or positive at different points in the $\sigma_\eta - \rho(\varphi, \eta)$ space. For a given correlation value, higher distortion dispersion is associated with lower covariance, consistent with relatively productive firms being sub-optimally small when input costs vary more across firms. Holding σ_η constant, on the other hand, higher $\rho(\varphi, \eta)$ tends to be associated with lower $\ddot{\Phi}_i$, consistent with productive firms getting inefficiently large. While misallocation would intuitively be lowest for low σ_η and $\rho(\varphi, \eta) = 0$, $\ddot{\Phi}_i$ does not peak at that point. Moreover, alternative parameterizations can produce non-monotonic patterns for $\ddot{\Phi}_i$, σ_η and $\rho(\varphi, \eta)$. These findings are consistent with results in Bartelsman et al. (2013).

Figure 1B shows how aggregate welfare varies with the misallocation parameters, under the same parameterization as above. All else constant, welfare decreases as the dispersion in distortion draws widens, and increases as the distortion and productivity draws become more positively correlated. The comparative statics for W and $\ddot{\Phi}_i$ are thus aligned with respect to σ_η , but reversed with respect to $\rho(\varphi, \eta)$. This reinforces the conclusion that $\ddot{\Phi}_i$ cannot fully capture the degree or welfare cost of misallocation.

This discussion has direct implications for the empirical analysis. If one believes that an economy lies strictly below its optimum covariance $\ddot{\Phi}_i^*$, and one is also willing to assume that economic shocks do not change this optimum, then increases (reductions) in $\ddot{\Phi}_i$ in response to such shocks can be interpreted as improvements (deteriorations) in allocative efficiency. Since it is difficult to validate this assumption, such inference is likely to be flawed. However, below we show that the OP decomposition is nevertheless informative because the effect of international trade on all three OP terms can reveal misallocation.

3.2.6.4 Welfare vs. measured aggregate productivity

Conceptually, welfare W_i differs from measured aggregate productivity $\tilde{\Phi}_i$ for two reasons. First, measured firm productivity $\Phi_i(\varphi)$ is a monotonic function of theoretical firm productivity φ only conditional on export status. An aggregate based on $\Phi_i(\varphi)$ need not be monotonic in an aggregate based on φ . Second, welfare in country i depends on the price index P_i faced by consumers in i , which reflects the prices of all varieties sold in i . Implicitly, W_i is related to the weighted average productivity of all domestic and foreign firms supplying market i , using their sales in i as weights. By contrast, $\tilde{\Phi}_i$ is the weighted average productivity of all domestic firms, using their global sales as weights. This distinction is irrelevant only with symmetric countries and bilateral trade costs, because then the measure, productivity, prices and market shares of firms exporting from i to j are identical to those of firms exporting from j to i . From a policy perspective, welfare and domestic aggregate productivity both matter but for different objectives: While W_i reflects consumer utility at a point in time, $\tilde{\Phi}_i$ indicates a country's competitiveness and productive capacity, improvements in which drive aggregate growth over time.

One can show that aggregate measured productivity is proportionate to w_i/P_i

under efficient resource allocation, but not in the presence of misallocation.¹⁴ In particular:

$$\tilde{\Phi}_i = \frac{w_i}{P_i} \frac{L_i}{L_i - M_i f_i^E} \chi_i = \left\{ \begin{array}{ll} \frac{\sigma\theta}{\sigma\theta - (\sigma-1)} \frac{w_i}{P_i} & \text{without misallocation} \\ \frac{\sigma\theta}{(\sigma-1)\theta K_i + \theta - (\sigma-1)} \frac{w_i}{P_i} & \text{with misallocation} \end{array} \right\}, \quad (3.26)$$

$$\text{where } \chi_i = \frac{w_i L_i - T_i}{w_i L_i} \text{ and } K_i = \frac{j \int \int_{\varphi\eta \geq \varphi_{ii}^*} \eta (\varphi\eta)^{\sigma-1} dH_i(\varphi, \eta)}{j \int \int_{\varphi\eta \geq \underline{\varphi}_{ii}^*} (\varphi\eta)^{\sigma-1} dH_i(\varphi, \eta)}. \quad (3.27)$$

Intuitively, the scaling factor $L_i/(L_i - M_i f_i^E)$ adjusts aggregate productivity for the (inverse) share of labor employed in productive activities rather than overhead costs of firm entry. When there are distortions in the economy, a second scaling factor is needed to account for the inefficient allocation of productive resources across firms. The latter can be represented either in terms of the dead-weight cost of distortionary taxation T_i , χ_i , or in terms of the size-weighted average distortion η to true firm productivity φ , K_i (recall that firm sales are an increasing function of $(\varphi\eta)^{\sigma-1}$). When $\eta = 1$ for all firms, there is no misallocation, and $\chi_i = K_i = 1$ drop out.

An important implication of (3.26) is that measured aggregate productivity $\tilde{\Phi}_i$ can be a summary statistic for unobserved welfare W_i only in the absence of misallocation. In addition, shocks that move the (distorted) productivity cut-offs for production and exporting will shift $\tilde{\Phi}_i$ through their effect on the equilibrium wage w_i (if $\beta = 1$), aggregate price index P_i , and extent of misallocation K_i . Together with Lemma 1, this implies the following:

¹⁴While $\tilde{\Phi}_i$ depends on the endogenous mass of firms, M_i is a constant determined solely by model parameters in the no-misallocation equilibrium under the baseline with Pareto distributed productivity. Barring misallocation, extensive numerical simulations indicate that W_i and $\tilde{\Phi}_i$ move in the same direction under alternative productivity distributions and reasonable parameter assumptions from the literature. Following the same logic, one can show that $W_i = \tilde{\Phi}_i$ holds exactly with efficient resource allocation, no outside sector, and an exogenous mass of firms instead of free entry.

Lemma 2 *Without misallocation, aggregate measured productivity increases with welfare and hence with the domestic productivity cut-off, $\frac{d\tilde{\Phi}_i}{dW_i} > 0$ and $\frac{d\tilde{\Phi}_i}{d\varphi_{ii}^*} > 0$. With misallocation, these relationships become ambiguous, $\frac{d\tilde{\Phi}_i}{dW_i} < 0$ and $\frac{d\tilde{\Phi}_i}{d\varphi_{ii}^*} < 0$.*

3.2.7 Impact of Trade Liberalization

We can now examine the impact of trade liberalization on welfare W_i and measured aggregate productivity $\tilde{\Phi}_i$, average productivity $\bar{\Phi}_i$, and productivity covariance $\ddot{\Phi}_i$. We consider three forms of trade liberalization: symmetric bilateral reduction in variable trade costs τ_{ij} and τ_{ji} , unilateral reduction in export costs τ_{ij} , and unilateral reduction in import costs τ_{ji} . We characterize the adjustment mechanisms that each reform triggers, and demonstrate that some effects can be unambiguously signed, while others are theoretically ambiguous.

3.2.7.1 Efficient allocation and flexible wages

In the case of efficient resource allocation and no outside sector ($\beta = 1$), equilibrium wages w_i are determined by labor market clearing and balanced trade. Wages thus endogenously respond to changes in market conditions, including trade reforms.

Consider first symmetric bilateral liberalization. On the export side, a fall in τ_{ij} creates more export opportunities for firms in i , as lower delivery costs allow them to charge lower prices in j and thereby benefit from higher export demand. This decreases the productivity cut-off for exporting φ_{ij}^* and more firms commence exporting, while continuing exporters expand sales abroad. This bids up labor demand and wages in i , making it more difficult for less productive firms in i to survive. These forces act to raise the productivity threshold for survival, φ_{ii}^* . On the import side, a decline in τ_{ji} enables foreign firms to sell more cheaply to i . This intensifies

import competition in i , reducing the aggregate price index and demand for locally produced varieties. This depresses domestic sales for all firms, and reinforces the rise in φ_{ii}^* . It follows from Lemmas 1 and 2 that bilateral trade liberalization unambiguously increases welfare W_i and measured aggregate productivity $\tilde{\Phi}_i$, as in Melitz (2003), Melitz and Redding (2014a), and Arkolakis et al. (2012). This results from the reallocation of economic activity across firms via the exit of low-productivity firms on the extensive margin and the shift in market share towards more productive firms on the intensive margin.

In the case of flexible wages, unilateral export and import liberalization spur the same adjustment processes and exert the same effects as bilateral reforms, as in Demidova and Rodriguez-Clare (2013).

Turning to the OP decomposition, it is clear that if globalization raises $\tilde{\Phi}_i$, then either average productivity $\bar{\Phi}_i$, or the productivity covariance $\ddot{\Phi}_i$, or both must rise as well. However, one cannot analytically sign the response of these OP terms without further parameter restrictions. This ambiguity arises due to the counteracting effects of several forces: the exit of the least productive firms in the economy, the shift in activity towards more productive surviving firms, and the differential increase in measured productivity $\Phi_i(\varphi)$ among producers. When trade costs fall, more efficient firms expand their foreign sales more and contract their domestic sales less than less efficient firms. In addition, the adjustments in φ_{ii}^* and φ_{ij}^* increase $\Phi_i(\varphi)$ disproportionately more for exporters than non-exporters. Nevertheless, the relative change in firm sales can vary non-monotonically along the productivity distribution without additional assumptions, such that $\bar{\Phi}_i$ and $\ddot{\Phi}_i$ can move in either direction.

Under no misallocation and flexible wages ($\beta = 1$), bilateral and unilateral trade liberalization (i.e. reduction in τ_{ij} , τ_{ji} , or both τ_{ij} and τ_{ji}) increase welfare W_i and aggregate productivity $\tilde{\Phi}_i$, but have ambiguous effects on average productivity $\bar{\Phi}_i$

and covariance $\ddot{\Phi}_i$.

3.2.7.2 Efficient allocation and fixed wages

With efficient resource allocation and an outside sector ($\beta < 1$), wages are exogenously determined and do not respond to trade reforms. One can show that bilateral and unilateral export liberalization exert the same welfare- and productivity-enhancing effects as with flexible wages. By contrast, unilateral import liberalization now lowers W_i and $\tilde{\Phi}_i$ in the liberalizing country.¹⁵

With exogenous wages, the unilateral reduction in import costs τ_{ji} triggers two mechanisms that are also active with endogenous wages, but their overall impact is now reversed. The direct effect of the reform is to lower the productivity cut-off for exporting from country j to the liberalizing economy i , φ_{ji}^* , and to induce continuing foreign exporters to sell more in i . This intensifies import competition in i , reducing demand for its home varieties and pushing its domestic productivity cut-off, φ_{ii}^* , upwards. The indirect effect of the reform is to raise the productivity threshold for survival in j , φ_{jj}^* , such that free entry still holds now that j firms expect higher export profits. This makes j a more competitive market for firms from i , and raises the cut-off for exporting from i to j , φ_{ij}^* . In turn, free entry in i acts to depress the survival threshold φ_{ii}^* .

When wages are flexible, their endogenous adjustment dampens the indirect effect and the direct effect dominates: Since expected firm profits depend both on wages and productivity cut-offs, smaller cut-off movements are required for the free-entry condition to continue to hold when wages can move as well. Conversely, when wages are fixed, the indirect effect dominates. As a result, cut-off productivity φ_{ii}^* , aggregate welfare W_i , and measured aggregate productivity $\tilde{\Phi}$ all decline, as in Demidova (2008)

¹⁵It also increases the consumer price index, a phenomenon known as the Metzler paradox.

and Bagwell and Lee (2016). The impact on average productivity $\bar{\Phi}_i$ and the OP gap $\ddot{\Phi}_i$ remains ambiguous.

Under no misallocation and fixed wages ($\beta < 1$), bilateral and unilateral export liberalization (i.e. reduction in τ_{ij} or both τ_{ij} and τ_{ji}) increase welfare W_i and aggregate productivity $\tilde{\Phi}_i$, but have ambiguous effects on average productivity $\bar{\Phi}_i$ and covariance $\ddot{\Phi}_i$. Unilateral import liberalization (i.e. reduction in τ_{ji}) reduces W_i and $\tilde{\Phi}_i$, but has ambiguous effects on $\bar{\Phi}_i$ and $\ddot{\Phi}_i$.

3.2.7.3 Resource misallocation

In the presence of resource misallocation, economies operate in a sub-optimal equilibrium both before and after any trade reforms. From the theory of the second best, it is therefore not possible to unambiguously determine the impact of trade liberalization on aggregate welfare and productivity. Moreover, this impact need not be monotonic in the initial degree of misallocation, such that initially more severe market frictions may either amplify or dampen the gains from globalization. This occurs because trade triggers resource reallocation across firms based on distorted productivity $\underline{\varphi}$ rather than true productivity φ , which can improve or worsen allocative efficiency.

Intuitively, misallocation acts by distorting firm selection on the extensive margin and firm market shares on the intensive margin. Hence the gains from trade depend on how different firms respond. Misallocation would reduce the gains from trade if more productive firms cannot fully respond to growth opportunities, while less productive firms are not forced to exit. For example, trade liberalization could magnify existing distortions if firms with inefficiently abundant access to inputs are able to expand their activity relatively more than firms with inefficiently constrained resources. Conversely, misallocation may increase the gains from trade if trade has a

cleansing effect on the economy and serves to reallocate activity towards truly more productive firms.

In sum, in the presence of misallocation, the welfare and productivity impact of trade liberalization hinges on initial state variables characterizing the economy and on model parameters, in particular the shape of the joint distribution $H_i(\varphi, \eta)$.

Under resource misallocation, bilateral and unilateral trade liberalization (i.e. reductions in τ_{ij} , τ_{ji} , or both τ_{ij} and τ_{ji}) have ambiguous effects on welfare W_i , aggregate productivity $\tilde{\Phi}_i$, average productivity $\bar{\Phi}_i$, and covariance $\ddot{\Phi}_i$.

3.2.8 Numerical Simulation

Given the theoretically ambiguous effects of globalization in different economic environments, we explore the impact of counterfactual trade reforms through numerical simulations. We study the effects of reducing trade costs by 20% from an initial value of $\tau_{ij} = \tau_{ji} = 1.81$ in three scenarios: bilateral trade liberalization (shocks to both τ_{ij} and τ_{ji}), unilateral export liberalization (shock to τ_{ij}), and unilateral import liberalization (shock to τ_{ji}).

We use model parameters from the recent literature (e.g. Burstein and Cravino (2015)), and set the elasticity of substitution to $\sigma = 3$ and the expenditure share of differentiated goods to $\beta = 0.7$, so that wages are exogenously fixed, $w_i = 1$. We assume that both countries have a unit measure of consumers, $L_i = L_j = 1$, and symmetric fixed costs of entry, production and exporting, $f_i^E = f_j^E = 0.1$, $f_{ii} = f_{jj} = 1.2$, and $f_{ij} = f_{ji} = 1.75$.

In the case of no misallocation, we consider Pareto-distributed productivity in both countries as in the model ($\varphi \sim G(\varphi) = 1 - (\varphi^m/\varphi)^\theta$, $\theta = \cdot, \varphi^m = \cdot$), and provide an alternative simulation with log-Normal productivity for robustness ($\ln \varphi \sim$

$\mathcal{N}(\mu_\varphi, \sigma_\varphi)$, $\mu_\varphi = 1$, $\sigma_\varphi = 1$). In the case of misallocation, we assume the productivity and distortion draws are bivariate log-Normal distributed:

$$\begin{bmatrix} \ln \varphi \\ \ln \eta \end{bmatrix} \sim \mathcal{N}(\mu, \Sigma), \quad \mu = \begin{bmatrix} \mu_\varphi \\ \mu_\eta \end{bmatrix}, \quad \Sigma = \begin{bmatrix} \sigma_\varphi^2 & \rho\sigma_\varphi\sigma_\eta \\ \rho\sigma_\varphi\sigma_\eta & \sigma_\eta^2 \end{bmatrix}.$$

We choose $\mu_\varphi = \mu_\eta = 1$ and $\sigma_\varphi = 1$ for both countries. For the foreign economy, we fix $\sigma_\eta = 0.05$, and $\rho = 0$. For the home economy, we consider varying degrees of misallocation in the range $\sigma_\eta \in \{0, 0.05, 0.15\}$ and $\rho \in [-0.5, 0.5]$.

Figure 2 visualizes the full results of these numerical exercises. Table 3.1 presents an instructive snapshot for the cases of no misallocation and misallocation with high distortion dispersion ($\sigma_\eta = 0.15$) and either negative, zero or positive productivity-distortion correlation ($\rho \in \{-0.4, 0, 0.4\}$).

Four patterns stand out in Table 3.1. First, in the absence of misallocation, bilateral and unilateral export liberalization increase welfare and measured aggregate productivity whether wages are flexible or not (Panels A and B). By contrast, unilateral import liberalization increases W_i and $\tilde{\Phi}_i$ when wages are flexible, but reduces both when wages are fixed. This is consistent with Propositions 1 and 2.

Second, in the absence of misallocation, both components of aggregate productivity, average productivity $\bar{\Phi}_i$ and covariance $\ddot{\Phi}_i$, play an economically significant role and always move in the same direction. On average, changes in average productivity $\bar{\Phi}_i$ account for 75% of the overall change in aggregate productivity $\tilde{\Phi}_i$, while allocative efficiency captured by $\ddot{\Phi}_i$ mediates 25%. This indicates that both firm entry/exit and reallocations of activity across active firms are important mechanisms of adjustment in response to trade shocks. These results are not specific to this parameterization and hold under a wide range of alternative reasonable parameterizations.

Third, resource misallocation dramatically affects the welfare and productivity gains from trade, and this effect is not monotonic in the degree of misallocation, consistent with Proposition 3 (Panel C). For consistency, we compare the results in Panels B and C. With flexible wages, the welfare and productivity gains from trade are either marginally smaller or indistinguishably higher with misallocation than without, and decrease smoothly with the correlation parameter ρ . The effects of globalization become much more nuanced with fixed wages. Bilateral and unilateral export liberalization now increase welfare strictly less with than without misallocation, but the gains are non-monotonic in ρ : they peak when distortions are close to orthogonal to productivity ($\rho \approx 0$), but decline significantly and can turn negative away from $\rho \approx 0$. At the same time, unilateral import liberalization can reduce welfare more severely with misallocation than without when $\rho \ll 0$, but may conversely increase welfare when ρ is sufficiently positive. As for productivity, trade liberalization generates less negative or higher productivity gains at higher values for ρ , and there are more likely to be productivity gains when $\rho > 0$. However in general, the presence of misallocation can increase, reduce, preserve the sign or reverse the sign of the productivity gains that obtain without misallocation.

Finally, the three OP productivity terms ($\tilde{\Phi}_i$, $\bar{\Phi}_i$ and $\ddot{\Phi}_i$) can move in different directions only in the presence of misallocation and fixed wages. In particular, while they may all increase or all decrease, it is possible for $\tilde{\Phi}_i$ and $\bar{\Phi}_i$ to both rise while $\ddot{\Phi}_i$ falls in response to the same shock (or vice versa). Extensive numerical exercises indicate that this result cannot obtain in the absence of misallocation under reasonable parameter assumptions.

It is useful to foreshadow our empirical findings in light of this simulation analysis. Using point estimates from our baseline IV regressions, we tabulate the implied productivity effects of a 20% unilateral cut in export and import costs in Panel D.

The empirical results are consistent with the sign pattern in Columns 6-8 and 10-12 in the last row of Panel C (misallocation with fixed wages and $\rho = 0.4$). The implied magnitudes are well in line with the numerical calculations for export reforms, and notably higher for import reforms. This anticipates our conclusion that in practice, export expansion and import competition both stimulate aggregate productivity, but they operate through different channels and their impact is moderated by resource misallocation.

3.2.9 Discussion

We conclude by discussing two model features that allow us to transition to the empirical analysis. First, for expositional simplicity, we have analyzed an economy with a single differentiated-good sector. We show in Appendix C that our main theoretical conclusions extend to a world with multiple symmetric differentiated-good sectors k , where consumer utility is a Cobb-Douglas aggregate across sector-specific CES consumption indices. The effect of any shock on aggregate welfare W_i and productivity $\tilde{\Phi}_i$ now depends on the weighted average response of sector-level productivity $\tilde{\Phi}_{ik}$. A uniform trade cost reduction affects $\tilde{\Phi}_{ik}$ equally across sectors, while a disproportionately bigger shock to sector k' changes $\tilde{\Phi}_{ik'}$ disproportionately more. This justifies our empirical estimation strategy which exploits variation across countries, sectors and time for identification purposes.

Second, in studying trade liberalization, we have considered the impact of reductions to trade costs, τ_{ij} and τ_{ji} . One can show that the effect of an exogenous shock to foreign demand - such as an increase to foreign market size L_j or aggregate expenditure E_j - would be isomorphic to the effect of a fall in export costs, τ_{ij} . Likewise, the effect of an exogenous shock to foreign supply - such as a rise in the

measure of foreign firms M_j or a shift in the foreign productivity distribution $G_j(\varphi)$ - would be isomorphic to the effect of a fall in import costs, τ_{ji} . This isomorphism holds because all of these shocks operate through and only through movements in home's (distorted) productivity cut-offs for production and exporting. This justifies our choice of instruments in the IV analysis.

3.3 Data

We empirically evaluate the impact of international trade on aggregate productivity using rich cross-country, cross-sector panel data from two primary data sources, CompNet and WIOD. This section describes the key variables of interest, and presents stylized facts about the cross-sectional and time-series variation in productivity and trade activity in the panel.

3.3.1 CompNet Productivity Data

We exploit unique new data on the evolution of macroeconomic indicators for 20 NACE 2-digit manufacturing sectors in 14 European countries over the 1998-2011 period from the CompNet Micro-Based Dataset.¹⁶ Two features of the data make it unprecedented in detail and ideally suited to our analysis. First, it contains not only aggregate measures at the country-sector-year level, but also multiple moments of the underlying distribution of economic activity across firms in each country-sector-year cell. This includes for example means, standard deviations and skewness of various firm characteristics, as well as key moments of the joint distribution of several such

¹⁶The 14 countries are: Austria, Belgium, Estonia, Finland, France, Germany, Hungary, Italy, Lithuania, Poland, Portugal, Slovakia, Slovenia, Spain. While CompNet covers all NACE 2-digit industries in the European classification, we restrict the sample to 20 manufacturing industries for which we can obtain WIOD data on trade activity. These correspond to NACE-2 sectors 10 to 31 without sectors 12 (tobacco products) and 19 (coke and refined petroleum products).

characteristics. The dataset is built from raw firm-level data that are independently collected in each country and maintained by national statistical agencies and central banks. These raw data have been standardized and consistently aggregated to the country-sector-year level as part of the Competitiveness Research Network initiative of the European Central Bank and the European System of Central Banks.¹⁷

Second, CompNet includes several productivity measures that are constructed specifically to permit an Olley and Pakes (1996) decomposition of aggregate productivity in country i , sector k and year t ($AggProd_{ikt}$) into unweighted average firm productivity ($AvgProd_{ikt}$) and the covariance of firm productivity and firm share of economic activity ($CovProd_{ikt}$).¹⁸

We examine labor productivity defined as log real value added per worker and weight firms by their share of total employment at the country-sector-year level.¹⁹ These empirical measures correspond exactly to the theoretical objects $\Phi_i(\varphi)$ and $\theta_i(\varphi)$ in Section 2.4.1, such that the measured aggregate productivity components also map exactly to the OP decomposition in Section 2.4.2, i.e. $\tilde{\Phi}_i = AggProd_{ikt}$, $\bar{\Phi}_i = AvgProd_{ikt}$, and $\ddot{\Phi}_i = CovProd_{ikt}$. The labor productivity measure also has the advantage that it is based on directly observable data, rather than on a TFPR residual from production function estimates that is subject to endogeneity and omit-

¹⁷See Lopez-Garcia et al. (2014) for details on the data methodology and structure.

¹⁸The empirical counterpart to the theoretical OP decomposition in equation (3.25) at the country-sector-year level is:

$$AggProd_{ikt} = \underbrace{\frac{1}{N_{ikt}} \sum_f Prod_{ikft}}_{AvgProd_{ikt}} + \underbrace{\sum_f (Prod_{ikft} - \overline{Prod}_{ikt}) (\theta_{ikft} - \bar{\theta}_{ikt})}_{CovProd_{ikt}} \quad (3.28)$$

¹⁹The empirical results are unchanged if we instead use firm sales as weights. We prefer employment weights because they produce a model-consistent measure of aggregate productivity that can be linked to welfare and because they are immune to potential variation in the price deflator across firms.

ted variable concerns.

Table 3.2 documents the variation in aggregate productivity and its constituent terms across countries, sectors and years in the panel. We report additional summary statistics for the variation across sectors and years within countries in Appendix Table A.1. The panel contains 2,811 observations and is unbalanced because of different time coverage across countries. Aggregate productivity averages 3.21 in the panel, with allocative efficiency contributing 0.23 (7.2%) on average as proxied by the covariance term. However, there are sizable differences in the level and composition of $AggProd_{ikt}$ across countries, with $CovProd_{ikt}$ capturing only 1.4% in Austria and 2.5% in Germany but up to 25.9% in Lithuania and 33.3% in Hungary. Moreover, the standard deviation of aggregate productivity across sectors and years reaches 0.56 for the average country, while the corresponding number for allocative efficiency stands at 0.17. Thus economy-wide productivity could be significantly lower if labor were randomly re-assigned across firms.

Table 3.2 also provides summary statistics for aggregate productivity growth at 1-, 3- and 5-year horizons. Figure 3 shows that the reallocation of labor across firms can account for a substantial share of aggregate labor productivity growth, as is the case for some Eastern European economies such as Lithuania, Croatia and Hungary prior to the 2008-2009 global financial crisis.

3.3.2 WIOD Trade Data

We use data on international trade activity by country, sector and year from WIOD, the World Input-Output Database. While standard trade statistics report gross trade flows by country and output sector, WIOD exploits country-specific input-output tables to infer trade in value added by sector of final use. This makes it possible to

identify the domestic value added embedded in a country's exports, as well as the foreign value added contained in its imports. WIOD also decomposes imports of a given sector into imports used for final consumption in that sector and imports used as intermediate inputs by producers in that sector and in other downstream sectors. Although WIOD relies on proportionality assumptions in value added and input use across countries and sectors, it is the first data of its kind and has been used in recent path-breaking studies of global value chains such as Bems and Johnson (2017).

WIOD reports the gross value of sales from input sector k in origin country i to output sector s in destination country j in year t , X_{ijkst} . Input sectors are in the NACE 2-digit classification, while output sectors comprise all NACE 2-digit sectors plus several components of final consumption. Trade values are recorded in US dollars, which we convert into euros using annual exchange rates.

We proxy export demand for exporting country i in sector k and year t , $ExpDemand_{ikt}$, with the log value of i 's gross exports in sector k . We do not distinguish between exports used for final consumption or downstream production abroad, since both represent foreign demand from the perspective of i . By contrast, we measure import competition in importing country i , sector k and year t , $ImpComp_{ikt}$, with the log of the value of i 's imports in sector k , less the value of sector k imports used by i in the production of sector k goods. We intentionally do not remove sector k imports used in i by producers in other sectors, since such imports too compete with locally produced k goods.

$$ExpDemand_{ikt} = \ln \left[\sum_{j,s} X_{ijkst} \right], \quad ImpComp_{ikt} = \ln \left[\sum_{j,s \neq k} X_{jikst} \right], \quad (3.29)$$

Table 3.2 provides summary statistics for $ExpDemand_{ikt}$ and $ImpComp_{ikt}$ across

the 14 countries and 20 NACE-2 sectors in our 1998-2011 sample with CompNet productivity data. $ExpDemand_{ikt}$ averages 7.65 in the panel, with a standard deviation of 1.74. The corresponding mean and dispersion for $ImpComp_{ikt}$ are 6.41 and 1.97, respectively. We summarize individual countries' trade exposure in Appendix Table A.1, and plot its evolution over time in Figure 4. While all countries experienced steady import and export expansion prior to the 2008-2009 financial crisis, they underwent a sharp contraction in 2009 before regaining some ground by 2011 (Figure 4A). Although EU-15 members and new EU member states display broadly comparable import activity, the latter saw dramatically faster export growth during the period we study (Figures 4B and 4C).

Since observed trade flows capture aggregate supply and demand conditions in general equilibrium, $ExpDemand_{ikt}$ confounds exogenous foreign demand for the products of country i with i 's endogenous export supply capacity. Analogously, $ImpComp_{ikt}$ reflects both the exogenous supply of foreign products to country i and i 's endogenous import demand. While we use $ExpDemand_{ikt}$ and $ImpComp_{ikt}$ as baseline measures of export demand and import competition, our estimation strategy will rely on instrumental variables to isolate the exogenous components of export demand and import competition. In particular, we will exploit import tariffs and Bartik-style shocks to foreign export supply and import demand, as well as the rise of China on world markets.

3.4 Trade and Aggregate Productivity: OLS Correlation

We empirically examine the effects of international trade on aggregate productivity in three steps. In this Section, we first provide baseline OLS evidence that countries' export and import activity is systematically related to their aggregate output,

value added, employment and productivity. While informative, this evidence is not conclusive because the empirical specifications cannot fully address concerns about the endogeneity of trade outcomes and aggregate economic performance. In order to identify the causal effects of globalization, in Section 5 we therefore pursue an IV-2SLS estimation strategy and conduct a series of robustness checks on the IV specification. Finally, in Section 6 we perform additional analyses to explore the channels through which export demand and import competition shape aggregate productivity.

3.4.1 OLS Specification

We explore the link between international trade activity and aggregate economic performance with the following baseline OLS specification:

$$Y_{ikt} = \alpha + \beta_{EX} ExpDemand_{ikt} + \beta_{IM} ImpComp_{ikt} + \Gamma Z_{ikt} + \psi_{it} + \varepsilon_{ikt}. \quad (3.30)$$

Here Y_{ikt} refers to aggregate productivity in country i , sector k and year t , $AggProd_{ikt}$, or its two sub-components, the unweighted average firm productivity, $AvgProd_{ikt}$, and the covariance between firm productivity and employment share, $CovProd_{ikt}$. Since the Olley-Pakes decomposition connects the three productivity outcomes, the coefficient estimates from the regressions for $AvgProd_{ikt}$ and $CovProd_{ikt}$ sum to the coefficient estimate from the regression for $AggProd_{ikt}$. There is nevertheless value in separately estimating all three regressions in order to determine the sign, economic magnitude and statistical significance of the effects of globalization on each productivity outcome. There are no efficiency gains from estimating the three regressions as a simultaneous system of equations because they all include the same set of fixed effects and right-hand side variables.

The main coefficients of interest, β_{EX} and β_{IM} , would in principle identify the causal impact of exogenous shocks to export demand and import competition if the latter are measured without error. Given the endogeneity of our baseline proxies for $ExpDemand_{ikt}$ and $ImpComp_{ikt}$, however, we interpret the OLS estimates of β_{EX} and β_{IM} only as indicative correlations.

Specification (3.30) includes country-year pair fixed effects, ψ_{it} , for the 14 countries and 14 years in our sample, such that β_{EX} and β_{IM} are identified from the variation across sectors within countries at a given point in time. The ψ_{it} account for macroeconomic supply and demand shocks at the country-year level that affect trade and productivity symmetrically in all sectors, such as movements in aggregate income, productivity, labor supply, exchange rates, interest rates, or price indices. Implicitly, the fixed effects also capture non-transient country characteristics such as general institutional quality, capital and labor market frictions, infrastructure and geographic remoteness, as well as global shocks that are common across countries such as the 2008-2009 financial crisis. We cluster standard errors, ε_{ikt} , by sector-year to accommodate cross-country correlation in sector-specific shocks.

We include several control variables Z_{ikt} to alleviate concerns with omitted variable bias, measurement error and sample selection. First, there may be worldwide sector trends in supply and demand conditions. To capture these, we condition on the average log number of active firms, $\overline{\ln N_{kt}}$, and the average log employment, $\overline{\ln L_{kt}}$, by sector-year, which we obtain by averaging $\ln N_{ikt}$ and $\ln L_{ikt}$ across countries. In alternative specifications we further include sector or sector-year fixed effects.

Second, the firm-level data that underlie the CompNet dataset are subject to minimum firm size thresholds. These thresholds vary across countries but do not change within countries over time, and are thus controlled for with the country-year pair fixed effects. As extra precaution, we also include the log number of firms by

country-sector-year, $\ln N_{ikt}$, but the results are not sensitive to this control.

Third, measurement error may bias β_{EX} and β_{IM} either upwards or downwards. On the one hand, classical measurement error in firm size L_{ikft} in the raw data would introduce negatively correlated noise in firms' labor productivity and employment share, and result in misleadingly low values for $CovProd_{ikt}$. This would lead us to underestimate β_{EX} and β_{IM} in specifications for allocative efficiency. On the other hand, non-classical measurement error in $\ln N_{ikt}$ may generate mechanical correlation between the left- and right-hand side variables of interest. Controlling for $\ln N_{ikt}$ addresses both of these concerns.

Finally, we implement two sample corrections to ensure that our results are not driven by outliers. We always exclude from the regression sample country-sector-year observations that are based on data for fewer than 20 firms. We also always drop observations with extreme annual growth rates in the top or bottom percentile of the distribution for any of the key variables of interest (aggregate productivity, average productivity, covariance term, exports or import competition, number of firms). These two corrections filter out 11% of the raw sample.

3.4.2 OLS Results

We first assess the correlation between trade and aggregate economic activity. In Columns 1-3 of Table 3.3, we estimate specification (3.30) for log total output, log value added and log employment by country, sector and year as the outcome variable Y_{ikt} , from CompNet. We find that export expansion is associated with higher overall output, greater value added in production, and more factor resources (labor) engaged in manufacturing. Conversely, more intense import penetration is correlated with lower total domestic output and employment, but nevertheless higher value added.

Turning to the trade-productivity nexus in Columns 4-6, aggregate exports and imports are both positively correlated with aggregate productivity. These correlations are economically large and highly statistically significant at 1%: A 20% rise in $ExpDemand_{ikt}$ and $ImpComp_{ikt}$ is associated with 2.5% and 2.1% higher $AggProd_{ikt}$, respectively. While comparable, these magnitudes mask important differences between export and import activity. Export expansion is accompanied by both stronger average firm productivity $AvgProd_{ikt}$ and increased concentration of activity in more productive firms $CovProd_{ikt}$, with the former channel roughly twice the size of the latter. By contrast, deeper import penetration entails higher firm productivity on average, but a shift in activity towards less productive firms.

Although not causal, this evidence is consistent with increased foreign demand boosting aggregate productivity and production activity, and with stiffer import competition stimulating productivity growth while depressing overall production. The OLS results also raise the possibility that different aspects of globalization may influence aggregate productivity through different mechanisms.

Specification (3.30) identifies the long-run correlation between productivity and trade activity. We explore this correlation in the short to medium term in Appendix Table A.2, where we analyze how changes in productivity co-move with concurrent changes in imports and exports over 1-, 3- and 5-year overlapping periods.²⁰ By first-differencing all left- and right-hand side variables and including year fixed effects, we implicitly subsume country-sector pair fixed effects and accommodate global macroeconomic shocks affecting all countries and sectors. We observe that the productivity-trade relationship is stronger at medium horizons of 3 to 5 years, but nevertheless sizeable even in the very short run of 1 year.

²⁰The exact estimating equation is $\Delta Y_{ikt} = \alpha + \beta_{EX} \Delta ExpDemand_{ikt} + \beta_{IM} \Delta ImpComp_{ikt} + \Gamma \Delta Z_{ikt} + \varphi_t + \varepsilon_{ikt}$.

3.5 Impact of Trade on Aggregate Productivity: IV Causation

3.5.1 The Endogeneity Problem

The baseline OLS results capture the correlation between countries' participation in international trade and their aggregate productivity performance. This correlation may not identify the causal effect of globalization because of two potential sources of endogeneity: simultaneity and reverse causality.

One possibility is that trade and productivity performance are jointly determined by some omitted variable. Given the country-year fixed effects in the OLS specification, such omitted variable bias would have to vary systematically across sectors within country-years to explain our findings. This rules out many alternative explanations based on country-year characteristics such as strong institutions, favorable macroeconomic conditions, or abundant physical and human capital.

Reverse causality poses a more important concern: Aggregate productivity can endogenously affect trade activity. In general equilibrium, observed export flows reflect both endogenous supply conditions in the exporting country and exogenous demand conditions in the importing country. Standard trade theory implies that firms in a more productive country-sector would be more competitive on world markets and therefore undertake more exports. As a result, the OLS estimates of β_{EX} would be positively biased. Symmetrically, observed import flows reflect both endogenous demand conditions in the importing country and exogenous supply conditions in the exporting country. Given local demand, a less productive domestic country-sector would be less competitive from the perspective of foreign firms and could induce more entry by foreign suppliers. This would introduce negative bias in the OLS estimates of β_{IM} . These examples illustrate only two of various possible mechanisms that

could generate reverse causality and bias our estimates of the productivity impact of globalization either upwards or downwards.

3.5.2 IV Strategy

In order to identify the causal effect of international trade on aggregate productivity, we adopt a two-stage least squares (2SLS) estimation strategy. In the first stage, we use instrumental variables IV_{ikt} to identify arguably exogenous movements in export and import activity, $\widehat{ExpDemand}_{ikt}$ and $\widehat{ImpComp}_{ikt}$, from observed export and import trade flows, $ExpDemand_{ikt}$ and $ImpComp_{ikt}$. In the second stage, we regress the productivity outcomes of interest on these predicted exogenous values in place of their endogenous counterparts:

$$Y_{ikt} = \alpha + \beta_{EX} \widehat{ExpDemand}_{ikt} + \beta_{IM} \widehat{ImpComp}_{ikt} + \Gamma Z_{ikt} + \psi_{it} (+\psi_{kt}) + \varepsilon_{ikt} \quad (\text{second stage}) \quad (3.31)$$

$$\{ExpDemand_{ikt}, ImpComp_{ikt}\} = \alpha_{IV} + \Gamma_{IV} Z_{ikt} + \Theta_{IV} IV_{ikt} + \phi_{it} (+\phi_{kt}) + \epsilon_{ikt} \quad (\text{first stage}) \quad (3.32)$$

We continue to condition on controls Z_{ikt} and country-year pair fixed effects, ψ_{it} and ϕ_{it} , as in the OLS baseline. In robustness checks, we further add sector fixed effects, ψ_k and ϕ_k , or sector-year fixed effects, ψ_{kt} and ϕ_{kt} . These account respectively for permanent or time-variant differences in supply and demand conditions across sectors that affect all countries, such as factor intensities, technological growth or consumer tastes. We continue to cluster standard errors, ε_{ikt} and ϵ_{ikt} , by sector-year.

The ideal instruments for trade exposure would be valid by having predictive power in explaining trade flows, and would meet the exclusion restriction by affecting productivity only through the trade channel. In the case of $ExpDemand_{ikt}$, we

would therefore like to isolate exogenous foreign demand for ik products in year t from country i 's endogenous export supply of sector k goods in year t . In the case of $ImpComp_{ikt}$, we would like to separate exogenous foreign supply of k products to i in year t from i 's endogenous import demand for k goods in year t .

We use two Bartik instruments for foreign export supply and foreign import demand, which we construct by combining information on countries' initial trade structure at the beginning of the panel with the contemporaneous trade flows of their trade partners with the rest of the world.²¹ This IV strategy capitalizes on two ideas: First, the share of country i 's exports in sector k going to destination d at time $t = 0$, $\frac{X_{idk,t=0}}{X_{ik,t=0}}$, and the share of i 's imports coming from origin o at time $t = 0$, $\frac{M_{oik,t=0}}{M_{ik,t=0}}$, are not influenced by subsequent exogenous shocks respectively to aggregate demand in d and to aggregate supply in o . Second, aggregate demand for sector k goods in destination d at time t can be proxied with d 's total absorption of k products, defined as domestic production plus worldwide imports minus worldwide exports, $Y_{dkt} + M_{dkt} - X_{dkt}$. This picks up total expenditure in destination d on sector k which is the relevant measure of market size in the model. Symmetrically, aggregate supply of sector k goods from origin o at time t can be measured with o 's export value added for final consumption of k products, XVA_{okt}^{final} . This accounts for the fact that country o may use imported inputs in producing k products, and aims to isolate supply shocks specific to o by considering only its own value added embedded in its exports. We focus on o 's exports used for final consumption to capture the import competition rather than the imported-input supply emanating from origin o .

For each country-sector-year triplet ikt in our sample, we thus instrument export

²¹These instruments are similar in spirit to those in Hummels et al. (2014) and Berman et al. (2015) among others.

demand with foreign demand conditions, $FDemand_{ikt}$, computed as the weighted average absorption across i 's export destinations using i 's initial export shares as weights. We instrument import competition with foreign supply capacity, $FSupply_{ikt}$, calculated as the weighted average export value added for final consumption across i 's import origins, using i 's initial import shares as weights. We construct both instruments using the WIOD data. To guard against outliers due to measurement error or business cycle fluctuations, we average the initial import and export weights across the first three years in our data, 1998-2000.

$$FDemand_{ikt} = \ln \left[\sum_{d \neq i} \frac{X_{idk,t=0}}{X_{ik,t=0}} (Y_{dkt} + M_{dkt} - X_{dkt}) \right], \quad (3.33)$$

$$FSupply_{ikt} = \ln \left[\sum_{o \neq i} \frac{M_{oik,t=0}}{M_{ik,t=0}} XVA_{okt}^{final} \right], \quad (3.34)$$

$$MTariff_{ikt} = \frac{1}{NP_k} \sum_{p \in \Omega_k} \tau_{ipt}. \quad (3.35)$$

In addition to the Bartik instruments, we also exploit the variation in import tariffs across countries, sectors and years, $MTariff_{ikt}$. We take the simple average applied tariff τ_{ipt} across all products p in sector k at time t using tariff data from WITS, where NP_k denotes the number of products mapped to a sector. $MTariff_{ikt}$ captures trade policy shocks that affect the degree of import competition by influencing foreign producers' incentives to enter the domestic market. In our panel, these tariffs vary primarily across sectors rather than across countries or over time.

Conceptually, we think of $FDemand_{ikt}$ as an instrument for $ExpDemand_{ikt}$, and view $FSupply_{ikt}$ and $MTariff_{ikt}$ as instruments for $ImpComp_{ikt}$. In practice of course, all three instruments enter as IV_{ikt} for both endogenous variables in the IV first stage.

3.5.3 Baseline IV Results

The results in Table 3.4 indicate that the three instruments perform well in the first stage and meet the validity requirement. The Bartik measure of exogenous foreign demand has a positive impact on observed exports, the measure of exogenous foreign supply has a positive effect on observed import penetration, and import tariffs strongly deter imports. These patterns are highly statistically and economically significant and robust to adding sector or sector-year fixed effects. The most conservative estimates in Columns 3 and 6 (with both country-year and sector-year fixed effects) imply that a one-standard-deviation improvement in $FDemand_{ikt}$ leads to 34% higher $ExpDemand_{ikt}$, while a one-standard-deviation rise in $FSupply_{ikt}$ increases $ImpComp_{ikt}$ by 49%. Reducing import barriers by 10% translates into 13% lower imports. The R-squared in these regressions reaches 89%-99% across the various specifications.

Table 3.5 presents the second-stage estimates for the causal effect of international trade on aggregate productivity. Two findings stand out. First, export demand and import competition both significantly increase aggregate productivity $AggProd_{ikt}$. In the baseline without sector fixed effects in Column 1, a 20% growth in export demand boosts overall productivity by 8%, while a 20% rise in import competition leads to 1.4% higher productivity. In the most restrictive specification that adds sector-year pair fixed effects in Column 7, export demand and import competition exert large effects of comparable magnitudes: The aggregate productivity gains following a 20% increase in export demand or import penetration now amount to 7.3% and 10%, respectively.

Second, Table 3.5 reveals that the productivity gains from export and import expansion are mediated through different channels. Export growth induces both size-

able improvements in average firm productivity, $AvgProd_{ikt}$, and a reallocation of economic activity towards more productive firms as manifested in higher $CovProd_{ikt}$. The reallocation of activity towards more productive firms contributes 26% (Column 3) to 38% (Column 9) of the total productivity benefit. By contrast, all of the productivity gains from import competition result from higher average firm productivity, and these gains are moreover partly countered by a shift in economic activity towards less productive firms. The latter negates 24% of average productivity growth in the baseline (Column 3) and 14% with sector-year fixed effects (Column 9).

3.5.4 Sensitivity Analysis

We perform extensive sensitivity analysis to establish the stability of our results to alternative specification choices. We record consistently large and significant effects of export demand and import competition on all three productivity outcomes with one exception: The impact of $ImpComp_{ikt}$ on allocative efficiency $CovProd_{ikt}$ always retains its negative sign but is often imprecisely estimated in specifications with both country-year and sector-year fixed effects.

First, we consider each dimension of trade exposure one at a time. This ensures that the magnitude and significance of the estimated effects of export and import activity are not driven by multi-collinearity. To focus on export activity, we include only $ExpDemand_{ikt}$ in the second stage and use $FDemand_{ikt}$ as the single instrument in the first stage. To examine import penetration, we introduce only $ImpComp_{ikt}$ in the second stage and exploit only $FSupply_{ikt}$ and $MTariff_{ikt}$ as instruments in the first stage. Panels A and B in Appendix Table 3 show that this delivers qualitatively similar results and quantitatively bigger magnitudes for each dimension of globalization.

Second, we perform additional tests to ensure that outliers are not driving the results. The baseline specification already excludes observations at the country-sector-year level that have been aggregated across fewer than 20 firms or that exhibit annual growth in the top or bottom percentile for key variables (i.e. $AggProd_{ikt}$, $AvgProd_{ikt}$, $CovProd_{ikt}$, $ExpDemand_{ikt}$, $ImpComp_{ikt}$, $FDemand_{ikt}$, $FSupply_{ikt}$). In Panel C of Appendix Table 3, we confirm that the results survive when we further winsorize these variables in levels at the 1st and 99th percentiles. In unreported regressions, we have checked that similar patterns hold if we alternatively drop each individual country or sector one at a time.

Third, we take into account the variation in different sectors' share of a country's overall economic activity. While sectors are treated symmetrically in the baseline specification, their effective contribution to aggregate outcomes such as employment, productivity or welfare depends on a country's industrial structure. Our findings remain unchanged or stronger when we weight observations by the initial country-specific employment share of each sector in Panel D of Appendix Table 3: In particular, both $ExpDemand_{ikt}$ and $ImpComp_{ikt}$ exert large significant effects on all three OP productivity terms even in the stringent specification with sector-year fixed effects.

Forth, we confirm that the results are robust to lagging $ExpDemand_{ikt}$ and $ImpComp_{ikt}$ by one year in Panel E of Appendix Table 3. This informs the possible delayed effects of international trade on aggregate productivity that arise through the gradual adjustment in economic activity within and across firms. The coefficient estimates remain virtually unchanged.

Finally, we establish that the results are robust to using a relative indicator of import competition instead of an absolute one. The baseline measure $ImpComp_{ikt}$ identifies the scale of foreign suppliers' activity in the home market, whose size is implic-

itly controlled for with the country-year fixed effects. Through the lens of the model, an equally valid measure of import competition is the ratio of imports to domestic production. We therefore construct $ImpCompRatio_{ikt} = \sum_{j,s \neq k} X_{jikt} / \overline{Output}_{ik}$, averaging the denominator by country-industry in the panel to mitigate concerns with domestic production endogenously responding to import penetration. In Panel A of Table 3.6, we estimate specification (3.31) using $ImpCompRatio_{ikt}$ in place of $ImpComp_{ikt}$ and an analogously constructed instrument $FSupplyRatio_{ikt}$ in place of $FSupply_{ikt}$. The evidence corroborates the baseline IV findings.²²

3.5.5 Import Competition from China

A major shock to the global economy in the 21st century has been the dramatic rise of China. Chinese worldwide exports grew rapidly after China joined the WTO in 2001 and after MFA binding quotas on Chinese textiles and apparel were lifted in 2005. This shock has contributed significantly to the deepening of import competition in many developed economies not only because of its scale, but also because it has increased competition specifically from producers in a large, lower-wage country.

In this section, we examine the impact of import competition specifically from China on aggregate productivity in Europe. This serves two purposes. First, this allows us to exploit a large trade shock that is exogenous from the perspective of individual countries and sectors in Europe and that acts as a quasi-natural experiment for identification purposes. Second, we can compare the effects of Chinese and overall import penetration to illuminate how local firms respond to competition from foreign firms with relatively low vs. high levels of productivity, cost and quality.

²²The results are also robust to proxying import competition with the ratio of imports to domestic employment - an alternative measure that is independent of local factor or good prices but not theoretically founded.

Using WIOD data as before, we measure import competition from China, $ChinaImpComp_{ikt}$, with country i 's imports of sector k goods from China in year t , net of sector k imports used by i in the production of k products.

$$ChinaImpComp_{ikt} = \ln \left[\sum_{s \neq k} X_{China \rightarrow i, kst} \right], \quad (3.36)$$

$$ChinaSupply_{ikt} = \left\{ \ln \left[\frac{M_{China \rightarrow i, k, t=0}}{M_{ik, t=0}} XVA_{China, kt}^{final} \right], \ln \left[\sum_{p \subset \Omega_k} \frac{M_{ip, t=0}}{M_{ik, t=0}} X_{China \rightarrow US, pt} \right] \right\} \quad (3.37)$$

We develop two new Bartik instruments $ChinaSupply_{ikt}$ for $ChinaImpComp_{ikt}$ in the spirit of Autor et al. (2016) and Bloom et al. (2016). The first instrument captures China's global export supply in sector k and year t with Chinese total export value added for final consumption, $XVA_{China, kt}^{final}$, and recognizes that the impact of this supply shock will vary across importing countries i based on China's initial share of i 's imports of k goods at time $t = 0$, $\frac{M_{China \rightarrow ik, t=0}}{M_{ik, t=0}}$. The second instrument focuses on Chinese exports to the US as a reference country to exploit finer product disaggregation in the data and to avoid contamination from Chinese sales to European countries in our panel. We start with Chinese exports to the US by NACE 4-digit product p that belongs to sector k , $X_{China \rightarrow US, pt}$, and obtain a China supply shock specific to country i by taking the weighted average of $X_{China \rightarrow US, pt}$ across products using their share of i 's initial imports in sector k from anywhere in the world, $\frac{M_{ip, t=0}}{M_{ik, t=0}}$.

We examine the productivity impact of Chinese import competition, $ChinaImpComp_{ikt}$, along with that of global export expansion, $ExpDemand_{ikt}$, in the new IV second stage. In the new IV first stage, we retain $FDemand_{ikt}$ and $MTariff_{ikt}$ as instruments, but we use $ChinaSupply_{ikt}$ in place of $FSupply_{ikt}$. Note that once China

enters the WTO, it is granted MFN status by all countries in our sample, such that $MTariff_{ikt}$ reflects the import tariffs relevant to Chinese goods.

We present the results in Panel B of Table 3.6. Our findings for the productivity impact of worldwide export demand remain qualitatively and quantitatively similar. As with overall import competition, Chinese import competition too significantly raises average firm productivity and has either an insignificant or a negative significant effect on the productivity covariance term. Its net impact on aggregate productivity is positive but insignificant at standard confidence levels. In terms of magnitudes, the coefficient estimates indicate that the overall productivity gains induced by Chinese import competition are 16-18% of those generated by total import competition.

3.6 How Trade Affects Productivity: Interpretation and Mechanisms

How shall we interpret the empirical results in light of the theoretical framework in Section 2? Our estimation approach identifies the independent effects of export demand and import competition. Through the lens of the model, we can therefore interpret them as the effects of unilateral export and import liberalizations. In particular, recall from Section 2.9 that the theoretical impact of changes in export and import trade costs (τ_{ij} and τ_{ji}) are isomorphic to the impact respectively of changes in foreign productivity (i.e. foreign's export supply capacity) and foreign market size (i.e. foreign's import demand).

Consider first the case of no resource misallocation (see Panels A and B in Table 3.1). On the export side, increased export demand would in the first instance facilitate export entry by less productive firms by lowering the productivity cut-off for

exporting. In general equilibrium with free entry, this would be accompanied by a rise in the productivity cut-off for domestic production and, correspondingly, in aggregate productivity, $AggProd_{ikt}$. The numerical exercises indicate that average firm productivity, $AvgProd_{ikt}$, would also rise, as would allocative efficiency, $CovProd_{ikt}$, because more productive firms would expand their exports by more.

On the import side, increased import competition has theoretically ambiguous effects on aggregate productivity. Its direct effect is to lower local demand for domestic firm output and raise the domestic productivity cut-off. At the same time, its indirect effect is to make the foreign market more competitive, and to thereby raise home's export productivity cut-off and lower home's survival cut-off due to free entry. With flexible wages, home wages can adjust down and ensure that the direct effect dominates, such that $AggProd_{ikt}$ goes up. When wages are fixed, by contrast, the indirect effect dominates, and $AggProd_{ikt}$ falls. Likewise, the two scenarios have different implications for the response of average productivity and the covariance term, determined respectively by firm entry/exit on the extensive margin and by the reallocation of activity across heterogeneous firms on the intensive margin. Of note, the numerical exercises establish that $AggProd_{ikt}$, $AvgProd_{ikt}$ and $CovProd_{ikt}$ always move in the same direction.

Consider next the case of resource misallocation (see Panel C in Table 3.1). Now both export and import liberalization can have ambiguous effects on aggregate productivity, because the economy transitions from one distorted steady state to another. As a result, trade shocks can trigger firm entry or exit and reallocate productive resources across inframarginal firms, in ways that bring the economy closer or further away from the first best. Numerical exercises show that export liberalization increases all three productivity terms, $\{AggProd_{ikt}, AvgProd_{ikt}, CovProd_{ikt}\}$, over a wide range of the parameter space. This holds regardless of whether wages are fixed

or flexible. By contrast, import liberalization can move these outcomes in different directions across different segments of the parameter space. Moreover, with fixed wages it is possible that $AggProd_{ikt}$ and $AvgProd_{ikt}$ both rise, while $CovProd_{ikt}$ declines. This occurs for intermediate levels of dispersion σ_η in the distortion draw and sufficiently positive correlation $\rho(\varphi, \eta)$ between the productivity and distortion draws.

Empirically, the sign pattern for the effect of $ExpDemand_{ikt}$ on $\{AggProd_{ikt}, AvgProd_{ikt}, CovProd_{ikt}\}$ is $\{+, +, +\}$, while that for $ImpComp_{ikt}$ is $\{+, +, -\}$. This evidence is consistent with the presence of misallocation, whereby export expansion and import competition both improve aggregate productivity. However, export expansion generates productivity gains both through the exit of relatively less productive firms and the reallocation of market share towards more productive firms, while import competition exerts a cleansing effect along the extensive margin, but worsens allocative efficiency along the intensive margin. The direction of these effects, as well as the impact of a 20% increase in $ExpDemand_{ikt}$ and $ImpComp_{ikt}$ implied by our baseline IV results, are thus in line with the numerical simulation results for the case of fixed wages, intermediate distortion dispersion, and positive productivity-dispersion correlation (see Panel D and last line of Panel C in Table 3.1).

In this section, we present results from several additional exercises that are consistent with this interpretation and provide more direct evidence for the firm selection and resource misallocation channels.

3.6.1 Firm Selection

We first examine the impact of trade exposure on the extensive margin of firm selection and thereby on aggregate productivity. The logic of this analysis is as fol-

lows. In the absence of misallocation, globalization can affect aggregate productivity $AggProd_{ikt}$ by (i) raising the first-best productivity cut-off φ_{ii}^* and by (ii) reallocating resources across inframarginal firms. Theory implies that channels (i) and (ii) would manifest in the adjustment of $AvgProd_{ikt}$ and $CovProd_{ikt}$, respectively. Moreover, the change in φ_{ii}^* would be a sufficient statistic for both (i) and (ii) in general equilibrium. Since there is no misallocation, the observed minimum productivity across firms in a given country-sector-year, $\min Prod_{ikt}$, would be the empirical counterpart to φ_{ii}^* . Controlling for $\min Prod_{ikt}$, any residual impact of international trade on $\{AggProd_{ikt}, AvgProd_{ikt}, CovProd_{ikt}\}$ would therefore indicate that mechanisms other than (i) and (ii) must also operate.

In the presence of misallocation, globalization still affects aggregate productivity via (i) and (ii), but also by (iii) changing the degree of misallocation by shifting resources across firms along the extensive and intensive margins. The observed minimum productivity, $\min Prod_{ikt}$, would now be the empirical counterpart to the distorted productivity threshold $\underline{\varphi}_{ii}^*$ (recall that $\underline{\varphi} = \varphi\eta$). Controlling for $\min Prod_{ikt}$, any residual impact of international trade on $\{AggProd_{ikt}, AvgProd_{ikt}, CovProd_{ikt}\}$ would now be consistent with mechanism (iii) and the presence of misallocation.

Guided by theory, we therefore assess how globalization affects firm selection at the bottom end of the observed productivity distribution. We measure $\min Prod_{ikt}$ with the first percentile of log value added per worker across firms in CompNet, in order to guard against outliers due to measurement error or idiosyncratic firm shocks. We find in Panel A of Table 3.7 that export demand and import competition both raise $\min Prod_{ikt}$ (Columns 1 and 5). The estimates imply that the lowest productivity among surviving firms would increase by 4%-6.3% and 1.5%-5% following a 20% expansion in exports and import penetration, respectively.

We next quantify the contribution of firm selection to the overall productivity

impact of trade, by expanding IV specification (3.31) to include $\min Prod_{ikt}$ in the second stage.²³ Higher $\min Prod_{ikt}$ is associated with higher aggregate and average productivity, but lower covariance between firm productivity and share of economic activity. Compared to the baseline in Table 3.5, the point estimates for β_{EX} and β_{IM} are reduced by 48% and 57% in the regressions for $AvgProd_{ikt}$ (Column 3). In the specification for $CovProd_{ikt}$, coefficient β_{EX} increases by 20%, while β_{IM} falls by 28% (Column 4). Overall, firm selection accounts for 31% of the impact of export demand and 62% of the impact of import competition on aggregate productivity $AggProd_{ikt}$ (Column 2). These numbers are respectively 48% and 54% when we further condition on sector-year fixed (Column 6).

Through the lens of the model, these results suggest that the observed productivity effects of globalization cannot be fully attributed to the reallocation of activity across firms in a frictionless economy via channels (i) and (ii). Instead, the patterns are consistent with the presence of resource misallocation, whereby international trade increases aggregate productivity in part by changing the efficiency with which resources are allocated across firms with different productivity and distortion levels. Along the extensive margin, the residual positive effects of trade in Columns 3 and 7 imply that export and import expansion cleanse the economy of low-productivity firms that would not have operated in the first best. Along the intensive margin, the evidence in Columns 4 and 8 indicates that higher export demand induces the reallocation of market share towards more productive firms, while steeper import competition worsens allocative efficiency.

²³We have obtained similar results when controlling for a cubic polynomial in $\min Prod_{ikt}$. This more flexible approach allows for the mapping between $\min Prod_{ikt}$, $AvgProd_{ikt}$ and $CovProd_{ikt}$ to be unique but non-linear under different modeling assumptions.

3.6.2 Productivity Upgrading

The model in Section 2 ignores the potential impact of globalization on productivity upgrading within firms. However, international trade liberalization may change the costs and returns associated with the development of new technologies or the adoption of existing technologies that bring a firm closer to the frontier. In this subsection, we argue that accounting for this mechanism does not affect our conclusions for the role of firm selection and resource misallocation in the productivity response to trade.

Globalization may influence technological change through different channels, with ambiguous consequences for $AggProd_{ikt}$, $AvgProd_{ikt}$ and $CovProd_{ikt}$. Higher export demand may increase expected profits sufficiently to induce firms to upgrade productivity if there are economies of scale in innovation and adoption (e.g. Bustos (2011)). Steeper import competition may discourage innovation by reducing profits from domestic sales, but it may conversely incentivize incumbents to upgrade productivity in order to remain competitive (e.g. Bloom et al. (2016); Dhingra (2013)). These effects may be non-monotonic or non-linear across the firm productivity distribution. In the presence of resource misallocation, distortions may prevent firms from upgrading in response to trade openness even when it would have been profitable in the first best. At the same time, if distortion-induced constraints are not binding, trade-induced innovation may correct some of the misallocation in market shares across firms.

We explore this question empirically in Panel B of Table 3.7. We proxy the aggregate amount of productivity upgrading with CompNet data on log research and development expenditures at the country-sector-year level, RD_{ikt} . We find that export demand growth has a positive but insignificant effect on R&D in the aggregate. The effect of import competition is large and significant, but its sign is sensitive to

the inclusion of sector-year dummies (Columns 1 and 5).²⁴

We then assess the extent to which firm selection and R&D activity together can account for the productivity impact of globalization, by controlling for both $\min Prod_{ikt}$ and RD_{ikt} in the IV second stage. The estimates for $\min Prod_{ikt}$, β_{EX} and β_{IM} remain similar to those in Panel A where we control only for $\min Prod_{ikt}$. Conditional on $\min Prod_{ikt}$, higher RD_{ikt} itself is associated with lower $AvgProd_{ikt}$ and higher $CovProd_{ikt}$, but not significantly correlated with $AggProd_{ikt}$.

3.6.3 Imperfect Institutions and Market Frictions

The results above are consistent with resource misallocation shaping the aggregate productivity response to trade. However, the evidence is indirect because we cannot observe or measure misallocation in the data: As Section 2 demonstrates, neither the level nor the trade sensitivity of any productivity term $\{AggProd_{ikt}, AvgProd_{ikt}, CovProd_{ikt}\}$ is a sufficient statistic for the degree of misallocation.

In order to provide more direct evidence for the role of resource misallocation, we exploit the cross-country variation in the strength of institutions that govern the efficiency of factor and product markets. This approach rests on two premises. First, institutional imperfections constitute structural problems in an economy that generate an inefficient allocation of production inputs or output market shares across firms. Institutional indicators thus identify primitive root causes that microfound resource misallocation in theoretical frameworks. For example, our model considers distortions to input costs that can be mapped to institutional measures of labor and capital market frictions. The theoretical results are, however, isomorphic to revenue or profit distortions via sales or corporate taxes, which can be mapped to

²⁴We tabulate results for concurrent R&D, but similar findings obtain if we instead lag R&D.

institutional measures of product market regulation.

Our second premise is that countries at different levels of institutional efficiency will respond differently to trade shocks if and only if misallocation is present and influences the trade-productivity nexus. Recall from Section 2 that trade expansion has theoretically ambiguous effects on aggregate productivity under misallocation, and that these effects need not vary smoothly with the degree of misallocation.²⁵ Showing that institutional frictions moderate the impact of trade is thus sufficient to establish a role for misallocation, while estimating the direction and magnitude of this moderating force is of independent policy relevance.

We therefore obtain country measures of institutional quality, $Institution_{it}$, and expand IV specification (3.31) to include interactions of export demand and import competition with $Institution_{it}$. The level effect of institutions is subsumed by the country-year fixed effects. We instrument the main and interaction trade terms using the same instruments as before and their respective interactions with $Institution_{it}$.

We exploit five indicators of institutional strength, defined such that high $Institution_{it}$ signifies more efficient and effective institutions. The first two are rule of law and corruption, from the *World Bank Governance Indicators* (Kaufmann et al., 2010). These are comprehensive indices respectively of general institutional capacity and scope for rent extraction for private gains, which arguably affect economic efficiency in both input and output markets. Rule of law has a mean of 1.11 and a standard deviation of 0.49 in the panel; the corresponding statistics for (inverse) corruption are 1.07 and 0.69.

The other three measures characterize institutional efficiency in specific markets.

²⁵On the one hand, countries with more efficient resource allocation may more effectively adjust to trade reforms and reap greater productivity gains from globalization. On the other hand, such countries are closer to the first best to begin with, and may gain less on the margin from trade liberalization.

We quantify labor market flexibility with a 0-6 index that averages 21 indicators for firing and hiring costs, from the *OECD Employment Database* (mean 3.28, standard deviation 0.37). We proxy financial market development with a 0-12 index that captures the strength of creditor rights' protection necessary to support financial contracts, from the *World Bank Doing Business Report* (mean 5.86, standard deviation 1.79). Finally, we assess the (inverse) tightness of product market regulation with the a 0-3 index that aggregates 18 measures for state control, barriers to entrepreneurship, and barriers to trade and investment, from the *OECD Market Regulation Database* (mean 1.17, standard deviation 0.25).

Table 3.8 reveals consistent patterns across all five institutional measures: Strong rule of law, low corruption, efficient factor and product markets amplify the productivity gains from import competition and dampen the productivity gains from export expansion. This is true for aggregate productivity, average firm productivity and allocative efficiency. The interaction terms are highly statistically and economically significant for all but 2 out of 30 coefficient estimates.²⁶

These results indicate the complex interactions between international trade and market frictions in shaping aggregate productivity. They also point to asymmetry between positive and negative shocks to domestic firms. The evidence suggests that growth opportunities, such as greater export demand, can partly correct accumulated misallocation and boost productivity more when markets and institutions are less efficient. This may occur if the "right" productive firms that start out with sub-optimal resources can more effectively scale up production than the "wrong" less

²⁶These findings are generally robust to adding sector-year fixed effects, although several interaction terms become imprecisely estimated (Panel A of Appendix Table 4). The key aspect of labor market flexibility is the governance of regular individual contracts (Panel B of Appendix Table 4). Additional provisions under collective regular contracts, as well as the governance of temporary employment contracts play a much lesser role.

productive firms. By contrast, contractionary shocks, such as heightened import competition, can engender more cleansing reallocation under more efficient markets and institutions, such that less productive firms downsize disproportionately more.

Note that the interaction analysis in Table 3.8 speaks to the differential effects of expansionary export demand shocks and contractionary import competition shocks across economies at different levels of institutional and market efficiency. This is conceptually distinct from the baseline asymmetric effects of export and import shocks on allocative efficiency $CovProd_{ikt}$ in Table 3.5, because the latter capture average effects across countries holding countries' institutional and market environment fixed. This baseline asymmetry signals that the "right" firms may be able to access relatively more resources than the "wrong" firms during boom times, compared to bust times. This raises the possibility that the specific nature of institutional and market imperfections matters. In the case of financial market frictions, for example, asymmetric information may play out in different ways during peaks and troughs. Financiers may have imperfect knowledge of firm fundamentals, and make financing decisions based on expected future profits (which depend on fundamentals such as productivity) and on past performance and collateralizable assets (which depend on previous distortions in capital allocation). Since rises in export demand and import competition have opposite effects on firm profits, our results are consistent with lenders being more willing to extend capital based on the net present value of future profits during boom times, and conversely tying funding more closely to collateral during bust times.

3.6.4 Misallocation Measures in the Literature

We conclude by examining the impact of international trade on several measures of resource misallocation that have been proposed in the literature. Although these measures have theoretical micro-foundations, they are valid under specific modeling assumptions that are difficult to test empirically but likely to fail in realistic economic environments. Under certain assumptions, Hsieh and Klenow (2009) and Gopinath et al. (2017) show that the observed dispersion across firms in revenue-based total factor productivity (TFPR), marginal revenue product of capital (MRPK), and marginal revenue product of labor (MRPL) is monotonically increasing with misallocation in input and output markets. Under certain assumptions, Edmond et al. (2015) likewise find that the observed dispersion in price-cost mark-ups (PCM) across firms signals output-market distortions.

There are several difficulties in interpreting these indicators in terms of allocative efficiency. First, measurement error in firm TFPR, MRPK, MRPL and PCM can inflate their observed dispersion. Second, they are inferred from production function estimates, such that treating them as regression outcomes can complicate econometric inference. Third, the nature of production technology and market competition can affect the productivity and mark-up dispersion even in the absence of resource misallocation. On market structure, Foster et al. (2008) and Berman et al. (2012) show that TFPR, MRPK and MRPL dispersion implies misallocation of production inputs under constant mark-ups, but not under variable mark-ups. Dhingra and Morrow (2016) further demonstrate that market-share misallocation arises in product markets with variable mark-ups even when there are no distortions in factor markets. On production technology, Bartelsman et al. (2013) and Foster et al. (2015, 2016) establish that TFPR, MRPK and MRPL dispersion signals resource misalloca-

tion under constant returns to scale and no shocks to firm demand or quantity-based productivity (TFPQ). However, this is no longer the case if firms face increasing returns to scale or adjustment costs.

Given prior empirical evidence of variable mark-ups, increasing returns to scale, and adjustment costs, it can thus be difficult to interpret the four dispersion measures. We nevertheless explore the effect of international trade on these dispersion outcomes in our data in Appendix Table 4. For each country, sector and year, CompNet reports the standard deviations of TFPR, MRPK and MRPL, as well as the 80th-20th interpercentile range for PCM. Using our IV strategy, we generally find positive significant effects of import exposure across the four $Dispersion_{ikt}$ metrics, but very mixed results for export demand (see also De Loecker and Warzynski (2012) on PCM). Were $Dispersion_{ikt}$ indicative of misallocation, our conclusion that export expansion (import competition) enhances (reduces) allocative efficiency would have been consistent with $Dispersion_{ikt}$ falling (rising) with $ExpDemand_{ikt}$ ($ImpComp_{ikt}$).

3.7 Conclusion

We examine the impact of international trade on aggregate productivity. Theoretically, we show that bilateral and unilateral export liberalization increase aggregate productivity, while unilateral import liberalization can either raise or reduce it. However, all three trade reforms have ambiguous effects in the presence of resource misallocation. Using unique new data on 14 European countries and 20 manufacturing industries during 1998-2011, we establish empirically that exogenous shocks to both export demand and import competition generate large gains in aggregate productivity. Although both trade activities increase average firm productivity, export

expansion reallocates activity towards more productive firms, while import penetration acts in reverse. Improved firm selection can account for only half of the productivity gains from trade, suggesting a potential role for resource misallocation. Indeed, efficient institutions, factor and product markets amplify the productivity gains from import competition, but dampen those from export expansion.

Our findings have important implications for policy design in developing countries that aspire to promote growth through greater economic integration but suffer from weak institutions and significant frictions in capital, labor and product markets. The analysis suggests that reallocations across firms is a key margin of adjustment and that alleviating market distortions is important for realizing the full welfare gains from globalization. Our results further indicate that developed economies also stand to gain from import and export liberalization, despite concerns about the impact of import competition from low-wage countries.

There remains much scope for further research. Richer data would make it possible to examine how international trade affects the incentives for technological upgrading across the firm productivity distribution. From a policy perspective, it would also be valuable to assess the impact of different frictions in capital, labor and product markets on firm selection, firm innovation, and reallocations across firms. These constitute some steps towards understanding how to design trade policy and coordinate it with structural reforms that remove institutional and market imperfections in order to improve welfare.

3.8 Tables and Figures

Table 3.1: Numerical Simulation: Productivity Gains from Trade Liberalization

| | Bilateral Liberalization | | | | Export Liberalization | | | | Import Liberalization | | | |
|--|--------------------------|--------------------|--------------------|--------------------|-----------------------|--------------------|--------------------|--------------------|-----------------------|---------------------|---------------------|---------------------|
| | Welfare (1) | Agg Prod (2) | Avg Prod (3) | Cov Term (4) | Welfare (5) | Agg Prod (6) | Avg Prod (7) | Cov Term (8) | Welfare (9) | Agg Prod (10) | Avg Prod (11) | Cov Term (12) |
| Panel A. No Misallocation (Pareto) | | | | | | | | | | | | |
| Endogenous w | 4,75% | 4,76% | 3,52% | 1,23% | 1,66% | 1,67% | 1,23% | 0,43% | 2,51% | 2,52% | 1,87% | 0,65% |
| Exogenous w | 3,30% | 4,75% | 3,52% | 1,23% | 4,96% | 7,16% | 5,32% | 1,83% | -0,85% | -1,21% | -0,91% | -0,31% |
| Panel B. No Misallocation (Log-Normal) | | | | | | | | | | | | |
| Endogenous w | 3,92% | 3,50% | 2,75% | 0,75% | 1,39% | 1,22% | 0,96% | 0,26% | 1,95% | 1,72% | 1,35% | 0,37% |
| Exogenous w | 2,73% | 3,50% | 2,75% | 0,75% | 3,77% | 4,89% | 3,84% | 1,05% | -0,49% | -0,60% | -0,48% | -0,12% |
| Panel C. Misallocation (Joint Log-Normal) | | | | | | | | | | | | |
| Endogenous w | 3,92% | 3,49% | 2,65% | 0,84% | 1,40% | 1,22% | 0,92% | 0,30% | 1,96% | 1,72% | 1,30% | 0,42% |
| | 3,87% | 3,47% | 2,80% | 0,67% | 1,37% | 1,21% | 0,98% | 0,22% | 1,93% | 1,70% | 1,38% | 0,32% |
| Exogenous w | 3,85% | 3,47% | 2,94% | 0,53% | 1,35% | 1,20% | 1,04% | 0,16% | 1,91% | 1,70% | 1,46% | 0,24% |
| | -1,68% | -0,05% | -0,16% | 0,11% | 2,32% | 2,26% | 1,77% | 0,49% | -3,27% | -1,55% | -1,37% | -0,18% |
| | 2,70% | 3,48% | 2,81% | 0,67% | 2,62% | 4,46% | 3,54% | 0,91% | 0,58% | -0,21% | -0,13% | -0,08% |
| | 0,92% | 7,71% | 6,42% | 1,29% | 0,15% | 8,47% | 7,11% | 1,36% | 1,38% | 0,03% | 0,11% | -0,09% |
| Panel D. Data | | | | | | | | | | | | |
| Estimated Effects (ctry-year FE) | | | | | | 13,53% | 17,91% | -4,18% | 0,00% | 0,00% | 0,00% | 0,00% |
| Estimated Effects (ctry-year & sector-year FE) | | | | | | 99,90% | 116,42% | -16,52% | 0,00% | 0,00% | 0,00% | 0,00% |

Notes: This table reports numerical and estimation results for the impact of reducing bilateral trade costs, unilateral export costs or unilateral import costs by 20%. Panels A-C show the change in welfare, aggregate productivity, average firm productivity and the covariance of firms' productivity and employment share predicted by different model scenarios with free entry and endogenous or exogenous wages. In Panels A and B, there is no resource misallocation, and productivity is Pareto or Log-Normal distributed. In Panel C, there is misallocation, and productivity and distortion are joint Log-Normal with $\theta=0.15$ and $\rho=0.4, 0.4$. All other parameter values are calibrated as discussed in the text. Panel D reports the estimated effect of increasing export demand or import competition by 20% based on the baseline IV results in Table 3.5.

Table 3.2: Summary Statistics

| | N | Mean | St Dev |
|--|-------|-------|--------|
| Panel A. Country-Sector-Year Level | | | |
| ln Output | 2 811 | 8,09 | 1,77 |
| ln Value Added | 2 811 | 13,51 | 2,03 |
| ln Employment | 2 811 | 10,21 | 1,35 |
| ln Exports | 2 811 | 7,65 | 1,74 |
| ln (Imports - Own-Sector Imp Inputs) | 2 811 | 6,41 | 1,97 |
| ln Aggregate Productivity | 2 811 | 3,21 | 1,13 |
| ln Average Productivity | 2 811 | 2,98 | 1,19 |
| Covariance Term | 2 811 | 0,23 | 0,22 |
| Δ ln Aggregate Productivity, $\Delta = 1$ year | 2 548 | 0,04 | 0,10 |
| Δ ln Average Productivity, $\Delta = 1$ year | 2 548 | 0,03 | 0,09 |
| Δ Covariance Term, $\Delta = 1$ year | 2 548 | 0,01 | 0,08 |
| Δ ln Aggregate Productivity, $\Delta = 3$ years | 2 073 | 0,11 | 0,19 |
| Δ ln Average Productivity, $\Delta = 3$ years | 2 073 | 0,09 | 0,17 |
| Δ Covariance Term, $\Delta = 3$ years | 2 073 | 0,02 | 0,12 |
| Δ ln Aggregate Productivity, $\Delta = 5$ years | 1 587 | 0,18 | 0,25 |
| Δ ln Average Productivity, $\Delta = 5$ years | 1 587 | 0,16 | 0,22 |
| Δ Covariance Term, $\Delta = 5$ years | 1 587 | 0,02 | 0,14 |
| Panel B. Country(-Year) Level | | | |
| Rule of Law | 144 | 1,11 | 0,49 |
| (Inverse) Corruption | 144 | 1,07 | 0,69 |
| Labor Market Flexibility | 130 | 3,28 | 0,37 |
| Creditor Rights Protection ⁸⁴ | 14 | 5,86 | 1,79 |
| (Inverse) Product Market Regulation | 13 | 1,17 | 0,25 |

This table summarizes the variation in aggregate economic activity, productivity, international trade activity, institutional and market frictions across countries, sectors and years in the 1998-2011 panel. All variables are defined in the paper.

Table 3.3: Trade and Aggregate Economic Activity: OLS Correlation

| Dep Variable: | Economic Activity | | | Aggregate Productivity | | |
|------------------------|-----------------------------|----------------------------|-----------------------------|----------------------------|----------------------------|-----------------------------|
| | ln Output (ikt) | ln Value Added (ikt) | ln Employ- ment (ikt) | ln Agg Prod (ikt) | ln Avg Prod (ikt) | Cov Term (ikt) |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp Dem (ikt) | 0.403*** (0.029) | 0.380*** (0.022) | 0.243*** (0.014) | 0.125*** (0.016) | 0.080*** (0.016) | 0.045*** (0.007) |
| Imp Comp (ikt) | -0.139*** (0.015) | 0.041*** (0.015) | -0.066*** (0.006) | 0.106*** (0.013) | 0.124*** (0.013) | -0.019*** (0.005) |
| ln N Firms (ikt) | 0.552*** (0.023) | 0.573*** (0.023) | 0.736*** (0.019) | -0.161*** (0.020) | -0.122*** (0.018) | -0.039*** (0.007) |
| Avg ln N Firms (kt) | -0.969*** (0.032) | -0.710*** (0.033) | -0.727*** (0.023) | 0.023 (0.033) | 0.100*** (0.033) | -0.077*** (0.010) |
| Avg ln Employment (kt) | 1.285*** (0.065) | 0.653*** (0.045) | 0.858*** (0.028) | -0.182*** (0.040) | -0.245*** (0.041) | 0.063*** (0.020) |
| N | 2,811 | 2,811 | 2,811 | 2,811 | 2,811 | 2,811 |
| R2 | 0.927 | 0.928 | 0.949 | 0.849 | 0.868 | 0.519 |
| Country*Year FE | Y | Y | Y | Y | Y | Y |

This table examines the relationship between aggregate economic activity, aggregate productivity and trade exposure at the country-sector-year level. The outcome variable is log output, log value added, log employment, or aggregate productivity terms from the OP decomposition as indicated in the column heading. All columns include country-year pair fixed effects, and control for the log number of firms by country-sector-year, the average log number of firms across countries by sector-year, and the average log employment across countries by sector-year. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

Table 3.4: Instrumenting Export Demand and Import Competition: IV First Stage

| Dep Variable: | Exp Dem (ikt) | | | Imp Comp (ikt) | | |
|------------------------|-----------------------------|----------------------------|----------------------------|-----------------------------|----------------------------|-----------------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Foreign Demand (ikt) | 0.638*** (0.034) | 0.458*** (0.056) | 0.443*** (0.062) | -0.002 (0.022) | -0.007 (0.027) | -0.036 (0.030) |
| Foreign Supply (ikt) | 0.087*** (0.015) | 0.139** (0.066) | 0.140* (0.081) | 0.868*** (0.007) | 0.422*** (0.027) | 0.345*** (0.031) |
| Import Tariff (ikt) | -4.693*** (0.847) | 0.307 (0.669) | 0.662 (0.816) | -2.802*** (0.507) | -0.986** (0.407) | -1.332*** (0.437) |
| ln N Firms (ikt) | 0.555*** (0.034) | 0.564*** (0.032) | 0.569*** (0.032) | 0.036** (0.018) | 0.008 (0.016) | 0.007 (0.016) |
| Avg ln N Firms (kt) | -0.741*** (0.033) | -0.539*** (0.134) | | -0.112*** (0.025) | 0.110* (0.062) | |
| Avg ln Employment (kt) | 0.344*** (0.065) | 0.490*** (0.089) | | 0.113*** (0.042) | -0.042 (0.055) | |
| N | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 |
| R2 | 0.889 | 0.921 | 0.924 | 0.974 | 0.985 | 0.986 |
| Country*Year FE | Y | Y | Y | Y | Y | Y |
| Sector FE | N | Y | N | N | Y | N |
| Sector*Year FE | N | N | Y | N | N | Y |

This table presents the baseline IV first stage. It examines the impact of foreign export supply, foreign import demand and import tariffs on export and import activity at the country-sector-year level. The outcome variable is indicated in the column heading. All columns include country-year pair fixed effects and the full set of controls in Table 3. Columns 2 and 5 (3 and 6) also include sector (sector-year pair) fixed effects. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

Table 3.5: Impact of Trade on Aggregate Productivity: IV Second Stage

| Dep Variable: | ln Agg Prod (ikt) (1) | ln Avg Prod (ikt) (2) | Cov Term (ikt) (3) | ln Agg Prod (ikt) (4) | ln Avg Prod (ikt) (5) | Cov Term (ikt) (6) | ln Agg Prod (ikt) (7) | ln Avg Prod (ikt) (8) | Cov Term (ikt) (9) |
|---------------------------|--------------------------------|--------------------------------|-----------------------------|--------------------------------|--------------------------------|-----------------------------|--------------------------------|--------------------------------|-----------------------------|
| \widehat{ExpDem} (ikt) | 0.398*** (0.039) | 0.295*** (0.039) | 0.103*** (0.014) | 0.300*** (0.097) | 0.197** (0.085) | 0.103** (0.045) | 0.367*** (0.109) | 0.226** (0.098) | 0.141*** (0.050) |
| $\widehat{ImpComp}$ (ikt) | 0.068*** (0.014) | 0.090*** (0.014) | -0.021*** (0.005) | 0.294** (0.131) | 0.296** (0.118) | -0.002 (0.042) | 0.502*** (0.185) | 0.585*** (0.166) | -0.083 (0.059) |
| ln N Firms (ikt) | -0.321*** (0.029) | -0.248*** (0.027) | -0.073*** (0.012) | -0.257*** (0.062) | -0.185*** (0.054) | -0.072** (0.029) | -0.292*** (0.067) | -0.196*** (0.061) | -0.097*** (0.032) |
| Avg ln N Firms (kt) | 0.327*** (0.046) | 0.334*** (0.046) | -0.007 (0.019) | 0.061 (0.127) | 0.030 (0.123) | 0.031 (0.052) | | | |
| Avg ln Employment (kt) | -0.461*** (0.054) | -0.458*** (0.055) | -0.003 (0.027) | 0.054 (0.128) | 0.021 (0.125) | 0.033 (0.052) | | | |
| N | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 |
| R2 | 0.820 | 0.852 | 0.485 | 0.869 | 0.897 | 0.635 | 0.856 | 0.887 | 0.649 |
| Ctry*Year FE, Controls | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Sector FE | N | N | N | Y | Y | Y | N | N | N |
| Sector*Year FE | N | N | N | N | N | N | Y | Y | Y |

This table presents the baseline IV second stage. It examines the impact of instrumented export demand and import competition on aggregate productivity at the country-sector-year level. The outcome variables follow the OP productivity decomposition and are indicated in the column heading. All columns include country-year pair fixed effects and the full set of controls in Table 3. Columns 4-6 (7-9) also include sector (sector-year pair) fixed effects. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

Table 3.6: Import Competition Ratio and Chinese Import Competition

Panel A. Import Competition Ratio

| Dep Variable: | (1) | (2) | (3) | (1) | (2) | (3) |
|---------------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|---------------------------|
| | ln Agg Prod (ikt) (1) | ln Avg Prod (ikt) (2) | Cov Term (ikt) (3) | ln Agg Prod (ikt) (4) | ln Avg Prod (ikt) (5) | Cov Term (ikt) (6) |
| \widehat{ExpDem} (ikt) | 0.433*** (0.038) | 0.329*** (0.038) | 0.104*** (0.013) | 0.465*** (0.140) | 0.345*** (0.124) | 0.121** (0.058) |
| $\widehat{ImpComp}$ Ratio (ikt) | 0.101*** (0.020) | 0.144*** (0.020) | -0.043*** (0.010) | 0.153*** (0.053) | 0.181*** (0.047) | -0.028 (0.024) |
| N | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 |
| R2 | 0.811 | 0.845 | 0.495 | 0.860 | 0.891 | 0.652 |
| Ctry*Year FE, Controls | Y | Y | Y | Y | Y | Y |
| Sector*Year FE | N | N | N | Y | Y | Y |

Panel B. Import Competition from China

| Dep Variable: | (4) | (5) | (6) | (1) | (2) | (3) |
|--------------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|---------------------------|
| | ln Agg Prod (ikt) (1) | ln Avg Prod (ikt) (2) | Cov Term (ikt) (3) | ln Agg Prod (ikt) (4) | ln Avg Prod (ikt) (5) | Cov Term (ikt) (6) |
| \widehat{ExpDem} (ikt) | 0.438*** (0.035) | 0.388*** (0.036) | 0.051*** (0.009) | 0.260*** (0.089) | 0.169** (0.077) | 0.091** (0.040) |
| $\widehat{ChinaImpComp}$ (ikt) | 0.011 (0.012) | 0.034*** (0.012) | -0.023*** (0.003) | 0.089 (0.057) | 0.104* (0.053) | -0.015 (0.024) |
| N | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 |
| R2 | 0.811 | 0.835 | 0.545 | 0.888 | 0.911 | 0.670 |
| Ctry*Year FE, Controls | Y | Y | Y | Y | Y | Y |
| Sector*Year FE | N | N | N | Y | Y | Y |

This table examines alternative measures of import competition at the country-sector-year level. The outcome variables follow the OP productivity decomposition and are indicated in the column heading. Import competition is measured by the ratio of imports to domestic turnover instead of by log imports in Panel A and by import competition from China instead of total import competition in Panel B. All columns include country-year pair fixed effects and the full set of controls in Table 3.3. Columns 4-6 also include sector-year pair fixed effects. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

Table 3.7: Mechanisms: Firm Selection and Innovation

Panel A. Firm Selection

| Dep Variable: | ln min Prod (ikt) (1) | ln Agg Prod (ikt) (2) | ln Avg Prod (ikt) (3) | Cov Term (ikt) (4) | ln min Prod (ikt) (5) | ln Agg Prod (ikt) (6) | ln Avg Prod (ikt) (7) | Cov Term (ikt) (8) |
|---------------------------|--------------------------------|--------------------------------|--------------------------------|-----------------------------|--------------------------------|--------------------------------|--------------------------------|-----------------------------|
| \widehat{ExpDem} (ikt) | 0.198*** (0.040) | 0.275*** (0.027) | 0.152*** (0.020) | 0.124*** (0.013) | 0.314*** (0.108) | 0.190*** (0.072) | 0.023 (0.053) | 0.166*** (0.049) |
| $\widehat{ImpComp}$ (ikt) | 0.073*** (0.015) | 0.026*** (0.010) | 0.039*** (0.007) | -0.013** (0.005) | 0.249 (0.173) | 0.230* (0.123) | 0.324*** (0.099) | -0.095 (0.059) |
| ln min Prod (ikt) | | 0.642*** (0.025) | 0.733*** (0.018) | -0.091*** (0.011) | | 0.653*** (0.024) | 0.676*** (0.021) | -0.023** (0.009) |
| N | 2,750 | 2,750 | 2,750 | 2,750 | 2,750 | 2,750 | 2,750 | 2,750 |
| R2 | 0.911 | 0.913 | 0.948 | 0.473 | 0.930 | 0.938 | 0.959 | 0.619 |
| Ctry*Year FE, Controls | Y | Y | Y | Y | Y | Y | Y | Y |
| Sector*Year FE | N | N | N | N | Y | Y | Y | Y |

Panel B. Firm Selection Innovation

| Dep Variable: | ln R&D (ikt) (1) | ln Agg Prod (ikt) (2) | ln Avg Prod (ikt) (3) | Cov Term (ikt) (4) | ln R&D (ikt) (5) | ln Agg Prod (ikt) (6) | ln Avg Prod (ikt) (7) | Cov Term (ikt) (8) |
|---------------------------|----------------------------|--------------------------------|--------------------------------|-----------------------------|-----------------------------|--------------------------------|--------------------------------|-----------------------------|
| \widehat{ExpDem} (ikt) | 0.103 (0.115) | 0.282*** (0.027) | 0.154*** (0.019) | 0.129*** (0.012) | 0.370 (0.448) | 0.237*** (0.083) | 0.055 (0.057) | 0.182*** (0.052) |
| $\widehat{ImpComp}$ (ikt) | 0.164*** (0.046) | 0.016* (0.009) | 0.038*** (0.007) | -0.022*** (0.004) | -3.680*** (0.527) | 0.190 (0.135) | 0.241** (0.105) | -0.051 (0.068) |
| ln min Prod (ikt) | | 0.657*** (0.022) | 0.736*** (0.016) | -0.079*** (0.009) | | 0.654*** (0.024) | 0.676*** (0.020) | -0.022** (0.009) |
| ln R&D (ikt) | | -0.000 (0.008) | -0.018*** (0.006) | 0.017*** (0.003) | | -0.018 (0.012) | -0.031*** (0.010) | 0.012** (0.006) |
| N | 2,777 | 2,750 | 2,750 | 2,750 | 2,777 | 2,750 | 2,750 | 2,750 |
| R2 | 0.999 | 0.915 | 0.949 | 0.501 | 0.999 | 0.936 | 0.961 | 0.599 |
| Ctry*Year FE, Controls | Y | Y | Y | Y | Y | Y | Y | Y |
| Sector*Year FE | N | N | N | N | Y | Y | Y | Y |

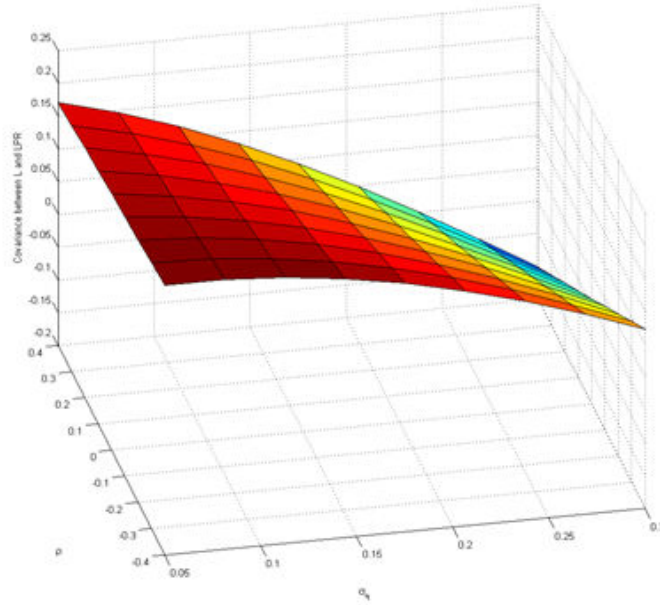
This table examines the mechanisms through which export demand and import competition affect aggregate productivity at the country-sector-year level. The outcome variables in Columns 2-4 and 6-8 follow the OP productivity decomposition and are indicated in the column heading. The outcome variable in Columns 1 and 5 is log firm productivity at the first percentile in Panel A and log RD expenditure in Panel B. All columns include country-year pair fixed effects and the full set of controls in Table 3. Columns 5-8 also include sector-year pair fixed effects. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

Table 3.8: Mechanisms: Imperfect Institutions and Market Frictions

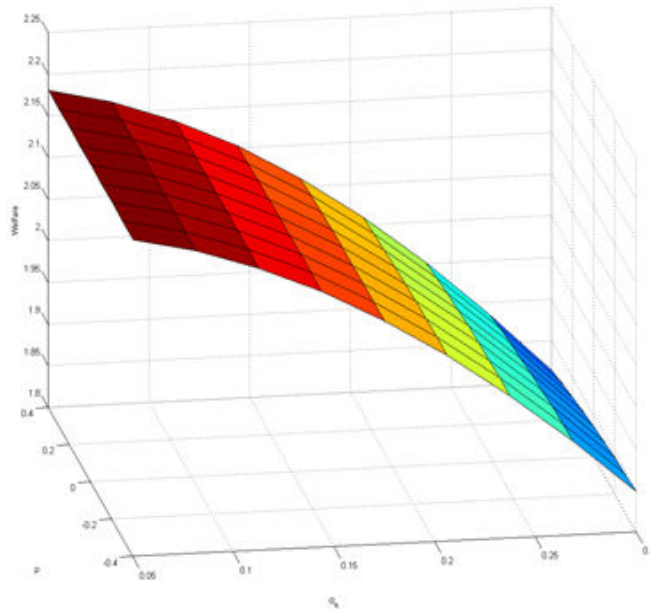
| Institution Measure: | Rule of Law | | | (Inverse) Corruption | | | Labor Market Flexibility | | | Creditor Rights Protection | | | (Inverse) Product Market Regulation | | |
|-----------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|--------------------------|---------------------|----------------------|----------------------------|---------------------|----------------------|-------------------------------------|----------------------|----------------------|
| | In Agg Prod (ikt) | In Avg Prod (ikt) | Cov Term (ikt) | In Agg Prod (ikt) | In Avg Prod (ikt) | Cov Term (ikt) | In Agg Prod (ikt) | In Avg Prod (ikt) | Cov Term (ikt) | In Agg Prod (ikt) | In Avg Prod (ikt) | Cov Term (ikt) | In Agg Prod (ikt) | In Avg Prod (ikt) | Cov Term (ikt) |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) |
| Exp Dem (ikt) | 1.066*** (0.126) | 0.862*** (0.111) | 0.204*** (0.037) | 0.850*** (0.096) | 0.670*** (0.085) | 0.180*** (0.031) | 1.121*** (0.261) | 0.763*** (0.238) | 0.358*** (0.063) | 0.718*** (0.158) | 0.511*** (0.147) | 0.207*** (0.040) | 1.314*** (0.172) | 1.047*** (0.155) | 0.267*** (0.045) |
| Imp Comp (ikt) | -0.113** (0.050) | -0.053 (0.044) | -0.060*** (0.012) | -0.063* (0.038) | -0.013 (0.034) | -0.050*** (0.010) | -0.202** (0.096) | -0.102 (0.089) | -0.100*** (0.027) | -0.108* (0.061) | -0.063 (0.055) | -0.045*** (0.015) | -0.045 (0.061) | 0.033 (0.055) | -0.078*** (0.016) |
| Exp Dem (ikt) x Institution (it) | -0.476*** (0.067) | -0.405*** (0.059) | -0.070*** (0.017) | -0.302*** (0.042) | -0.252*** (0.036) | -0.050*** (0.012) | -0.218*** (0.069) | -0.143** (0.063) | -0.075*** (0.016) | -0.048** (0.019) | -0.033* (0.017) | -0.015*** (0.005) | -0.769*** (0.130) | -0.636*** (0.118) | -0.133*** (0.032) |
| Imp Comp (ikt) x Institution (it) | 0.136*** (0.031) | 0.106*** (0.028) | 0.030*** (0.006) | 0.095*** (0.020) | 0.074*** (0.018) | 0.021*** (0.004) | 0.083*** (0.027) | 0.060** (0.026) | 0.024*** (0.008) | 0.028*** (0.009) | 0.025*** (0.008) | 0.003 (0.002) | 0.085* (0.046) | 0.039 (0.043) | 0.046*** (0.013) |
| N | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 |
| R2 | 0.792 | 0.835 | 0.459 | 0.797 | 0.839 | 0.460 | 0.747 | 0.802 | 0.447 | 0.811 | 0.848 | 0.463 | 0.825 | 0.858 | 0.398 |
| Ctrl*Year FE, Controls | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |

This table examines the role of institutional efficiency in moderating the impact of export demand and import competition on aggregate productivity at the country-sector-year level. The outcome variables follow the OP productivity decomposition and are indicated in the column heading. Institutional efficiency is measured by rule of law in Columns 1-3, the inverse of corruption in Columns 4-6, labor market flexibility in Columns 7-9, creditor rights protection in Columns 10-12, and the inverse of product market regulation in Columns 13-15. All columns include country-year pair fixed effects and the full set of controls in Table 3. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

Figure 3.1: Welfare, Misallocation, and OP Covariance



(a) OP Covariance and Misallocation Parameters

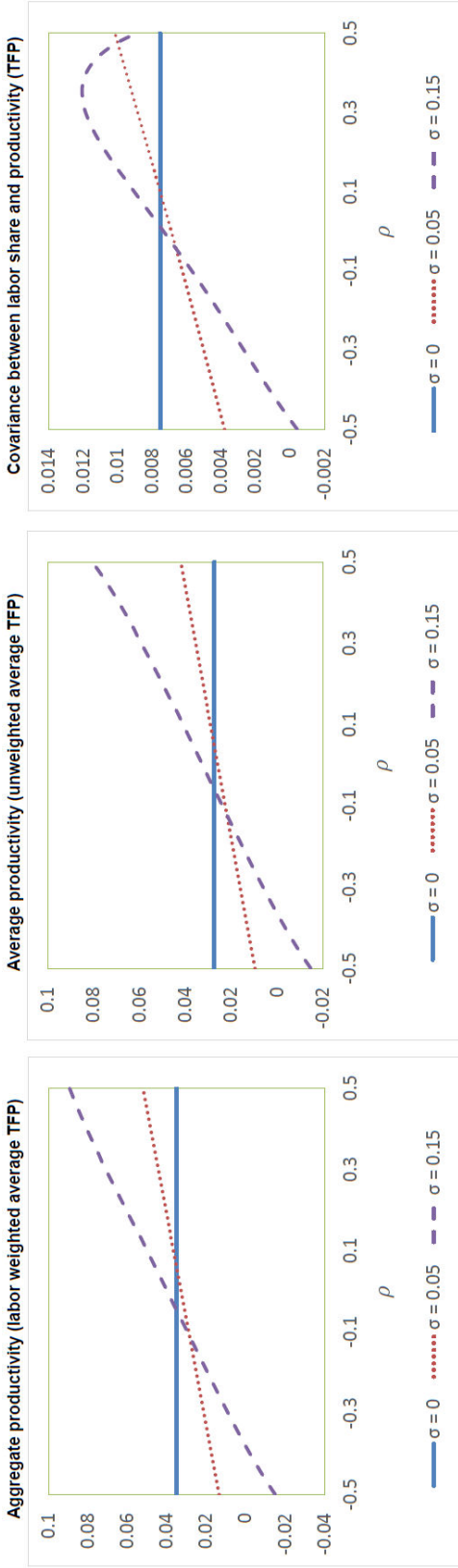


(b) Welfare and Misallocation Parameters

This figure illustrates the relationship between aggregate welfare, the OP covariance and the parameters governing misallocation based on numerical model simulations. Figure A plots the covariance on the z-axis against the standard deviation of distortion on the x-axis and the productivity-distortion correlation (ρ) on the y-axis. Figure B plots welfare W on the z-axis instead. All other parameter values are described in the text.

Figure 3.2: Numerical Simulation

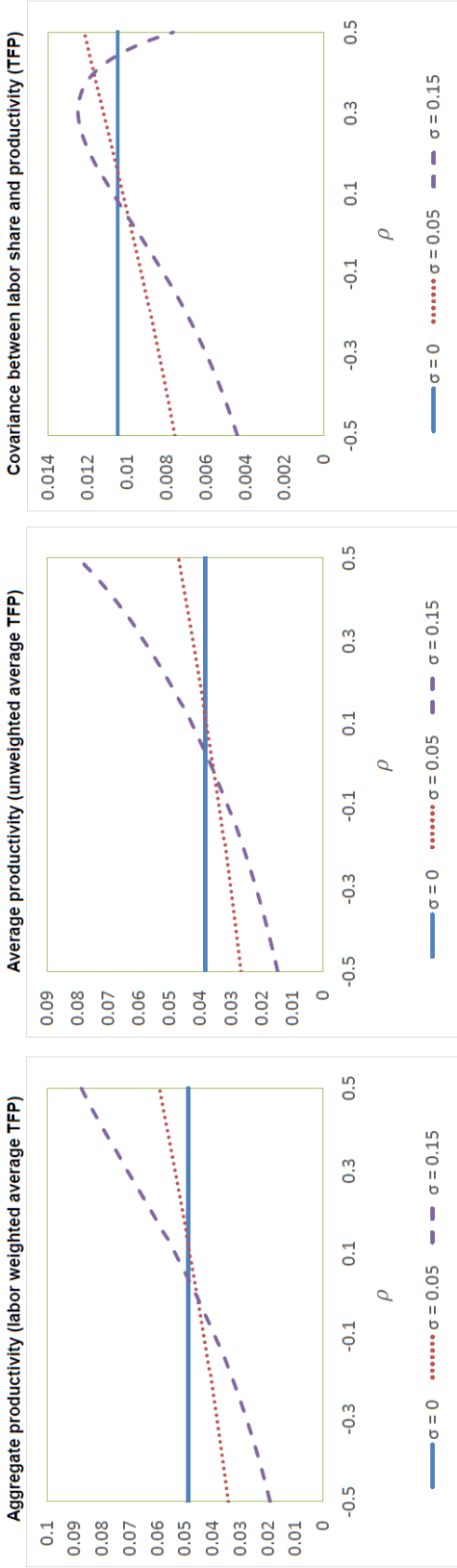
A. Bilateral Trade Liberalization



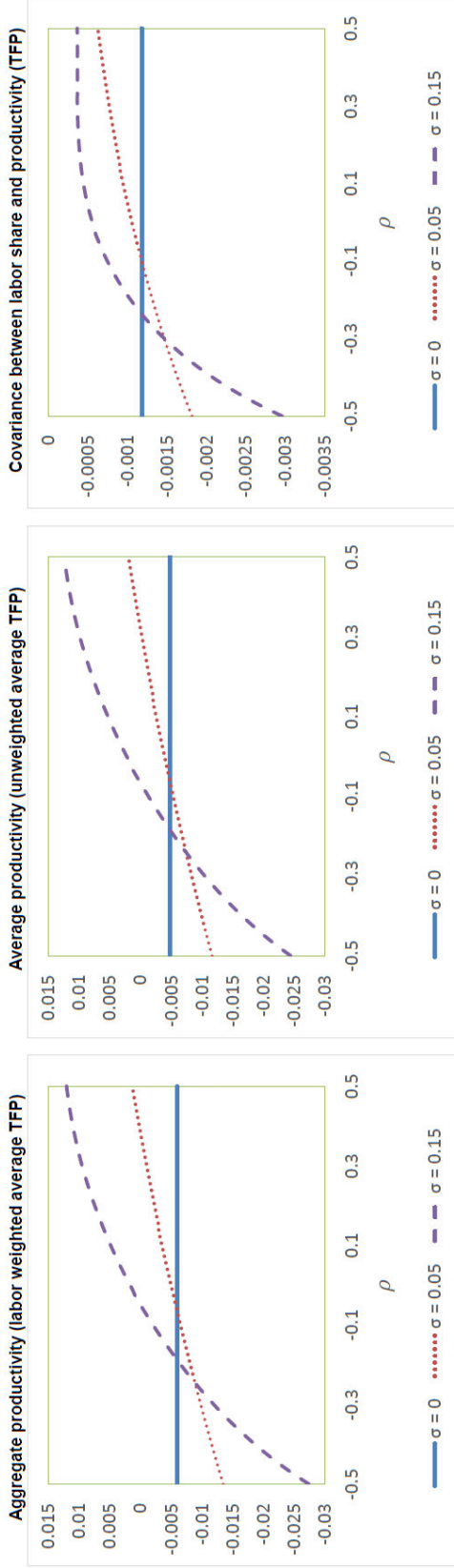
This figure displays results from numerically simulating the model to assess the productivity impact of reducing bilateral trade costs by 20%. Each line shows how the predicted change in aggregate productivity, average firm productivity and the covariance of firms' productivity and employment share on the vertical axis varies with the correlation between firm productivity and distortion $\rho(\varphi, \eta)$ on the horizontal axis. The flat line corresponds to the case of no misallocation (when the standard deviation of firm distortion is $\sigma\eta=0$) to two possible degrees of misallocation (when $\sigma\eta=0.05, 0.15$). All other parameter values are chosen as discussed in the text.

Figure 3.2: Numerical Simulation (cont.)

B. Unilateral Export Liberalization

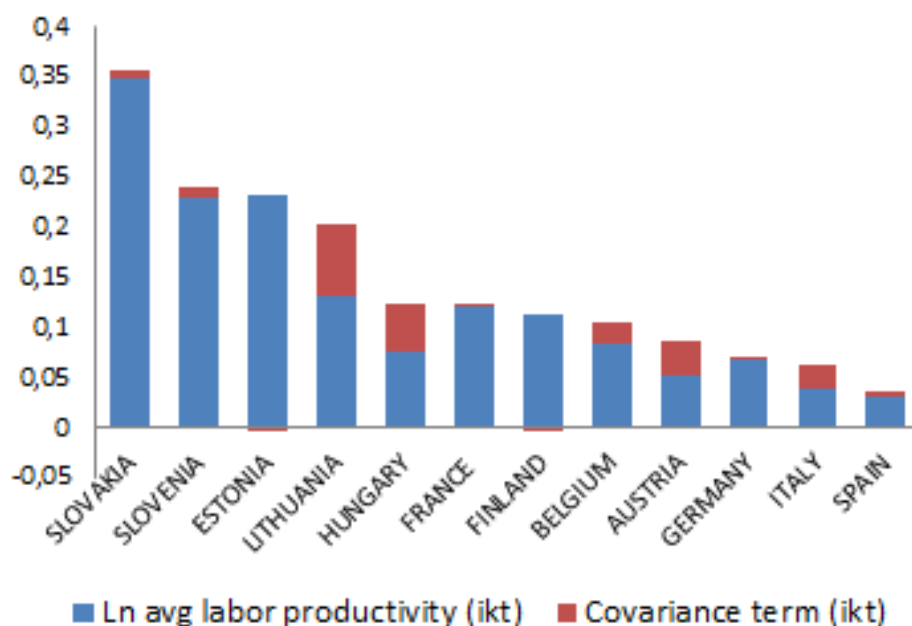


C. Unilateral Import Liberalization

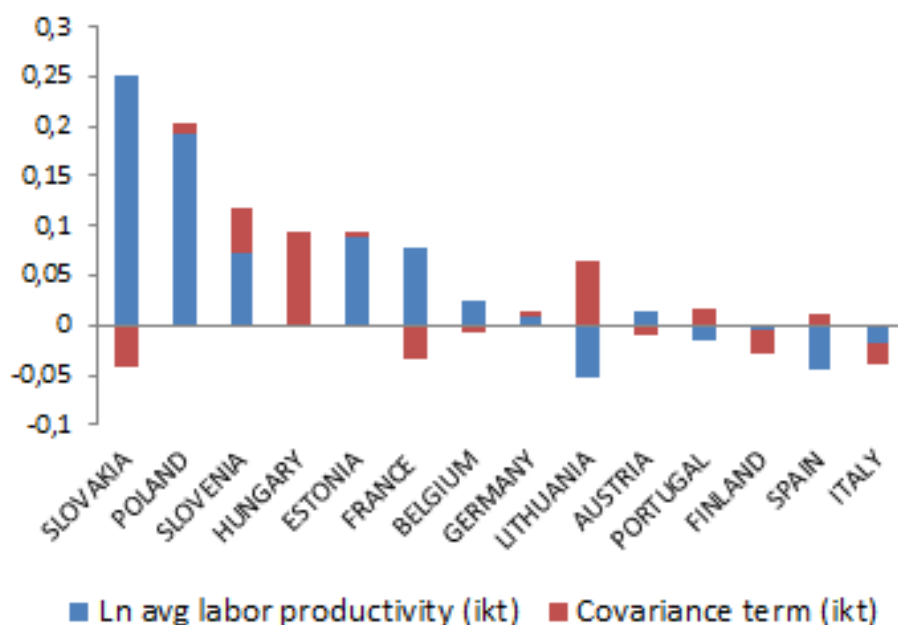


This figure displays results from numerically simulating the model to assess the productivity impact of reducing unilateral export or import costs by 20%. Each line shows how the predicted change in aggregate productivity, average firm productivity and the covariance of firms' productivity and employment share on the vertical axis varies with the correlation between firm productivity and distortion $\rho(\varphi, \eta)$ on the horizontal axis. The flat line corresponds to the case of no misallocation (when the standard deviation of firm distortion is $\sigma\eta=0$) to two possible degrees of misallocation (when $\sigma\eta=0.05, 0.15$). All other parameter values are chosen as discussed in the text.

Figure 3.3: Sources of Productivity Growth: Overlapping 3-Year Growth Rates



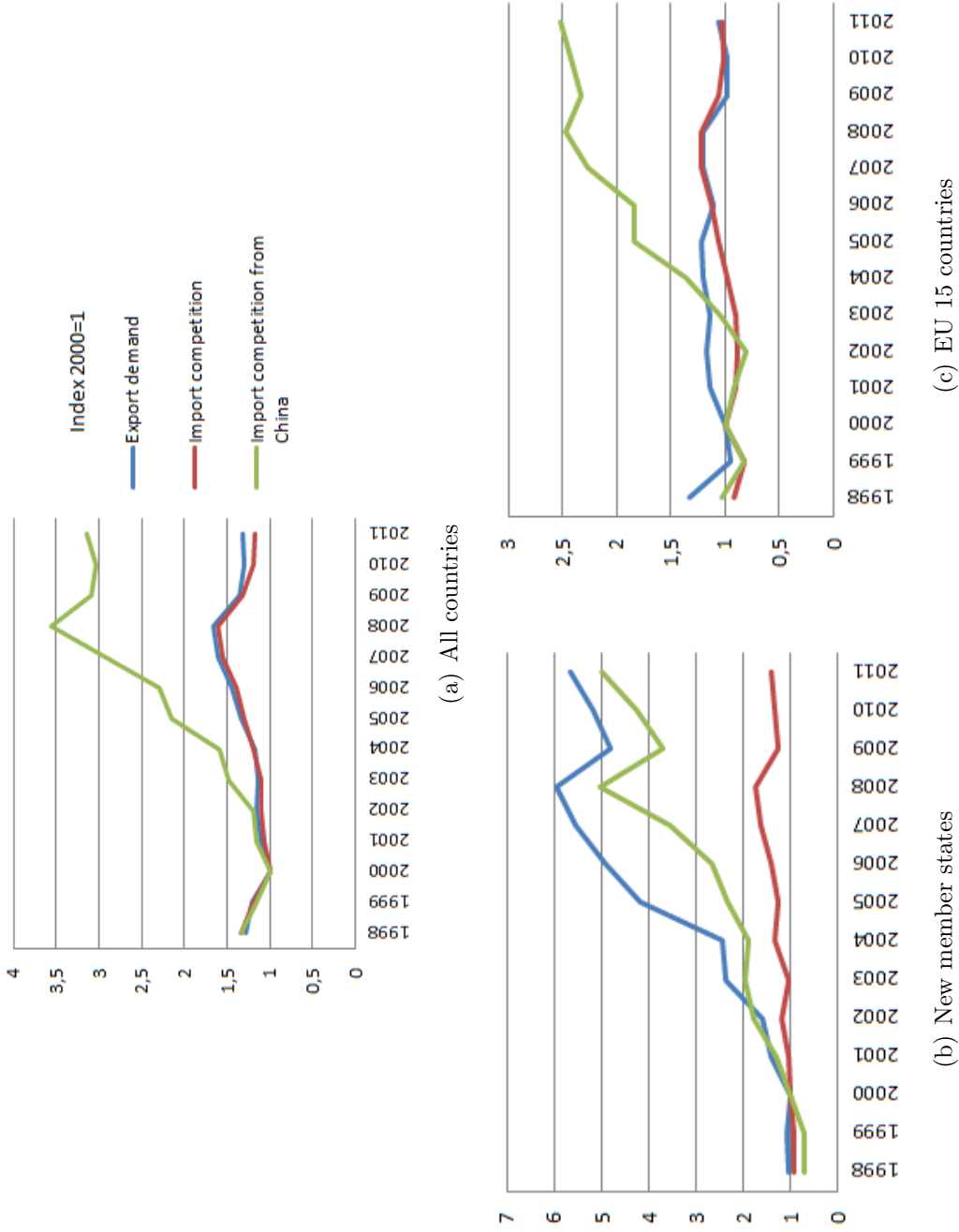
(a) Growth 2003-2007



(b) Growth 2008-2011

This figure displays the variation in the 3-year growth rates of aggregate productivity and its OP decomposition components across countries in the panel. Each bar averages overlapping 3-year growth rates across sectors and years within a country. Figures A and B focus on the pre- and post-crisis periods of 2003-2007 and 2008-2011 respectively.

Figure 3.4: Trade Exposure Over Time



This figure displays the evolution of export and import activity in the panel. Each point represents an average value across countries and sectors in a given year. Each trade flow series is normalized to 1 in year 2000. Figure A covers all countries, while Figures B and C distinguish between EU-15 countries and new EU member states.

4 Input Prices, Allocation of Resources and TFP Growth: Evidence from Chinese Imports in France

4.1 Introduction

Country integration in global value chains is an important vector of competitiveness and directly impacts firm-level and aggregate productivity. In France, a large part of intermediate inputs used by firms are imported and a growing share is coming from China. Intermediate inputs represent more than fifty percent of trade flows in France in the 2000s. Chinese goods represent 1.7% of total imports of intermediate goods in 1999 and 7.4% in 2011. Moreover, the annual growth rate of total imports of intermediate inputs is around 3% against 15% for Chinese goods ²⁷. While the average unit cost of imported intermediate inputs from China relative to other origin countries falls between 2000 and 2003 (figure 4.1a), the number of firms importing from China almost doubled between 2001 and 2007 (figure 4.1b). China's accession to the WTO in 2001 has boosted its competitiveness and considerably change the composition of French trade flows.

The objective of this paper is to understand how firm outsourcing strategy in China impacts aggregate productivity and resource allocation across firms in France. More precisely, I establish how the Chinese trade liberalization in the early 2000s has contributed to aggregate productivity growth in France between 1995 and 2013. Trade liberalization eases access to foreign inputs with high value for money for some firms, and hence reduces their marginal cost of production and increases their sales and productivity. At the sector level, it rises the relative market share of more productive firms. These firms are the only ones able to benefit from trade liberalization

²⁷Source: WIOD database and author's computation

as they are able to pay a entry fixed cost for finding suppliers abroad. Aggregate TFP being a weighted average of firm-level TFP, this generates aggregate productivity gains. For instance, the biggest French firms in the car industry have outsourced intensively in China in the early 2000s. They have gained market shares from their domestic and foreign competitors by reducing their production cost. At the aggregate level, they weight more in the weighted average of firm-level TFP and this generates aggregate productivity gains.

However, all firms do not evenly benefit from trade liberalization because of market frictions. The French statistic institute (INSEE) survey provided by Fontagné and D'Isanto (2013) reveals that anxiety among employees and trade unions in France is one of the main reasons for planned but not carried out outsourcing (see Table 4.1 in appendix). Other barriers cited by French companies are legal or administrative barriers and uncertainty about quality of goods and services provided abroad. This survey clearly highlights some institutional and market frictions that prevent access to foreign inputs for some firms regardless of their productivity. These firms lost market share due to frictions that generate resource misallocation and aggregate productivity loss.

The contribution of the paper is threefolds. The first contribution is theoretical. I introduce imported inputs in a heterogeneous-firm trade model with price distortions as in Hsieh and Klenow (2009). I suppose firms maximize their profits (defined as sales minus the cost of production factors) to determine the optimal amount of production. They use three types of inputs: capital, labour and intermediate inputs and they face price distortions for each type of inputs. Intermediate inputs can be outsourced domestically or abroad, but there is a fixed cost for importing foreign varieties. In that context, there are two sources of firm heterogeneity that determine relative firm sales: price distortions and productivity. First, firms receive

exogenous distortions on each input price which create a wedge between the social and the private marginal product of inputs. These distortions disproportionately increase or reduce firms' sales and generate an inefficient allocation of production resources, called misallocation. Second, firms have to pay a fixed entry cost for finding suppliers abroad. The fixed cost is proportional to the number of varieties after profit maximization and denominated in labor unit as in Gopinath and Neiman (2014). To identify variation of marginal products of inputs coming from price distortions and from firm heterogeneity, I compare marginal products of intermediate inputs of firms using the same share of domestic goods in their total expense in intermediate inputs. Wedges on intermediate inputs then only capture frictions that affect input prices for firms with comparable outsourcing strategy.

The second contribution is methodological. I propose a new theoretically-grounded decomposition of aggregate TFP that allows quantifying TFP gains from resource reallocation across firms after the Chinese trade shock. I rewrite the decomposition proposed by Osotimehin (2016) with a third production factor: intermediate inputs. Aggregate TFP growth captures variations of within-firm TFP (called technical efficiency) and variations of firm size measuring resource reallocation (called allocative efficiency). This decomposition is crucial as it goes beyond measuring market share reallocation across firms ; and defines allocative efficiency from the point of view of the social planner. The allocation is optimal if marginal products of each input are equalized across firms within a sector for a given outsourcing strategy. Reducing imported input prices reduces the relative advantage of subsidized firms that have already paid the entry fixed cost and lowers dispersion of firm marginal product of inputs within a sector. By allowing more firms to get closer to their optimal size, trade openness improves overall allocative efficiency and aggregate productivity growth.

The third contribution is empirical. I estimate the impact of the Chinese trade

shock on aggregate productivity growth and allocative efficiency in France. I compute the decomposition on French firm-level data in manufacturing sectors between 1995 and 2013. I find that 1% increase in intermediate inputs imported from China is associated with a 0.038% increase in annual aggregate TFP growth in France. The impact is sizable as Chinese intermediate inputs represents less than 2% of French trade flows in the early 2000s and grow on average by 15% per year over the period. By looking at different trade margins, the extensive margin growth is the main driver of better allocative efficiency and TFP growth, which the theoretical mechanisms.

I am the first to introduce trade intermediate inputs to study resource misallocation and the consequences of the Chinese trade shock. In Hsieh and Klenow (2009), distortions on capital and final good markets create resource misallocation and explain the productivity gap observed between US, China and India. They use a closed-economy model of monopolistic competition with heterogeneous firms. Based on the same model, Bellone et al. (2014), Fontagné and Santoni (2015) and Libert (2017) show that misallocation is also important in France in 2000s. Benkovskis (2015) introduces intermediate inputs in this framework and finds that misallocation of intermediate inputs is the major source of TFP loss in Latvia, but he also uses a closed-economy model without imported intermediate inputs. Contrary to these papers from literature in macroeconomics, I propose open-economy model with traded inputs.

My second contribution is to characterize and quantify productivity gains from trade liberalization in presence of price distortions. A burgeoning literature in trade shows that improved access to foreign supplier of intermediate inputs increases firm-level productivity (Amiti and Konings, 2007; Kasahara and Rodrigue, 2008; Goldberg et al., 2010; Lileeva and Trefler, 2010; Halpern et al., 2015). Trade liberalization for intermediate inputs also boosts firm productivity thanks to within-firm reallocation

(Vandenbussche and Viegelaan, 2016) or by decreasing firm marginal cost (Gopinath and Neiman, 2014; Blaum et al., 2015; Bernard et al., 2014). A new potential channel is the reallocation of market shares across firms. Few papers provide evidence of reallocation effect (Bloom et al., 2016; Berthou et al., 2017; Tito and Wang, 2017), but they do not show how decreasing marginal cost of imported inputs reallocate resources across firm in an open-economy model with heterogeneous firms and price distortions.

The rest of this paper is organized as follow. Section 2, I develop a model of producers and derive the decomposition of aggregate TFP growth. Section 3, I describe data, estimation methods and results to quantify the impact of raising Chinese intermediate inputs in aggregate productivity in France. Section 4 concludes.

4.2 Theoretical Framework

In this section, I show in a simplified framework how traded intermediate inputs affect aggregate productivity. I use a standard model of monopolistic competition with heterogeneous firms to illustrate gains from trade coming from variations of allocative efficiency. I present the discussion from the point of view of the home country.

4.2.1 Technology and firm behaviors

I assume an economy with a single final good Y_t produced each year t by a representative firm in a perfectly competitive market. Final firm combines sector output Y_{st} by using a Cobb-Douglas technology :

$$Y_t = \prod_{s=1}^S Y_{st}^{\rho_{st}} \tag{4.1}$$

with $\sum_s \rho_{st} = 1$ and $\rho_{st} = P_{st}Y_{st}/P_tY_t$ is the share of industry s in total gross output. These share are allowed to vary over time. P_{st} is the price of industry production Y_{st} . Final good Y_t is assumed to be the numeraire and $P_t = 1$.

Sector s is composed by firms indexed by $i = \{1, \dots, n\}$ and the output is given by the CES aggregate:

$$Y_{st} = n_{st}^{\frac{\theta-1}{\theta}} \left(\sum_{i \in N_{st}} Y_{it}^\theta \right)^{1/\theta} \quad (4.2)$$

Where n_{st} is the number of firms in each sector s and the elasticity of substitution within sector s equals $1/(1 - \theta)$ with $0 < \theta < 1$ ²⁸.

Firms use Cobb-Douglas technology for producing a differentiated final good:

$$Y_{it} = A_{it}K_{it}^\alpha L_{it}^\beta X_{it}^\gamma \quad (4.3)$$

Firm i combines intermediate composite good X_{it} with labor L_{it} and capital K_{it} in a Cobb-Douglas fashion with efficiency A_{it} . Sector inputs are denoted by $L_{st} = \sum_{i \in N_{st}} L_{it}$, $K_{st} = \sum_{i \in N_{st}} K_{it}$ and $X_{st} = \sum_{i \in N_{st}} X_{it}$. The Cobb-Douglas weights, α , β and γ , measured importance of each input for production. Firms face constant returns to scale such as $\alpha + \beta + \gamma = 1$ ²⁹. Factor elasticities are assumed to be identical within a sector.

Capital is internationally mobile with a sector price R_t and input share α . Labor is an internationally immobile primary factor with a sector prices w_t and input shares β . The third factor of production is a composite intermediate good with firm-level price index $P_{X_{it}}$ and input share γ . Intermediate goods could be either produced

²⁸As in Osotimehin (2016), I assume that each good has the same weight in the aggregation and hence abstract from firm-specific demand shocks.

²⁹Constant returns to scale is needed in empirical parts to estimate factor elasticities in production function. This hypothesis has no impact on the model conclusions.

domestically or imported. A composite intermediate good is a CES composite of a domestic variety, Z_{it} , and a foreign one M_{it} ³⁰.

$$\begin{aligned} X_{it} &= [Z_{it}^\rho + M_{it}^\rho]^{\frac{1}{\rho}} \\ M_{it} &= \left(\sum_k^{\Omega_{it}} m_{ikt}^\rho \right)^{\frac{1}{\rho}} \end{aligned} \tag{4.4}$$

Where Ω_{it} is the set of foreign input varieties imported by firm i , m_{ikt} is the quantity of imported variety k and $(1/1 - \rho)$ is substitution elasticity between foreign and domestic input varieties or the elasticity of substitution within foreign varieties ($\rho > 1$).

Producers are price-takers in intermediate input market. Prices of domestic and foreign inputs are respectively denoted P_{Zt} and P_{Mit} . Note that P_{Zt} is identical for all firms because there is a unique domestic variety. P_{Mit} includes all variable trade costs and is firm-specific depending on the number of varieties that firms decide to import. By solving the cost-minimization problem associated with equation (4.4), the effective price of composite good is:

$$\begin{aligned} P_{Xit} &= (P_{Zt}^{\frac{\rho}{\rho-1}} + P_{Mit}^{\frac{\rho}{\rho-1}})^{\frac{\rho-1}{\rho}} \\ P_{Mit} &= \left(\sum_k^{\Omega_{it}} P_{mt}^{\frac{\rho}{\rho-1}} \right) = P_{mt} |\Omega_{it}|^{\frac{\rho}{\rho-1}} \end{aligned} \tag{4.5}$$

Imported input price index differs across firms depending on the number of imported goods Ω_{it} as in Gopinath and Neiman (2014)³¹. Moreover higher number of

³⁰I suppose no relative efficiency (i.e. quality advantage) of foreign inputs in firm production process contrary to Bas and Berthou (2013) ; Halpern, Koren and Szeidl (AER, 2015) ; Blaum, Lelarge and Peters 2016 where they measure the impact of traded inputs on firm-level productivity.

³¹I suppose all firms are importers. This hypothesis is supported by data in the empirical part.

imported inputs is lower marginal cost, all else equal.

Firm i chooses the set of imported varieties Ω_{it} to maximize profit net of the fixed entry cost:

$$\Omega_{it} = \operatorname{argmax} \pi_{it} - wF(|\Omega_{it}|) \quad (4.6)$$

With:

$$\pi_{it} = P_{it}Y_{it} - R_t(1 + \tau_{Kit})K_{it} - w_t(1 + \tau_{Lit})L_{it} - P_{Xit}(1 + \tau_{Xit})X_{it} \quad (4.7)$$

Firms have to pay a fixed entry cost for importing foreign varieties denominated in units of labour, $wF(|\Omega_{it}|)$. Each foreign country supplies one variety and firms pay a fixed cost for each variety. A variation of the marginal cost of intermediate inputs produced abroad directly enters in equation (4.6). If it declines over time, firms are able to import a broader set of varieties from abroad that reduces their marginal cost of production and increases their sales.

Firms then decide the optimal amount of capital, labour and the quantity of each type of intermediate inputs by maximizing their annual profit in equation (4.7). They face frictions on each input market and these frictions are captured by wedges on capital $(1 + \tau_{Ki})$, labour $(1 + \tau_{Li})$ and intermediate inputs $(1 + \tau_{Xi})$.

The profit maximization yields standard conditions where firm's output price is

After combining customs database and Fiben firms' balance sheet database, more than 50% of incumbent firms in the sample import intermediate inputs each year and they represent about 90% of total value added between 1995 and 2012.

³¹For instance, the fixed entry cost reflects efforts to find a partner abroad and fix contract issues and create a relationship of trust.

a fixed markup over marginal cost ³² :

$$P_{it} = \frac{\sigma}{\sigma - 1} \left(\frac{R_t(1 + \tau_{Kit})}{\alpha} \right)^\alpha \left(\frac{w_t(1 + \tau_{Lit})}{\beta} \right)^\beta \left(\frac{P_{Xit}(1 + \tau_{Xit})}{\gamma} \right)^\gamma \frac{1}{A_{it}} \quad (4.8)$$

The next objective is to define firm-level distortions and I use firm marginal revenue products of inputs as in Hsieh and Klenow (2009). First, marginal revenue products of capital and labor can be written as:

$$\begin{aligned} MRPK_{it} &= \alpha \frac{P_{it}Y_{it}}{P_{st}K_{it}} = R_t(1 + \tau_{Ki}) \\ MRPL_{it} &= \beta \frac{P_{it}Y_{it}}{P_{st}(L_{it} - f_{it})} = w_t(1 + \tau_{Li}) \end{aligned} \quad (4.9)$$

Where P_{st} is the sector price index of final good and f_{it} is amount of labor for paying fixed costs. If there is no friction on capital and labor markets, firms' marginal revenue products are equal to the respective sector-level price, *i.e.* marginal revenue products are equalized across firms and resources are efficiently allocated. If firms face distortions, marginal revenue products are no longer equalized and inputs are not efficiently allocated across firms. Here, a distortion is defined as the wedge in the first-order condition of the first-best allocation of resources. Moreover, fixed costs mechanically raise wedges on labor and misallocation because they are dead-weight loss in the partial equilibrium model.

Secondly, firm marginal revenue product of intermediate composite good is:

$$MRPX_{it} = \gamma \frac{P_i Y_i}{P_t X_{it}} = P_{Xit}(1 + \tau_{Xi}) \quad (4.10)$$

³²Due to CES preferences and monopolistic competition, the constant markup of price over marginal cost ensures that higher firm productivity is passed on fully to consumers in the form of a lower prices. Since demand is elastic, this lower price implies higher revenue for more productive firms (see Melitz and Redding, 2015).

To measure firm-level distortions from equation (4.10), I need to define firm-level price index of intermediate inputs. Even if I do not separately observe quantities and prices at firm level in data, I got the total expenditures on intermediate inputs: $V_{it} = P_{Xit}X_{it}$. As in Blaum et al. (2015), the unobserved price index P_{Xit} is related to the observed expenditure share of the domestic variety sd_{it} under the CES assumption such as:

$$sd_{it} = \left(\frac{P_{Zt}}{P_{Xit}}\right)^{\frac{\rho}{\rho-1}} \quad (4.11)$$

Where P_{Zt} is the domestic price of input.

The measured quantity of intermediate inputs used by firm is then:

$$X_{it}^{obs} = V_{it}sd_{it}^{\frac{\rho-1}{\rho}} \quad (4.12)$$

And the measured marginal revenue product of inputs is:

$$MRPX_{it}^{obs} = \gamma \frac{P_{it}Y_{it}}{P_t X_{it}^{obs}} = P_{Zt}(1 + \tau_{Xit}) \quad (4.13)$$

P_{Zt} is the price of the unique domestic variety. The wedge $(1 + \tau_{Xit})$ captures frictions that change the price of inputs and the composition of the basket of intermediate inputs. For instance, marginal costs of Chinese intermediate inputs decrease after Chinese trade liberalization and an increasing number of firms is able to import cheaper varieties. The quantity of inputs X_{it} increases in these firms, and their $MRPX_{it}$ decreases, all else equal. As only firms in the mid-to-top productivity distribution benefit from trade liberalization due to the fixed cost for importing new varieties, trade shock generates resource reallocation towards the most productive firms. The reallocation of market share across firms can correct the sub-optimal allocation of resources if many firms are initially constraint due to trade barriers.

4.2.2 Sectoral production functions and aggregate TFP

In the previous section, I show that trade shock could allow some firms in the mid-to-top productivity distribution to grow faster. The next step is to determine if resource reallocation improves allocative efficiency at sector level and the contribution to aggregate productivity growth. Here, I define how to measure aggregate firm-level productivity and resource allocative efficiency at sector level.

For aggregating firm-level production functions, I follow the methodology proposed by Osotimehin (2016). My contribution is to introduce a third production factor which is a composite intermediate good. I first aggregate production functions at sector level and then aggregate sectoral production functions at country level (Cobb-Douglas aggregate defined in equation (4.1))³³. In fact, the sectoral production function $Y_{st} = F_{st}(L_{st}, K_{st}, X_{st}, TFP_{st}, \tau_{st})$ in sector s at time t has the same functional form as the individual production functions. Sector output is given by a CES aggregate demand defined in equation (4.2) such as:

$$F_{st}(L_{st}, K_{st}, X_{st}, TFP_{st}, \tau_{st}) = TFP_{st} K_{st}^{\alpha} L_{st}^{\beta} X_{st}^{\gamma}$$

With

$$TFP_{st} = \left(\sum_{i \in N_{st}} A_{it}^{\theta} \left(\frac{K_{it}}{K_{st}} \right)^{\alpha\theta} \left(\frac{L_{it}}{L_{st}} \right)^{\beta\theta} \left(\frac{X_{it}}{X_{st}} \right)^{\gamma\theta} \right)^{1/\theta} \quad (4.14)$$

Where K_{it}/K_{st} , L_{it}/L_{st} and X_{it}/X_{st} are functions of the vector of firm-level productivities $TFP_t = \{A_{it}, i \in C_{st}\}$ and wedges $\tau_t = \{\tau_{it}, i \in C_{st}\}$ with C_{st} the

³³First, I derive the aggregate production function for a given allocation rule, which define how inputs are allocated across firms. I set the allocation rules as a function of firm-level distortions (i.e. the difference from the first order condition of the best allocation of resources). I then aggregate the sectoral production functions and take into account the heterogeneity between sectors.

number of continuing firms.³⁴ From first order conditions, I can rewrite:

$$\begin{aligned}
K_{it} &= A_{it}(1 + \tau_{Kit})^{\frac{1-(1-\alpha)\theta}{1-\theta}}(1 + \tau_{Lit})^{-\frac{\beta\theta}{1-\theta}}(1 + \tau_{Xit})^{-\frac{\gamma\theta}{1-\theta}} \\
L_{it} - f_{it} &= A_{it}(1 + \tau_{Kit})^{-\frac{\alpha\theta}{1-\theta}}(1 + \tau_{Lit})^{\frac{1-(1-\beta)\theta}{1-\theta}}(1 + \tau_{Xit})^{-\frac{\gamma\theta}{1-\theta}} \\
X_{it}^{obs} &= A_{it}(1 + \tau_{Kit})^{-\frac{\alpha\theta}{1-\theta}}(1 + \tau_{Lit})^{-\frac{\beta\theta}{1-\theta}}(1 + \tau_{Xit})^{\frac{1-(1-\gamma)\theta}{1-\theta}}
\end{aligned} \tag{4.15}$$

Sectoral TFP growth among continuing firms can be decomposed into changes in technical efficiency (ΔTE_{st}) and allocative efficiency (ΔAE_{st}) such as:

$$\Delta TFP_{st} = \Delta TE_{st} + \Delta AE_{st} \tag{4.16}$$

Changes in firm-level productivity can be approximated as a combination of weighted average of the firm-level productivity changes³⁵:

$$\Delta TE_{st} \approx \frac{1}{1-\theta} \sum_{i \in C_{st}} \frac{\Delta A_{it}}{A_{it-1}} \left(\frac{P_{it-1}Y_{it-1}}{P_{st-1}Y_{st-1}} - \alpha\theta \frac{K_{it-1}}{K_{st-1}} - \beta\theta \frac{L_{it-1}}{L_{st-1}} - \gamma\theta \frac{X_{it-1}}{X_{st-1}} \right) \tag{4.17}$$

Where C_{st} is the set of continuing firms in sector s at time t . Technical efficiency component includes both the effects of changes in firm-level productivity with firms' input shares constant and the effect of the implied changes in input shares for a given level of allocative efficiency³⁶.

The changes in allocative efficiency is a combination of weighted averages of the

³⁴Allocotive efficiency measures the efficiency of resource allocation across incumbent firms in Osotimehin (2016). As the paper objective is to determine how resource reallocation after a trade shock improves allocative efficiency and aggregate productivity, I do not look at entry and exit firms which would be the extensive margin of aggregate productivity. Moreover, I do not observe firm entries and exits in the data and I can not quantify their exact contribution in the TFP growth, contrary to Osotimehin (2016) that uses an exhaustive firm-level data from INSEE.

³⁵More details in appendix B.1.

³⁶Technical efficiency is also likely to reflect other shocks than technology upgrading such as demand shocks or factor utilization. When goods are heterogeneous the firm's productivity is also a function of firm-specific demand shocks (see Osotimehin, 2016). Furthermore, technical efficiency is also affected by the composition of intermediate inputs used. Firms with access to high productive inputs have higher productivity (see Halpern et al. (2015)).

firm-level changes in input price distortions :

$$\begin{aligned}
\Delta AE_{st} \approx & -\frac{\alpha}{(1-\theta)} \sum_{i \in C_{st}} \frac{\Delta \tau_{Kit}}{\tau_{Kit-1}} \left(\frac{p_{it} Y_{it}}{P_{st} Y_{st}} - (1 - (1-\alpha)\theta) \frac{K_{it}}{K_{st}} - \beta \theta \frac{L_{it}}{L_{st}} - \gamma \theta \frac{X_{it}}{X_{st}} \right) \\
& - \frac{\beta}{(1-\theta)} \sum_{i \in C_{st}} \frac{\Delta \tau_{Lit}}{\tau_{Lit-1}} \left(\frac{p_{it} Y_{it}}{P_{st} Y_{st}} - \alpha \theta \frac{K_{it}}{K_{st}} - (1 - (1-\beta)\theta) \frac{L_{it}}{L_{st}} - \gamma \theta \frac{X_{it}}{X_{st}} \right) \\
& - \frac{\gamma}{(1-\theta)} \sum_{i \in C_{st}} \frac{\Delta \tau_{Xit}}{\tau_{Xit-1}} \left(\frac{p_{it} Y_{it}}{P_{st} Y_{st}} - \alpha \theta \frac{K_{it}}{K_{st}} - \beta \theta \frac{L_{it}}{L_{st}} - (1 - (1-\gamma)\theta) \frac{X_{it}}{X_{st}} \right)
\end{aligned} \tag{4.18}$$

The allocative efficiency measures the effect of changes in input allocation across firms on aggregate productivity. In the general case, allocative efficiency changes equal zero if the level of distortions is unchanged or if changes in input price distortions is identical across all firms (i.e. firms' marginal productivity remains relatively unchanged).

To sum up, the aim of the decomposition is to quantify productivity gains in France from trade liberalization in China. First, there is a drop in marginal cost of Chinese imports right after the trade reforms. Regarding the model, more firms in the mid-to-top productivity distribution are able to pay the fixed cost for importing the Chinese variety. If wedges on input prices are mainly due to trade barriers, I expect that more and more firms in the mid-to-top productivity distribution get closer to their optimal size by reducing the negative impact of price distortions. This would promote higher allocative efficiency and aggregate productivity gains. However, if subsidies on small and median firms to enter foreign markets significantly drive the distribution of firm-level wedges on inputs, I expect an ambiguous impact of trade reforms as these firms may already import too much inputs regarding their level of productivity.

4.3 Empirical framework

To test mechanisms described below, I measure how decreasing marginal costs of Chinese intermediate inputs contributes to aggregate productivity growth and allocative efficiency in France between 1995 and 2012. In this section, I describe data used, the estimation of aggregate productivity growth and its decomposition, the empirical strategy and results.

4.3.1 Data description

To implement the productivity decomposition described in the previous section, I use French firm-level dataset collected by the Banque de France, called Fiben. This database includes all firms with a turnover of at least 750 000 euros between 1995 and 2013. It gathers accounting and financial data from firm balance sheets, which includes measures of firms' value added, investment expenditures, number of employees and raw material costs.

Each firm is assigned by an identification number (siren) which allows us to detect potential entries and exits. However, Fiben is not the appropriate database to study the extensive margin due to the presence of a turnover threshold. I am exclusively focusing on continuing firms and the decomposition of the intensive margin of aggregate productivity. I assume that industries correspond to the 2-digit industry-level of the NACE revision 2 classification. I only keep manufacturing industries. Thus, I exclude agricultural and mining sectors and remove sectors which do not provide market services (*i.e.* education, health, education and non-profit sectors) due to measurement issues on capital and raw materials. I then exclude from the sample firms whose productivity changes are in the bottom and top 2 percentiles as

³⁶As I am not able to identify continuing firms in 2013, I lost this year in the analysis.

in Osotimehin (2016).

Table 4.2 gives some descriptive statistics about the firm-level data. The sample contains about 1 454 active firms per sector and year between 1995 and 2012. There are 22 manufacturing sectors. Firm revenue Rev_{it} is the turnover (gross output and commercial margins) deflated by the corresponding production deflators defined at 2 digit level from EU-klems database. I measure labor cost as wage bill, but the number of employees (L_{it}) is also available in the data. Following the CompNet methodology (Lopez-Garcia et al. (2014)), I compute the capital stock rK_{it} as the book value of tangible fixed assets, deflated by the industry price deflators defined at 2 digit level from EU-klems database. Intermediate input expenditure is raw material costs deflated by the corresponding domestic producer price indices defined at 2 digit level from EU-klems database. On average, firm turnover is around 18 million of euros. The average firm uses 74 employees, 16 million of euros of capital, 12 million of euros of intermediate inputs. I combine Fiben with the customs database at firm level. I use the BEC classification for determining which imported goods are intermediate inputs. On average, 92% of intermediate inputs are domestically bought. I report additional summary statistics for the within-sector variations of firm-level characteristics over time in Appendix Table 4.5.

Finally, I also use World Input Output Database (WIOD) to measure all intermediate inputs by sector that are imported in France between 1995 and 2013. WIOD is available in NACE 2-digit classification defined at 2 digit level and imports are classified according to the type of use. In figure 4.2a, the values of imported inputs from China in customs database combined with Fiben database is lower than the values in WIOD. As I do not have the universe of firms in Fiben database and I identify intermediate inputs by using the concordance table between BEC and NACE rev. 2 classifications, I lost some values that are well-measured in WIOD. In the

two databases, Chinese imported inputs grow around 15% per year. In figure 4.2b, intermediate inputs imported from China represent on average 2.3% of total imports of intermediate goods. In customs and Fiben databases, firms importing from China seem to be over-represented as they represent 2.9% of total imports of intermediate inputs. The most productive firms seem to import more from China than the least productive ones that are not in the Fiben database. This would bias upward our results on the impact on Chinese shock on aggregate productivity growth because of the absence of small firms in the data. As a robustness check, I will use WIOD data for computing the growth rate of Chinese imported inputs in France.

4.3.2 Estimation method of aggregate TFP

In this section, I describe methods used to estimate firm-level distortions, factor elasticities, firm- and sector-level productivities, and the aggregate productivity growth decomposition.

4.3.2.1 Definition of measured wedges and productivities at firm level

Distortions facing by firms are described in equations (4.9) and (4.13). They are wedges between firm marginal productivities and frictionless value measuring by the sector price index. As shown by Osotimehin (2016), the impact of the distortions on aggregate productivity only depends on the relative marginal productivity of firms. This property simplifies the estimation of firm-level distortions that can be computed

from firm-marginal productivities in nominal terms:

$$\begin{aligned}
(1 + \tau_{K_i}) &= \alpha \frac{P_{it}Y_{it}}{rK_{it}P_{st}} \\
(1 + \tau_{w_i}) &= \beta \frac{P_{it}Y_{it}}{L_{it}P_{st}} \\
(1 + \tau_{X_{it}}) &= \gamma \frac{P_{it}Y_{it}}{rV_{it}sd_{it}^{\rho} P_{st}}
\end{aligned} \tag{4.19}$$

Where rK_{it} is the deflated value of capital stock, L_{it} is the number of employees and rV_{it} is the deflated value of raw material cost.

Substitute in equation (4.18), allocative efficiency is then:

$$\begin{aligned}
\Delta AE_{st} \approx & -\frac{\alpha}{(1-\theta)} \sum_{i \in C_{st}} \frac{\Delta MVPK_{it}}{MVPK_{it-1}} \left(\frac{p_{it}Y_{it}}{P_{st}Y_{st}} - (1 - (1-\alpha)\theta) \frac{K_{it}}{K_{st}} - \beta\theta \frac{L_{it}}{L_{st}} - \gamma\theta \frac{X_{it}^{obs}}{X_{st}^{obs}} \right) \\
& - \frac{\beta}{(1-\theta)} \sum_{i \in C_{st}} \frac{\Delta MVPL_{it}}{MVPK_{it-1}} \left(\frac{p_{it}Y_{it}}{P_{st}Y_{st}} - \alpha\theta \frac{K_{it}}{K_{st}} - (1 - (1-\beta)\theta) \frac{L_{it}}{L_{st}} - \gamma\theta \frac{X_{it}^{obs}}{X_{st}^{obs}} \right) \\
& - \frac{\gamma}{(1-\theta)} \sum_{i \in C_{st}} \frac{\Delta MVPX_{it}^{obs}}{MVPX_{it-1}^{obs}} \left(\frac{p_{it}Y_{it}}{P_{st}Y_{st}} - \alpha\theta \frac{K_{it}}{K_{st}} - \beta\theta \frac{L_{it}}{L_{st}} - (1 - (1-\gamma)\theta) \frac{X_{it}^{obs}}{X_{st}^{obs}} \right)
\end{aligned} \tag{4.20}$$

Technical efficiency in equation (4.17) is computed as a Laspeyres index and allocative efficiency in equation (4.20) as a Paasche index for simplicity. To tackle this arbitrary choice, I compute allocative efficiency and technical efficiency as Fischer indexes. Fischer index is a geometric mean of Laspeyres and Paasche indexes. The exact decomposition of aggregate productivity growth is given in appendix B.1.

The estimation of production function is challenging in presence of resource misallocation. I can not implement the Olley and Pakes (1996) semi-parametric method, as in Halpern et al (2015). In this framework, firm decision depends on its produc-

³⁶See more details in appendix.

tivity but also on factor distortions. Olley and Pakes' approach can only deal with a unique unobservable state variable and it is not appropriate here because firm-level distortions are also unobserved.

Following Osotimehin (2016), I assume that input price heterogeneity is the only source of average distortions ($\frac{1}{T} \sum_t \frac{1}{1+\tau_t} = 1$ and $\frac{1}{T} \sum_t \frac{1}{e_{it}G_i} = 1$). I then use labor income and raw material cost shares to respectively estimate labor and input elasticities :

$$\begin{aligned}\beta_s &= \frac{1}{T} \sum_t \frac{w_{st}L_{st}}{P_{st}Y_{st}} \\ \gamma_s &= \frac{1}{T} \sum_t \frac{P_{Xst}X_{st}}{P_{st}Y_{st}}\end{aligned}\tag{4.21}$$

Assuming constant return to scale, I get $\alpha_s = 1 - \beta_s - \gamma_s$. Table 4.3 summarizes production function parameters which are sectors-specific. Estimated values from factor share approach are closed to estimates in Halpern et al. (2015).

Sectoral productivity is given by the standard Solow residual:

$$TFP_{st} = \frac{Y_{st}}{K_{st}^{\alpha_s} L_{st}^{\beta_s} X_{st}^{\gamma_s}}\tag{4.22}$$

To estimate TFP at firm-level, I have to deal with unobservable firm-level prices. I use the common assumption about CES demand function³⁷, $P_{it}/P_{st} = (Y_{it}/Y_{st})^{\theta-1}$ and estimated firm productivity is:

$$TFP_{it} = \frac{(P_{it}Y_{it})^{1/\theta}}{K_{it}^{\alpha_s} L_{it}^{\beta_s} X_{it}^{obs\gamma_s}} Y_{st}^{\frac{(\theta-1)}{\theta}}\tag{4.23}$$

Where P_{st} is measured by sectoral deflator of production and Y_{st} is sector nominal

³⁷ A standard limitation of this firm productivity measure is that it does not capture only technical productivity, but also firm-specific demand shocks or shifting in factor utilization for instance.

revenue. I set a within-sector elasticity of substitution of 3 ($\theta = 0.66$), in line with Broda and Weinstein (2006).

In figure 4.3, French manufacturing industries experiment a revenue-based TFP growth by around 0.1% per year between 1996 and 2012. Even if technical efficiency remains the main component of aggregate productivity growth, allocative efficiency is also an important driver. It improves considerably between 2001 and 2002, and becomes positive in 2005. One caveat is that TFP growth computed over continuing firms in Fiben (ΔTFP_{st}) seems to be under-estimated before 2003 compared to the RVA-based annual TFP growth of the entire economy coming from OECD. One possible explanation is that the extensive margin significantly contributes to TFP growth during that sub-period. TFP gains from Chinese trade expansion in the early 2000s could be underestimated as the (possible) positive contribution of entry and exit of firms after increasing import competition (Berthou et al. (2017)) is missing in this study. I report the decomposition of average annual TFP growth by sector in Appendix Table 4.4.

4.3.3 Heterogeneous impact of Chinese trade shock along firm size distribution: evidence from firm-level wedges

The objective of the section is to understand the role played by the Chinese intermediate goods on aggregate TFP dynamics. China's entry at WTO is like a foreign productivity shock that has decreased the marginal cost of intermediate inputs. As the impact of trade shock is heterogeneous across firms, I provide quantitative evidence on the impact of Chinese imports on firm-level wedges and their dispersion at sector level.

Regarding the theoretical part, we expect that wedges on intermediate inputs go

down for firms in the mid-to-top size distribution after the Chinese trade shock. The drop in the marginal cost of traded inputs from China directly reduces firm marginal product for firms that start to import from this origin country because they are now able to import cheaper varieties. Figures 4.4 display the distribution of firm-level productivity and wedges by firm size.

First, firm-level productivity is positively correlated with firm size as expected (figure 4.4(a)). The median firm in 2012 with more than 200 employees is on average 2.9 times more productive than the sector-level medians.

Figure 4.4(b) reveals that wedges on intermediate inputs are decreasing in firm size, consistently with the fact that larger and more productive firms are more likely to face less frictions for importing foreign varieties. However, firm-level wedges relative to the sector median are decreasing for each size class between 1995 and 2012, excepted for the classes with firms having less than 30 employees or more than 200 employees. This confirms that firms in the middle of productivity distribution are more likely to benefit from trade liberalization and they correspond to firms employing between 50 and 200 people. Nevertheless, their wedges move away from the optimal allocation (defined at 1) over time. This could reflect an increasing dispersion of wedges within each size class, for instance due to subsidies helping some firms to find partners abroad. The impact on overall misallocation is then ambiguous. Furthermore, firms with more than 200 employees are expected to import the optimal number of varieties in absence of market friction as they are enough productive to pay fixed entry costs. In that specific case, their wedges relative to the sector median would be equal 1. In data, their wedges are around 0.9 on average and constant over time, meaning that their marginal product of inputs is sub-optimally too high compared to the sector median. This could capture permanent differences in quality of inputs used by heterogeneous firms. As allocative efficiency captures variations of

wedges, this systematic difference in input quality across firm size should be cancelled in the productivity growth decomposition.

In figure 4.4(c), capital distortions are negatively related to firm size. More productive firms are more likely to face lower financial frictions. For instance, creditors may base loan decision on a noisy signal of firm productivity in presence of asymmetric information that favors the largest ones. Between 1995 and 2001, wedges for firms with at least 100 employees slightly decline, but the trend is reverse in 2007 and 2012 for firms with more than 200 employees. As allocative efficiency improves if wedges relative to the sector median converge to 1, the hypothesis of a cleansing effect after the Great crisis has to be taken into account.

At the opposite, labor wedges are increasing in firm size in figure 4.4(d). For instance, labor distortions capture adjustment costs and tighter regulations for firms with more than 50 employees. Moreover, marginal revenue product of labor is increasing in fixed costs for importing foreign variety in the theory. Wedges for firms with more than 200 employees significantly rise in 2001 relatively to 1995, but the trend is reversed in 2007 with a greater convergence to 1 in 2012. The inverted-U shape of the distribution of relative wedges in 2007 and 2012 indicate a downturn in labor misallocation. As the largest firms do not seem to change the composition of input bundle (no variation in relative wedges for these inputs), the trend initiated from 2003 seem to coincide with the implementation of the Fillon reforms and the exemption from social contribution in July 2003. The objective was to lowering the labor cost on low wages ³⁸ and these exemptions have an undeniably positive effect on employment (?). This kind of reforms in labor market may have magnify the gains from trade in 2000s.

More details about the dynamic of the dispersion of firm-level wedges and the

³⁸More details in Security Social circular No. DSS/5B 2003/282.

evolution of standard deviation by sector and year in Appendix B.1.1.

4.3.4 TFP growth and Chinese trade shock: OLS correlation

In the theory, within-sector reallocation of market share is driven by the fall of marginal cost of foreign intermediate inputs. The cost minimization gets incentive to firms to increase the number of foreign varieties used and more firms are able to import new varieties at a lower price.

In this section, I quantify the impact of Chinese trade shock on aggregate productivity growth and allocative efficiency in France. I look at the different trade margins in order to test theoretical mechanisms. As I can only decompose the growth rate of TFP to identify allocative efficiency, that is why the dependant variables used in this section are in delta logs.

4.3.4.1 OLS baseline specification To further explore the link between Chinese trade flows and aggregate productivity growth, the baseline OLS specification takes the following form:

$$\Delta TFP_{kt} = \alpha + \beta_1 \Delta TradeMargin_{kt} + \beta_2 ShareCN_{kt-1} + \Lambda M_{kt-1} + \Gamma Z_{t-1} + \phi_s + \epsilon_{kt} \quad (4.24)$$

Here ΔTFP_{kt} is the change of log aggregate productivity growth or its sub-components, technical efficiency ΔTE_{kt} and allocative efficiency ΔAE_{kt} , in industry k defined at the 2-digit Nace rev.2 level between years t and $t - 1$. I use annual growth rates due to the decomposition constraint. Since the decomposition connects the three depend variables, the estimates of β_1 for ΔTE_{kt} and ΔAE_{kt} sum up to the estimates of β_1 for ΔTFP_{kt} .

As main explanatory variables, I use three trade margins one by one, $TradeMargin_{kt}$,

coming from customs data: the values of Chinese imported intermediate inputs, the number of French firms importing intermediate inputs from China and the average number of products imported by firms from China and used as intermediate inputs.

The main coefficient of interest is β_1 capturing percentage change in sector TFP growth associated with the growth of Chinese trade flows, $\Delta TradeMargin_{kt}$, in sector k between year t and $t - 1$. Firm-level innovation and reallocation of market across firms have been identify as the main margins through which trade can foster sector-level productivity. Regarding the theoretical part, increasing trade flows of intermediate inputs by allowing more firms to have access to a broader set of input varieties rises aggregate productivity through higher allocative efficiency (positive β_1). Given endogeneity issues (described in details in the next section), the estimates of β_1 simply gives indicative correlation.

Depending on the trade margin, I add the initial share of Chinese trade flows, $ShareCN_{kt-1}$, that is either the initial share of Chinese goods in total French imports of intermediate inputs, the initial share of firms importing from China or the initial share of product importing from China, according to the studied trade margin. Sectors with initially large share of Chinese trade flows are well integrated in the global value chains and take less advantage of greater trade liberalization.

I also control for initial sector characteristics M_{kt-1} , comprising initial level of TFP, $\ln TFP_{kt-1}$, and initial number of firms, $\ln N_{kt-1}$, by sector and year, in order to capture catch-up effect.

The specification 4.24 includes industry fixed effects, ϕ_k , to absorb unobserved heterogeneity across sectors in the determinants of productivity such as β_1 are identified from the variation within sector over time. I cluster standard errors, ϵ_{kt} , by year to accommodate correlation in year-specific shock.

Finally, I include several control variables, Z_{t-1} , to alleviate concerns with omitted

variable bias, measurement errors and sample selection. First, they may be country-specific trends over time in supply and demand conditions. The total number of firms, $\ln N_{t-1}$ and employees, $\ln L_{t-1}$ per year capture unobserved year-specific macro shocks. Secondly, I introduce a dummy variable equal 1 for crisis years in 2008 and 2009. In alternative specifications, I further include year fixed effects.

4.3.4.2 OLS baseline results First, I estimate the impact of the different trade margins on aggregate productivity growth between 1995 and 2012 using equation 4.24. In table 4.6, the dependant variable is always the sector aggregate TFP growth. In column 1, the main explanatory variables is the delta logs of Chinese trade flows in values. Higher growth rate of trade flows is significantly associated with higher TFP growth. In columns 2 and 3, the margins of trade are respectively the total number of firms importing intermediate inputs from China and the average number of products imported by firms from China and used as inputs. Increasing the number of firms having access of Chinese markets is significantly associated with higher TFP as shown in the theoretical part. Moreover, the average number of products imported by firms has non significant impact of TFP growth supporting the idea that extensive margin is the key channel for TFP gains from trade liberalization.

In table 4.7, I look closely to the impact of Chinese trade flows on aggregate productivity and its sub-components. In columns 1-3, Chinese imported inputs are in values. All TFP gains from growth of imported inputs from China are coming from higher allocative efficiency. However, these gains are sharply diminished by technical efficiency lost. In columns 4-6, the trade margin is the number of firms importing from China. A growing number of firms having access to Chinese intermediate inputs is significantly associated with higher TFP growth and higher allocative efficiency.

4.3.5 Impact of outsourcing in China on French TFP growth: IV causality

4.3.5.1 Endogeneity of industry trade flows and productivity The above OLS estimations characterize the correlation between the growth of Chinese imported inputs and aggregate productivity. This correlation may not identify the causal effect of trade on productivity because of endogeneity issues link to simultaneity and reverse causality biases (Berthou et al. (2017)).

First, trade and sector performance can be jointly determined by some omitted variables. Such omitted variables would have to vary systematically over time within sectors given industry fixed effects in the baseline OLS specification. For instance, they could be variations of macroeconomic conditions, speed variation of physical and human capital accumulations, etc. However, crisis dummy variable and the indicators of the size of the French manufacturing industry would capture most of macroeconomic variations in the short run.

Secondly, reverse causality brings up a more important concern as aggregate productivity can endogenously determine the amount of imported intermediate inputs and the number of importing firms. Observed import flows capture both endogenous demand conditions in the domestic country and exogenous supply conditions in the foreign country. Regarding the standard trade theory, if a sector becomes more productive, it increases its demand for intermediate inputs to respond to the rising final demand and more firms are willing to import foreign varieties. Thus β_1 would be biased upwards because demand factor reinforces trade impact.

However, a large share of intermediate inputs are traded within sector in French input-output tables. A high productive sector is more competitive from the perspective of foreign country and leads to less entry of foreign input suppliers. In that

case, increasing sector productivity diminishes trade impact by discouraging foreign competitors and β_1 would be biased downward.

4.3.5.2 Baseline IV specification To tackle these endogeneity issues and determine the causal effect of Chinese trade shock on French productivity, I develop a two-step least squares (2SLS) estimation strategy. The ideal instrument for the growth and initial share of Chinese traded inputs would have a high predictive power in explaining the variation in trade flows and would affect the French sector productivity only through the trade channel. I would like to separate exogenous growth of Chinese input supply of product k from endogenous French import demand for product k .

First, I construct one instrument for delta logs of Chinese trade flows in values. I construct a Bartik-type instrument to capture the exogenous productivity shock in China. It combines information on country's initial trade structure with the global growth of Chinese trade flows. First, I use the fraction of Chinese imports in industry k in 1995 and 1996 to capture the initial structure of French trade, $\frac{M_{CN,kt=0}^{FR}}{M_{kt=0}^{FR}}$. I suppose that structure of trade in 1995 and 1996 is not influenced by the China's productivity shock in 2000s. Secondly, I measure Chinese supply capacity in delta logs. I use the total Chinese export value-added of intermediate inputs from WIOD database, $XVA_{CN,k,t}$. The instrument is in the spirit of Bloom et al. (2016) and Berthou et al. (2017):

$$\Delta CN supply_{kt} = \frac{M_{CN,kt=0}^{FR}}{M_{kt=0}^{FR}} \Delta XVA_{CN,k,t} \quad (4.25)$$

Secondly, I construct two instruments for the delta logs of the number of firms importing intermediate inputs from China. First, I use the delta logs of number of enterprises in China by sector and year, using INDSTAT data from UNIDO. More

suppliers in China increase the number of firms importing their goods in France as this would reflect rising supply in China and the ease to find a pattern abroad. In addition, I exploit the variation of tariffs across products, sectors and year. I take a simple average of applied tariffs defined at product level using tariff data from WITS between 1996 and 2012. In the panel, these tariffs mainly vary across sectors rather than over time.

Finally, I construct two instruments for the initial share of Chinese goods or number of firms importing from China. The first instrument is the relative unit cost of Chinese intermediate inputs compared to the ones from the rest of the world. A lower unit cost of Chinese goods relative to products coming from other countries means that Chinese goods are more competitive and increase the share of imported inputs from China. I take the weighted average of product-level relative unit cost such as:

$$UC_{kt}^{CN} = \sum_i \frac{M_{ikt}}{M_{kt}} \frac{UC_{ikt}^{CN}}{UC_{ikt}^{other}} \text{ with } UC_{ikt} = \frac{M_{ikt}}{Q_{ikt}} \quad (4.26)$$

And M_{ikt} and Q_{ikt} are respectively the amount and the quantity of imported inputs of product i , in sector k at time t from customs database.

The second instrument is the Chinese supply capacity compared to the worldwide supply capacity:

$$ShareCNsupply_{kt} = \frac{\frac{M_{CN,kt=0}^{FR}}{M_{kt=0}^{FR}} XVA_{CN,k,t}}{\sum_c \frac{M_{c,kt=0}^{FR}}{M_{kt=0}^{FR}} XVA_{c,k,t}} \quad (4.27)$$

Where c is the origin countries of French imports of intermediate inputs and $XVA_{c,k,t}$ the exported value-added of French trading partners from WIOD database.

4.3.5.3 Baseline IV results The 2SLS first stage is in table 4.8. All instrumental variables have the expected sign. Increasing Chinese supply capacity significantly rises imported inputs from China (column 1). Larger Chinese supply capacity relative to the rest of the world and lower relative unit cost of Chinese intermediate inputs rise the share of Chinese imports in total imported inputs (column 2) and the share of firms importing intermediate goods from that country (column 4). The higher rate of enterprise creation in China and lower tariffs explains the rise of French firms importing inputs from China (column 3).

The second stage is in table 4.9 and represents the causal effect of Chinese trade shock on intermediate input market on French aggregate productivity growth between 1995 and 2012. First, changes in Chinese imported inputs significantly boost the aggregate productivity growth (column 1), and all the gains are due to higher allocative efficiency (column 3). One percentage rise in Chinese import growth leads to 0.038% higher TFP growth, or one standard deviation rise of imports from China (4%) increases aggregate TFP growth by 0.15%. The impact of Chinese intermediate inputs is relative sizable as Chinese goods only represent 2% of imported inputs used by French firms. As expected in the theoretical part, growing inputs from China significantly raises aggregate TFP growth via an efficient reallocation of market shares across firms.

Secondly, the growing number of firms importing intermediate inputs from China also leads to aggregate productivity gains. If the growth rate of the number of firms importing Chinese inputs rises by one standard deviation (around 15%), annual TFP growth increases by 1.92%. However, the channel of transmission is not clear. In columns 2 and 3, technical efficiency represents 85% of the overall effect, but the coefficient is not significant. The non-significance of the coefficients can be due to the low number of observations because tariffs used as an instrumental variable are

not available for all years. Finally, the initial share of firms importing from China positively and significantly contributes to better technical efficiency, but the overall effect is partially cancelled by the negative impact on allocative efficiency.

4.3.6 Robustness checks

In the previous section, I find that aggregate productivity gains following the Chinese trade shock are due to better allocative efficiency of market shares across firms.

Alternative specifications

The number of continuing firms per year and sector can be correlated with the initial share of goods or firms importing from China. Results remain stable when we drop the initial share of Chinese trade flows or the initial number of continuing firms (columns 1-3 respectively in tables 4.10 and 4.11). If we withdraw one of these two variables in the specification looking at the growth rate of firms importing from China (columns 4-6 in tables 4.10 and 4.11), TFP gains from trade remain significant and with the same magnitude. However, they are totally explained by the improvement of technical efficiency even if the coefficient is not significant.

Secondly, I introduce the initial levels of R&D expenditure in the baseline specification. Data are coming from STAN-OECD. I use the stock of R&D expenditure as proxy for technology and innovation potential for sectors. In table 4.12, the initial stock of R&D has a negative impact of the TFP growth due to the catching up effect. The coefficients on the growth of Chinese trade flows and initial share of Chinese goods are almost unchanged even if the coefficient on allocative efficiency is no longer significant (columns 1-3). If we look at the coefficients on the growth rate of firms importing from China, the overall effect on aggregate TFP growth remains almost

unchanged and significant. Nevertheless, allocative efficiency now represents more than 70% of the overall effect (columns 4-6). The lower number of observations can explain the instability of coefficients which are more sensitive to outliers.

Finally, the sample period includes the 2008-09 financial crisis, European debt crisis and the trade collapse. These events may add a lot of variability in the data and cleaning effects. In table 4.13, I show that results with trade flows in values are consistent when working with data up to 2007, in columns 1-3. In columns 4-6, I include year fixed effects in the baseline specification and the coefficients remains stable relative to the baseline results. These last results are robust when I use trade flows from WIOD database instead of customs data. This alleviates concerns about over-representation of firms importing from China in customs data merged with Fiben data.

Alternative measures of Chinese trade flows

In the baseline specification, I focus the analysis on Chinese trade flows because it has been the only exogenous trade reforms over the period. However, the same results would be expected for intermediate inputs coming from other origin countries. In table 4.14, I look at the impact of imports of inputs from other countries (columns 1-3) and the impact of imports of final goods from China (columns 4-6). Rising imports of intermediate inputs also improves aggregate TFP growth through better allocative efficiency. The magnitude of coefficients is close to the one in the baseline specification and confirms our previous findings. Moreover, growing imports of final goods from China is also significantly associated with higher TFP growth and better allocative efficiency, but statistical significance and magnitude are low.

4.4 Conclusion

This paper examines the impact of firm outsourcing strategy abroad on French aggregate productivity growth. More precisely, I study the effect of falling marginal cost of Chinese intermediate inputs on French aggregate TFP.

Theoretically, I show that a drop in marginal cost of foreign intermediate inputs has a direct impact on domestic aggregate productivity through input-output linkages. Trade liberalization allows more firms in the mid-to-top productivity distribution to outsource and grow faster thanks to the reduction of production costs. A higher supply of foreign goods corrects resource misallocation due to market frictions that used to prevent some firms to outsource and positively contributes to aggregate productivity growth.

I then provide compelling quantitative evidence of the importance of allocative efficiency to aggregate productivity growth. I quantify both the aggregate productivity gains due to the Chinese shock and the contribution of technical and allocative efficiency separately. I show that a 1% increase in the growth of Chinese intermediate inputs leads to 0.038% higher TFP growth. The impact is sizable as China represents 2% of total imported inputs. The gains are fully explained by higher allocative efficiency.

The measure of firm-level distortions is useful to decompose aggregate productivity growth and to measure efficiency gains after the Chinese trade shock, but they rely on the CES demand assumption. One main caveat of this assumption is that it does not allow to rule out alternative explanations such as growing competition and demand shift. In future research, I could relax the CES assumption on the demand side which would allow firm markups to adjust after trade. Moreover, I could introduce intersectoral linkages to see the propagation of trade shocks through

input-output linkages that may amplify the initial impact shown in this study as in Osotimehin and Popov (2018).

Another avenue for future research lies in the identification of firm-level outsourcing strategy. In the theory, I do not identify the interaction between market frictions and the number of imported varieties.

4.5 Tables and Figures

Table 4.1: Barriers cited by French companies as important or very important for planned but not performed outsourcing abroad

| | Total (%) | Share cited as very important (%) |
|--|-----------|-----------------------------------|
| Uncertainty about the quality of goods and services provided abroad | 57 | 13 |
| Need proximity to current customers | 55 | 23 |
| Concern from employees or unions in France | 48 | 15 |
| Legal or administrative barriers | 48 | 15 |
| Insufficient management and know-how | 40 | 7 |
| Tariffs and non-tariff barriers | 39 | 8 |
| Tax Issues | 37 | 11 |
| Difficulties in identifying suitable foreign suppliers | 34 | 6 |
| Language or cultural barriers | 31 | 5 |
| Risk of patent infringement or infringement of intellectual property | 27 | 5 |
| Access to finance and other financial constraints | 25 | 3 |
| Political or economic instability of the country or area | 22 | 4 |

Notes: Survey conducted by INSEE in the period 2009 to 2011 over 866 plants.

Table 4.2: Descriptive Statistics

| | $\#Firms_{st}$ | Rev_{it} | L_{it} | rK_{it} | V_{it} | s_{dit} |
|------|----------------|------------|----------|-----------|----------|-----------|
| Mean | 1 454 | 17 630 | 74 | 16 335 | 11 662 | 0.92 |
| SD | 1 341 | 306 088 | 492 | 299 713 | 265 210 | 0.14 |

Notes: $\#Firms_{st}$ is the number of firms per sector and year in the manufacturing industries. Rev_{it} is the annual firm revenue in thousand of euros. L_{it} is the number of employees. rK_{it} is the stock of capital in thousand of euros. V_{it} is the expenditure on raw material in thousand of euros. s_{dit} is the share of domestic inputs in total expenditure.

Table 4.3: Cobb-Douglas coefficients in the revenue-based production function

| Formula | Estimated values (sd)* | Halpern et al.** |
|--|------------------------|------------------|
| $\beta_s = \frac{1}{T} \sum_t \frac{w_{st} L_{st}}{P_{st} Y_{st}}$ | 0.230 (0.06) | 0.198 |
| $\gamma_s = \frac{1}{T} \sum_t \frac{M_{Xst}}{P_{st} Y_{st}}$ | 0.690 (0.07) | 0.752 |
| $\alpha_s = 1 - \beta_s - \gamma_s$ | 0.081 (0.03) | 0.041 |

* Simple average of sector-level values

** Refers to Halpern et al. (2015): they estimate coefficients for the entire manufacturing sector following Olley and Pakes' approach.

Table 4.4: Average allocative efficiency, technical efficiency and annual TFP growth by sector

| Sector | AE_s | TE_s | ΔTFP_s |
|------------------------|----------|----------|----------------|
| Food | -0,1231 | 0,00959 | -0,10714 |
| Beverages | -0,49647 | 0,30888 | -0,04398 |
| Textiles | -0,43742 | 0,52913 | 0,0092 |
| Wearing apparel | -0,75371 | 0,88362 | 0,20874 |
| Leather | -0,17541 | 0,7967 | 0,87956 |
| Wood | -0,4201 | 0,81264 | 0,27798 |
| Paper | 0,07049 | 0,08585 | 0,12371 |
| Reproduction | -0,38972 | 0,5333 | 0,23231 |
| Chemicals | -0,43498 | 0,68958 | 0,25132 |
| Pharmaceutical prod. | -0,52784 | 0,32564 | -0,22008 |
| Plastic | 0,1789 | 0,18869 | 0,40571 |
| Other nonmetal. Prod. | -0,65636 | 0,70738 | 0,12007 |
| Basic metals | -0,06621 | -0,44474 | -0,37799 |
| Fabricated metal prod. | -0,05045 | -0,29189 | -0,30888 |
| Computer | -0,54644 | 2,07746 | 1,52474 |
| Electrical equip. | -0,04437 | 1,22793 | 1,06214 |
| Machinery | -0,12952 | 0,37428 | 0,25208 |
| Motor vehicules | 1,58584 | -2,22674 | -0,6382 |
| Other transp. Equip. | 2,16104 | -2,43364 | -0,41032 |
| Furniture | -0,82299 | 0,38191 | -0,37093 |
| Other manuf. | -0,44037 | 0,2148 | -0,35441 |
| Repair | -1,08439 | 1,4735 | 0,44245 |

Notes: Annual TFP growth (ΔTFP_s) is the average of sector TFP growth over time and AE_s and TE_s are the 2 sub-components from the decomposition in equation (4.16).

Table 4.5: Summary statistics for the within-sector variation of firm-level characteristics over time

| Sector | # Firms _{st} | | Rev _{it} | | L _{it} | | rK _{it} | | V _{it} | | sd _{it} | |
|------------------------|-----------------------|-----|-------------------|---------|-----------------|------|------------------|--------|-----------------|---------|------------------|------|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Food | 4192 | 222 | 17576 | 72750 | 75 | 223 | 6532 | 33352 | 15291 | 65245 | 0,97 | 0,08 |
| Beverages | 920 | 50 | 15963 | 69395 | 44 | 184 | 9531 | 40344 | 12426 | 52045 | 0,98 | 0,06 |
| Textiles | 1102 | 210 | 7524 | 15655 | 55 | 97 | 3331 | 8319 | 5447 | 12549 | 0,83 | 0,19 |
| Wearing apparel | 1139 | 316 | 7191 | 21519 | 56 | 135 | 1351 | 6892 | 5006 | 14763 | 0,89 | 0,13 |
| Leather | 322 | 70 | 8761 | 38385 | 82 | 185 | 2154 | 9295 | 5529 | 21834 | 0,84 | 0,17 |
| Wood | 1711 | 50 | 4933 | 14165 | 33 | 56 | 2257 | 9467 | 3374 | 10858 | 0,92 | 0,15 |
| Paper | 772 | 49 | 19571 | 53680 | 91 | 193 | 14000 | 52174 | 13678 | 39144 | 0,84 | 0,19 |
| Reproduction | 1946 | 221 | 4524 | 10915 | 35 | 72 | 1797 | 6314 | 2714 | 7236 | 0,97 | 0,09 |
| Chemicals | 1127 | 32 | 38079 | 171266 | 124 | 438 | 22024 | 152335 | 29774 | 147634 | 0,85 | 0,18 |
| Pharmaceutical prod. | 256 | 13 | 76705 | 265019 | 281 | 617 | 32445 | 114475 | 50146 | 181905 | 0,87 | 0,16 |
| Plastic | 2022 | 45 | 11260 | 63673 | 75 | 354 | 5564 | 40611 | 7647 | 43603 | 0,88 | 0,17 |
| Other nonmetal. Prod. | 1436 | 24 | 12865 | 49783 | 73 | 297 | 8705 | 45225 | 8345 | 30594 | 0,93 | 0,14 |
| Basic metals | 510 | 27 | 49227 | 225694 | 201 | 705 | 51341 | 495257 | 40951 | 188867 | 0,84 | 0,20 |
| Fabricated metal prod. | 6326 | 222 | 4957 | 18245 | 42 | 120 | 2194 | 9898 | 3487 | 14323 | 0,94 | 0,13 |
| Computer | 1117 | 169 | 33955 | 208785 | 131 | 605 | 7877 | 70231 | 17915 | 123156 | 0,91 | 0,15 |
| Electrical equip. | 824 | 24 | 35879 | 195393 | 148 | 576 | 8723 | 38907 | 19388 | 124560 | 0,89 | 0,17 |
| Machinery | 2454 | 151 | 13456 | 51946 | 74 | 213 | 3681 | 16662 | 8845 | 36536 | 0,92 | 0,14 |
| Motor vehicles | 699 | 25 | 101235 | 1798755 | 288 | 2704 | 37480 | 575049 | 90092 | 1724065 | 0,88 | 0,18 |
| Other transp. Equip. | 193 | 51 | 113988 | 615707 | 414 | 1351 | 30791 | 151731 | 87170 | 571832 | 0,89 | 0,17 |
| Furniture | 929 | 68 | 7132 | 23936 | 57 | 164 | 2168 | 9957 | 4494 | 15464 | 0,94 | 0,12 |
| Other manuf. | 962 | 40 | 8142 | 27957 | 59 | 162 | 2713 | 12635 | 4750 | 18088 | 0,92 | 0,14 |
| Repair | 2637 | 354 | 6242 | 56090 | 46 | 286 | 1387 | 24994 | 3591 | 34665 | 0,98 | 0,08 |

Notes: This table provides summary statistics for the variation in firm-level characteristics within sector over time in the 1995-2012 panel. Sectors are defined at 2 digit level using Nace rev. 2 Classification. #Firms_{st} is the number of firms per sector and year. Rev_{it} is the annual firm revenue in thousand of euros. L_{it} is the number of employees. rK_{it} is the stock of capital in thousand of euros. V_{it} is the expenditure on raw material in thousand of euros. sd_{it} is the share of domestic inputs in total expenditure.

Table 4.6: OLS baseline - Aggregate TFP growth and trade margins

| Trade margin: | (1) Values | (2) # Firms | (3) # Products |
|---------------------------|---------------------|---------------------|---------------------|
| $\Delta TradeMargin_{kt}$ | 0.012* (0.006) | 0.024** (0.009) | -0.007 (0.013) |
| $ShareCN_{kt-1}$ | -0.067 (0.068) | 0.010 (0.011) | -0.101 (0.082) |
| $\ln TFP_{kt-1}$ | -0.157** (0.061) | -0.192** (0.069) | -0.159** (0.059) |
| $\ln N_{kt-1}$ | -0.040** (0.018) | -0.028 (0.017) | -0.043** (0.019) |
| Crisis dummy | -0.010 (0.006) | -0.011* (0.006) | -0.014* (0.007) |
| $\ln N_{t-1}$ | -0.004 (0.081) | -0.036 (0.075) | -0.015 (0.089) |
| $\ln L_{t-1}$ | -0.032 (0.037) | 0.010 (0.025) | -0.048 (0.050) |
| Observations | 374 | 374 | 374 |
| R-squared | 0.274 | 0.255 | 0.240 |

The constant term is not reported. The outcome variable is delta logs of aggregate TFP growth. indicated in the column heading. Standard errors are in parentheses. All columns include industry fixed effects. *** p<0.01, ** p<0.05, *p<0.1

Table 4.7: OLS baseline - Chinese trade flows in values and decomposition of TFP growth

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---------------------------|---------------------|---------------------|--------------------|---------------------|--------------------|--------------------|
| Trade margin: | | Values | | | # Firms | |
| | ΔTFP_{kt} | ΔTE_{kt} | ΔAE_{kt} | ΔTFP_{kt} | ΔTE_{kt} | ΔAE_{kt} |
| $\Delta TradeMargin_{kt}$ | 0.012* (0.006) | -0.033** (0.012) | 0.044** (0.017) | 0.024** (0.009) | -0.006 (0.012) | 0.031** (0.014) |
| $ShareCN_{kt-1}$ | -0.105 (0.079) | 0.191 (0.230) | -0.296 (0.195) | 0.010 (0.011) | -0.013 (0.010) | 0.023 (0.018) |
| $\ln TFP_{kt-1}$ | -0.148** (0.060) | 0.014 (0.094) | -0.162 (0.125) | -0.192** (0.069) | 0.088 (0.146) | -0.280 (0.194) |
| $\ln N_{kt-1}$ | -0.042** (0.018) | 0.074 (0.054) | -0.116 (0.070) | -0.028 (0.017) | 0.055 (0.047) | -0.083 (0.061) |
| Crisis dummy | -0.010 (0.006) | -0.018** (0.008) | 0.008 (0.007) | -0.011* (0.006) | -0.009* (0.004) | -0.002 (0.005) |
| $\ln N_{t-1}$ | -0.000 (0.082) | 0.130 (0.103) | -0.130 (0.084) | -0.036 (0.075) | 0.212 (0.130) | -0.248* (0.134) |
| $\ln L_{t-1}$ | -0.040 (0.038) | 0.016 (0.082) | -0.056 (0.077) | 0.010 (0.025) | -0.063 (0.074) | 0.073 (0.080) |
| Observations | 374 | 374 | 374 | 374 | 374 | 374 |
| R-squared | 0.276 | 0.236 | 0.344 | 0.255 | 0.141 | 0.213 |

All variables are in logs. The constant term is not reported. The outcome variable is delta logs of aggregate TFP, technical efficiency or allocative efficiency as indicated in the column heading. Standard errors are in parentheses. All columns include industry fixed effects. *** p<0.01, ** p<0.05, *p<0.1

Table 4.8: IV baseline - First stage

| Trade margin: | (1) | (2) | (3) | (4) |
|-------------------------------|---------------------------|----------------------|---------------------------|----------------------|
| | Values | | # Firms | |
| | $\Delta TradeMargin_{kt}$ | $ShareCN_{kt-1}$ | $\Delta TradeMargin_{kt}$ | $ShareCN_{kt-1}$ |
| $\Delta \ln CN supply_{kt}$ | 0.419*** (0.130) | -0.003 (0.004) | | |
| $\Delta \ln \# CN Firms_{kt}$ | | | 0.031* (0.018) | 0.008 (0.017) |
| $\Delta \ln tariffs_{kt}$ | | | -0.062 (0.068) | 0.015 (0.062) |
| Share CN supply $_{kt-1}$ | 0.052 (1.466) | 0.210** (0.091) | -0.509 (0.621) | 2.020*** (0.599) |
| $\ln UC_{kt-1}^{CN}$ | -0.001 (0.009) | -0.001* (0.000) | -0.004 (0.003) | -0.011*** (0.002) |
| Crisis | -0.182** (0.067) | 0.004* (0.002) | -0.147*** (0.041) | 0.070*** (0.015) |
| $\ln N_{t-1}$ | -0.546 (1.074) | 0.071 (0.053) | -0.151 (0.534) | 0.922 (0.610) |
| $\ln L_{t-1}$ | 0.173 (0.864) | -0.174*** (0.029) | -0.212 (0.252) | -1.584*** (0.287) |
| $\ln TFP_{kt-1}$ | -0.026 (0.775) | 0.198*** (0.028) | -0.006 (0.264) | 2.276*** (0.256) |
| $\ln N_{kt-1}$ | -0.104 (0.206) | -0.059*** (0.010) | 0.129* (0.071) | -1.139*** (0.150) |
| Observations | 361 | 361 | 271 | 271 |
| R-squared | 0.135 | 0.854 | 0.185 | 0.883 |

The constant term is not reported. The outcome variable is delta logs of Chinese imported inputs, the share of Chinese goods in total imports, delta logs of the number of firms importing inputs from China or the share of firms importing inputs from China as indicated in the column heading. All columns include industry fixed effects. In columns 4-6, the number of observations is lower because tariffs data start in 1996. Standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 4.9: IV baseline - Second stage

| Trade margin: | (1) | (2) | (3) | (4) | (5) | (6) |
|--------------------------------------|---------------------|----------------------------|-------------------|-------------------|-----------------------------|--------------------|
| | ΔTFP_{kt} | Values ΔTE_{kt} | ΔAE_{kt} | ΔTFP_{kt} | # Firms ΔTE_{kt} | ΔAE_{kt} |
| $\Delta \ln \text{TradeMargin}_{kt}$ | 0.038** (0.016) | 0.005 (0.025) | 0.033* (0.018) | 0.128* (0.060) | 0.109 (0.114) | 0.019 (0.111) |
| $\text{Share}CN_{kt-1}$ | 0.400 (0.417) | 0.983 (0.757) | -0.583 (0.565) | 0.088 (0.073) | 0.216** (0.096) | -0.128* (0.071) |
| Crisis | -0.005 (0.005) | -0.011 (0.007) | 0.006 (0.007) | -0.007 (0.011) | -0.009 (0.016) | 0.002 (0.016) |
| $\ln N_{t-1}$ | -0.040 (0.068) | 0.066 (0.089) | -0.106 (0.102) | -0.065 (0.125) | 0.009 (0.172) | -0.074 (0.119) |
| $\ln L_{t-1}$ | 0.054 (0.083) | 0.142 (0.112) | -0.087 (0.100) | 0.116 (0.148) | 0.351* (0.183) | -0.235 (0.153) |
| $\ln TFP_{kt-1}$ | -0.257** (0.107) | -0.156 (0.193) | -0.101 (0.136) | -0.310 (0.190) | -0.614* (0.337) | 0.304 (0.216) |
| $\ln N_{kt-1}$ | -0.008 (0.034) | 0.134* (0.075) | -0.142 (0.089) | 0.074 (0.094) | 0.188 (0.119) | -0.113 (0.081) |
| Observations | 361 | 361 | 361 | 271 | 271 | 271 |
| Hansen statistic | 1.251 | 1.251 | 1.251 | 1.251 | 1.251 | 1.251 |
| p-value of Hansen | 0.263 | 0.263 | 0.263 | 0.263 | 0.263 | 0.263 |

All variables are in logs. The constant term is not reported. The outcome variable is delta logs of aggregate TFP, technical efficiency, allocative efficiency or extensive margins as indicated in the column heading. All columns include industry and year fixed effects. Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 4.10: IV baseline without the initial share of Chinese trade flows - Second stages

| | (1) | (2) | (3) | (4) | (5) | (6) |
|--------------------------------------|---------------------|--------------------|--------------------|-------------------|-------------------|-------------------|
| Trade margin: | | Values | | | # Firms | |
| | ΔTFP_{kt} | ΔTE_{kt} | ΔAE_{kt} | ΔTFP_{kt} | ΔTE_{kt} | ΔAE_{kt} |
| $\Delta \ln \text{TradeMargin}_{kt}$ | 0.034** (0.015) | -0.005 (0.020) | 0.039** (0.017) | 0.141* (0.067) | 0.145 (0.162) | -0.003 (0.138) |
| Crisis | -0.005 (0.005) | -0.009* (0.005) | 0.004 (0.006) | 0.001 (0.008) | 0.012 (0.021) | -0.011 (0.020) |
| $\ln N_{t-1}$ | -0.002 (0.069) | 0.159 (0.108) | -0.161* (0.092) | 0.039 (0.074) | 0.266 (0.204) | -0.227 (0.154) |
| $\ln L_{t-1}$ | -0.025 (0.025) | -0.053 (0.072) | 0.028 (0.073) | -0.042 (0.048) | -0.036 (0.097) | -0.006 (0.091) |
| $\ln TFP_{kt-1}$ | -0.170** (0.061) | 0.057 (0.134) | -0.228 (0.157) | -0.100 (0.058) | -0.098 (0.144) | -0.002 (0.119) |
| $\ln N_{kt-1}$ | -0.033* (0.017) | 0.072 (0.048) | -0.105 (0.064) | -0.027 (0.020) | -0.061 (0.045) | 0.035 (0.036) |
| Observations | 361 | 361 | 361 | 271 | 271 | 271 |
| R-squared | 0.182 | 0.177 | 0.329 | -0.506 | -0.204 | 0.077 |
| Hansen statistic | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 |
| p-value of Hansen | 0.327 | 0.327 | 0.327 | 0.327 | 0.327 | 0.327 |

The constant term is not reported. All columns include industry fixed effects. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4.11: IV baseline without the initial number of firms per year and sector - Second stages

| | (1) | (2) | (3) | (4) | (5) | (6) |
|--------------------------------------|----------------------|-------------------|---------------------|--------------------|-------------------|---------------------|
| Trade margin: | | Values | | | # Firms | |
| | ΔTFP_{kt} | ΔTE_{kt} | ΔAE_{kt} | ΔTFP_{kt} | ΔTE_{kt} | ΔAE_{kt} |
| $\Delta \ln \text{TradeMargin}_{kt}$ | 0.039* (0.020) | -0.008 (0.023) | 0.048* (0.027) | 0.137** (0.081) | 0.137 (0.155) | 0.000 (0.105) |
| $\text{Share}CN_{kt-1}$ | 0.487* (0.266) | 0.099 (0.519) | 0.388 (0.451) | 0.079 (0.081) | 0.208 (0.155) | -0.129 (0.105) |
| Crisis | -0.005 (0.006) | -0.012 (0.007) | 0.007 (0.009) | -0.007 (0.012) | -0.008 (0.015) | 0.001 (0.014) |
| $\ln N_{t-1}$ | -0.045 (0.048) | 0.213 (0.123) | -0.259** (0.116) | 0.004 (0.051) | 0.182* (0.086) | -0.178** (0.077) |
| $\ln L_{t-1}$ | 0.064 (0.062) | 0.025 (0.105) | 0.039 (0.116) | 0.131 (0.204) | 0.422 (0.361) | -0.292 (0.256) |
| $\ln TFP_{kt-1}$ | -0.292*** (0.099) | 0.075 (0.287) | -0.367 (0.328) | -0.315 (0.247) | -0.668 (0.530) | 0.353 (0.345) |
| Observations | 339 | 339 | 339 | 271 | 271 | 271 |
| R-squared | 0.090 | 0.121 | 0.247 | -0.620 | -0.514 | -0.091 |
| Hansen statistic | 1.024 | 1.024 | 1.024 | 1.024 | 1.024 | 1.024 |
| p-value of Hansen | 0.312 | 0.312 | 0.312 | 0.312 | 0.312 | 0.312 |

The constant term is not reported. All columns include industry fixed effects. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4.12: IV baseline with initial RD expenditure - Second stages

| | (1) | (2) | (3) | (4) | (5) | (6) |
|--------------------------------------|---------------------|-------------------|-------------------|-------------------|--------------------|-------------------|
| Trade margin: | | Values | | | # Firms | |
| | ΔTFP_{kt} | ΔTE_{kt} | ΔAE_{kt} | ΔTFP_{kt} | ΔTE_{kt} | ΔAE_{kt} |
| $\Delta \ln \text{TradeMargin}_{kt}$ | 0.042** (0.018) | 0.011 (0.031) | 0.031 (0.021) | 0.164* (0.074) | 0.044 (0.090) | 0.120 (0.070) |
| ShareCN_{kt-1} | 0.438 (0.473) | 0.967 (0.806) | -0.530 (0.622) | 0.082 (0.074) | 0.201** (0.090) | -0.119 (0.070) |
| $\ln \text{R\&D exp.}_{kt-1}$ | -0.004 (0.006) | 0.000 (0.008) | -0.004 (0.008) | -0.002 (0.007) | 0.004 (0.011) | -0.006 (0.010) |
| Crisis | -0.005 (0.006) | -0.008 (0.008) | 0.003 (0.009) | -0.001 (0.013) | -0.015 (0.019) | 0.014 (0.020) |
| $\ln N_{t-1}$ | -0.050 (0.083) | 0.087 (0.118) | -0.137 (0.129) | -0.066 (0.115) | -0.010 (0.171) | -0.056 (0.129) |
| $\ln L_{t-1}$ | 0.061 (0.100) | 0.138 (0.127) | -0.077 (0.123) | 0.075 (0.136) | 0.320* (0.160) | -0.245 (0.152) |
| $\ln N_{kt-1}$ | -0.005 (0.038) | 0.134 (0.079) | -0.139 (0.094) | 0.076 (0.096) | 0.185 (0.116) | -0.109 (0.083) |
| $\ln \text{TFP}_{kt-1}$ | -0.260** (0.121) | -0.145 (0.215) | -0.114 (0.145) | -0.316 (0.210) | -0.597* (0.327) | 0.281 (0.223) |
| Observations | 323 | 323 | 323 | 241 | 241 | 241 |
| R-squared | 0.089 | 0.106 | 0.348 | -0.447 | -0.119 | -0.132 |
| Hansen statistic | 0.792 | 0.792 | 0.792 | 0.792 | 0.792 | 0.792 |
| p-value of Hansen | 0.373 | 0.373 | 0.373 | 0.373 | 0.373 | 0.373 |

The constant term is not reported. All columns include industry fixed effects. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4.13: IV baseline with controls for global shocks - Second stages

| VARIABLES | ΔTFP_{kt} | ΔTE_{kt} | ΔAE_{kt} | ΔTFP_{kt} | ΔTE_{kt} | ΔAE_{kt} |
|--------------------------------------|-------------------|--------------------|---------------------|--------------------|-------------------|--------------------|
| $\Delta \ln \text{TradeMargin}_{kt}$ | 0.032 (0.020) | -0.043* (0.022) | 0.076** (0.033) | 0.032* (0.020) | -0.010 (0.030) | 0.042 (0.032) |
| ShareCN_{kt-1} | 0.471 (0.518) | 0.970 (0.668) | -0.499 (0.712) | 0.266 (0.607) | 0.854 (0.892) | -0.588 (0.824) |
| $\ln \text{TFP}_{kt-1}$ | -0.399 (0.236) | -0.072 (0.266) | -0.327 (0.229) | -0.236* (0.124) | -0.134 (0.194) | -0.102 (0.205) |
| $\ln N_{kt-1}$ | -0.018 (0.032) | 0.139* (0.063) | -0.157* (0.074) | -0.018 (0.043) | 0.122* (0.069) | -0.140* (0.078) |
| $\ln N_{t-1}$ | 0.075 (0.065) | -0.022 (0.078) | 0.096 (0.105) | | | |
| $\ln L_{t-1}$ | -0.134 (0.086) | 0.318** (0.115) | -0.452** (0.143) | | | |
| Observations | 213 | 213 | 213 | 361 | 361 | 361 |
| R-squared | 0.325 | 0.413 | 0.510 | 0.221 | 0.235 | 0.375 |
| Hansen statistic | 0.295 | 0.295 | 0.295 | 0.295 | 0.295 | 0.295 |
| p-value of Hansen | 0.587 | 0.587 | 0.587 | 0.587 | 0.587 | 0.587 |
| Years | 1995-2007 | | | 1995-2012 | | |
| Sector FE | Y | Y | Y | Y | Y | Y |
| Year FE | N | N | N | Y | Y | Y |

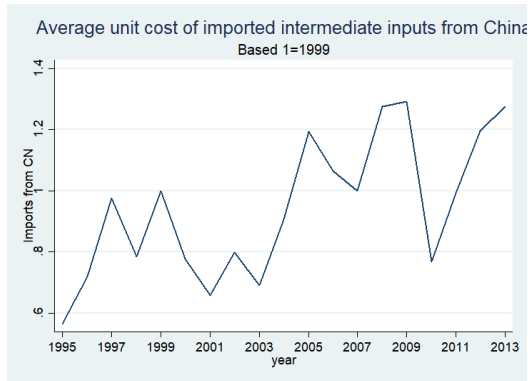
$\Delta \ln \text{TradeMargin}_{kt}$ is the delta logs of Chinese imports of intermediate goods and ShareCN_{kt-1} is the initial share of Chinese goods in total imports. The constant term is not reported. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4.14: OLS - Alternative trade flows

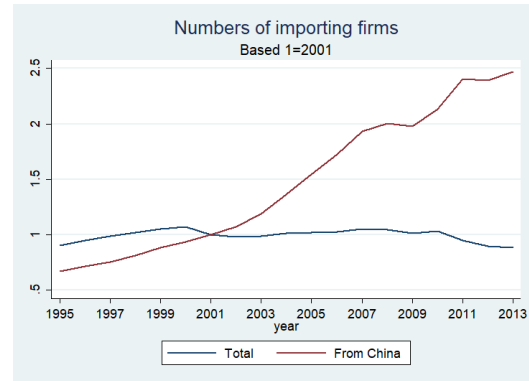
| Trade Flows: | Imports of inputs from the RoW | | | Imports of final goods from CN | | |
|-------------------------------------|--------------------------------|--------------------|---------------------|--------------------------------|--------------------|--------------------|
| VARIABLES | (1) | (2) | (3) | (4) | (5) | (6) |
| | ΔTFP_{kt} | ΔTE_{kt} | ΔAE_{kt} | ΔTFP_{kt} | ΔTE_{kt} | ΔAE_{kt} |
| $\Delta \ln \text{TradeFlows}_{kt}$ | 0.051*** (0.009) | -0.016 (0.010) | 0.068*** (0.009) | 0.009* (0.004) | -0.005 (0.006) | 0.014 (0.009) |
| $\ln TFP_{kt-1}$ | -0.135*** (0.043) | 0.047 (0.128) | -0.182 (0.141) | -0.168*** (0.055) | 0.056 (0.131) | -0.224 (0.163) |
| $\ln N_{kt-1}$ | -0.026 (0.016) | 0.063 (0.049) | -0.089 (0.063) | -0.036* (0.020) | 0.065 (0.051) | -0.101 (0.070) |
| Crisis | -0.005 (0.004) | -0.011* (0.005) | 0.006 (0.006) | -0.011* (0.006) | -0.010* (0.005) | -0.001 (0.007) |
| $\ln N_{t-1}$ | -0.116* (0.065) | 0.218 (0.130) | -0.333** (0.132) | -0.029 (0.084) | 0.192 (0.119) | -0.221* (0.116) |
| $\ln L_{kt-1}$ | 0.016 (0.024) | -0.034 (0.086) | 0.050 (0.096) | -0.017 (0.040) | -0.024 (0.079) | 0.006 (0.084) |
| Observations | 374 | 374 | 374 | 374 | 374 | 374 |
| R-squared | 0.362 | 0.141 | 0.250 | 0.253 | 0.139 | 0.210 |

$\Delta \ln \text{TradeFlows}_{kt}$ is the delta logs of total imports of intermediate goods from the rest of the world (columns 1-3) or delta logs of imports of final goods from China. The constant term is not reported. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Figure 4.1: Evolution of traded intermediate inputs in France



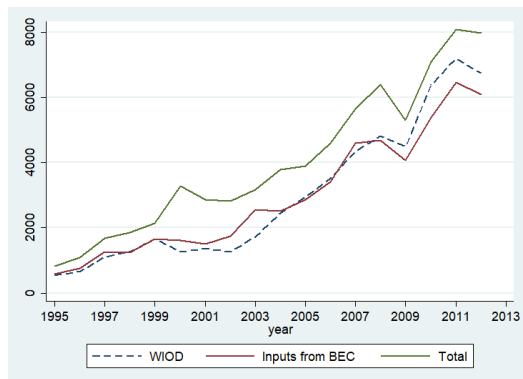
(a) Average unit cost of French imports by origin country (in Euros)



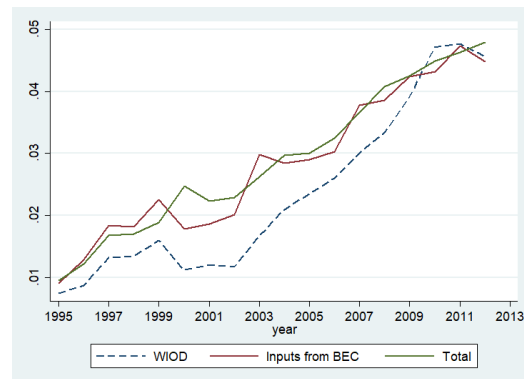
(b) Number of importing firms by origin country (Based 1 = 1999)

Source: French customs data

Figure 4.2: Evolution of imported inputs from China in French customs and WIOD databases

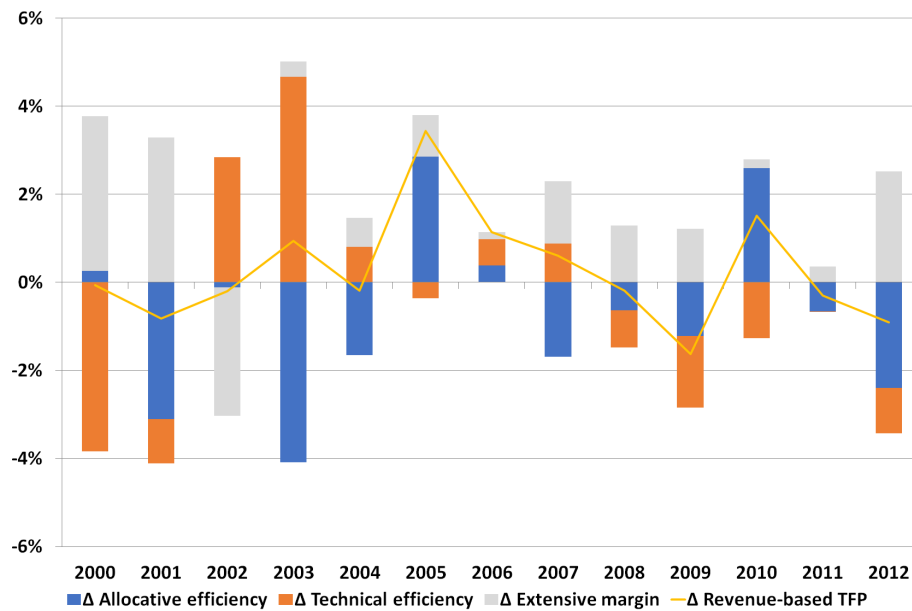


(a) Values of French imports from China (in million of Euros)



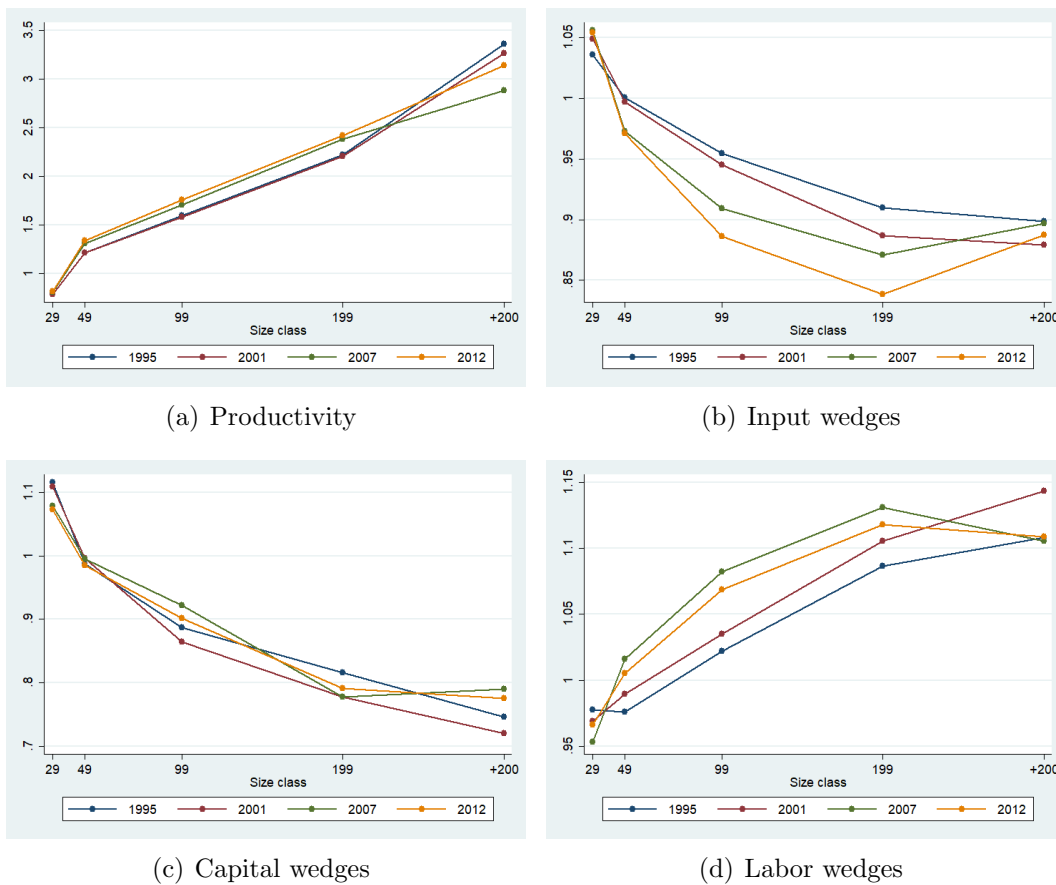
(b) Share of Chinese goods in total imports of intermediate inputs

Figure 4.3: Decomposition of revenue-based aggregate TFP growth



Notes: AE_{st} is the allocative efficiency, TE_{st} is the technical efficiency and ΔTFP_{st} is revenue-based aggregate TFP growth. The sum of allocative efficiency and technical efficiency is exactly equal to aggregate TFP growth. The three variables are weighted average of sector-level measures. They are weighted by the sector share in total gross output. $\Delta TFP_{st} - OECD$ is the RVA-based annual TFP growth of the entire economy coming from OECD.

Figure 4.4: Firm-level productivity and input wedges in 1995, 2001, 2007 and 2012 by firm size



Note: The figure gives the median of the relative firm-level productivity, and intermediate input, capital and labor wedges in 1995, 2001, 2007 and 2012 by firm size. The size classes refer to the number of employees and they are: 20-29, 30-49, 50-99, 100-199 and +200. Each size class is represented by a midpoint. The productivity and wedges are relative to 2-digit industry medians.

5 Resource Misallocation in India: The Role of Cross-State Labor Market Reform and Financial Development

5.1 Introduction

Promoting long-term economic development and improving living standards are the key challenges for developing countries. Studies find productivity—output per unit of input—is the main driver underlying cross-country differences in GDP per capita (see Jones (2016); Restuccia and Rogerson (2017)). Lower productivity can then be a consequence of slow progress in adopting frontier technologies and best practices in the productive process or even the lack of efficiency in allocating productive resources. Productivity gains, therefore, are vital for developing countries to climb up the ladder of economic development.

Institutional features and government policies can have important effects on aggregate productivity and efficiency, as they determine firms' decision making on production, investment, and the allocation of their limited resources. Policies may deter factors of production from being allocated to their best use, so-called misallocation, hindering growth at the macro level. Such policies may range barriers to entry/exit, limits on firm capacity, tax and subsidy policies etc that may cause deviations from optimal allocative choices. Addressing distortionary policies would help removing misallocation and raise aggregate productivity. Focusing on India, evidence suggests that the extent of resource misallocation both labor and capital is quite significant and likely driven by distortionary policies as well as other structural impediments. Hsieh and Klenow (2009) found sizeable misallocation in China and India compared

to that of the United States, and showed that eliminating misallocation to achieve US efficiency could result in manufacturing productivity gains of about 40-60 percent in India.

This paper investigates the impacts of labor market reforms and credit availability on misallocation in Indian states. We use a model of monopolistic competition to show how institutional and market distortions change the allocation of resources across firms. Then, we define a new measure of misallocation. As we suppose that firm-level productivity and distortions are jointly lognormally distributed, the median-mean ratio of Revenue (TFPR) measures the extend of misallocation for each state and sector. Using Indian firm-balance sheet database for the years 2003/04, 2006/07, 2008/09 and 2010/11, we empirically establish four main findings. (i) In line with existing literature, the magnitude of misallocation in India is relatively large compared to the U.S. and has increased over time. (ii) Across Indian states, the magnitude of misallocation is sizable and there is significant heterogeneity. (iii) Econometric evidence suggests that reforms to increase labor market flexibility help reduce misallocation, an effect observed in states where informality is high. (iv) The evidence suggests that credit is not always well allocated, and more credit tends to be associated with greater degree of misallocation, except in sectors that are highly depend on external financing. The latter echoes similar findings (e.g. Duranton et al. (2015)) that find evidence of inefficiency in allocation of financial resources in India.

This paper contributes to the existing literature by addressing a number of common themes in the productivity debate on India including labor laws, informality, and financial access—particularly at the state level. It is well-known that India’s labor laws have remained one of the more restrictive laws in the world and strict labor laws may relate to a large informality in the Indian economy (Dougherty (2008)). While labor reforms appear hard to implement at the federal level in India, , in

particular labor market reforms. Some efforts have been made more recently by individual states to get around this problem (though some recent changes have come about at the federal level as well). It is thus important to gauge the effectiveness of state-level labor reforms on state-level resource misallocation and productivity and growth (Besley and Burgess (2004)).

In addition, this paper explores the extent to which credit constraints may lead to suboptimal allocation of capital across firms and between organized and unorganized sectors. Considerable disparities in access to finance within India resulted in capital misallocation through financial markets (Gupta et al. (2008); Bas and Berthou (2012); Duranton et al. (2015)). Moreover, such policies contribute to price distortions faced by firms in the formal sector and large informality in the Indian economy (Chatterjee (2011)).

The rest of the paper is organized as follows. Section II provides literature reviews of the misallocation and productivity growth with a focus on Indian evidences. Section III describes the methodology used for measuring misallocation. Section VI explains data used for the analysis and presents stylized facts on misallocation across Indian states. Section V and VI lays out the empirical analysis and regression results of the key drivers of misallocation in India respectively. Section VII concludes.

5.2 Literature Reviews

One of the most important developments in growth literature of the last decade is the enhanced appreciation of resource misallocation across firms and sectors to explain low aggregate productivity (Jones (2013)). In the seminal paper by Hsieh and Klenow (2009), firm-level price distortions create resource misallocation that explains the productivity gaps observed between US, China and India. Low produc-

tivity growth can be a consequence of slow progress in adopting frontier technologies and best practices or the lack of efficiency in allocating productive resources. Institutional features and government policies can have important effects on aggregate productivity and efficiency, as they determine firms' decision making on production, investment, and the allocation of their limited resources.

In India, differences in institutional and regulatory framework are found to be key drivers of the disparities of resource misallocation and productivity growth across states. Besley and Burgess (2004); Gupta et al. (2008) and Kapoor (2015) presented a large heterogeneity of firms' output performance across Indian states, which are likely driven by state-specific labor and product market regulations, financial development and investment in infrastructure. Dougherty et al. (2011)u focused on firm-level productivity across Indian states and found that firms in labor-intensive industries located in states with flexible labor markets have higher productivity than those in states with more stringent labor laws. Dougherty et al. (2014) analyzed productivity effects of deregulation related to state-level variation in policy across Indian states and found firms would benefit substantially through gains in total factor productivity growth in states with higher levels of pro-employer reform. In addition, Chatterjee (2011) extended Hsieh and Klenow (2009)'s methodology to analyze the linkages and key drivers of resource misallocation and productivity in Indian manufacturing. She found distortionary policies including firm-size tax distortions, strict labor laws, as well as shortage of capital and limited access to intermediate inputs contributed to misallocation across Indian manufacturing firms.

In addition, access to finance and capital availability directly affect capital allocation across firms. Midrigan and Xu (2014); Gopinath et al. (2017); Gamberoni et al. (2016) and Misch and Saborowski (2018) showed that restrictive bank credit standards and credit availability are among key drivers of misallocation in Korea,

Columbia, Mexico and Europe. Leon-Ledesma and Christopoulos (2016) also found that access-to-finance and credit to private sector increase firm-level distortions and misallocation in 45 countries including India. Using India data, Bas and Berthou (2012) found there were large disparities in access to finance across firms, sectors, and states, whereby constraints in access to finance and credit availability to firms resulted in capital misallocation through financial markets. Duranton et al. (2015) compute an index to measure misallocation in financial markets and presented significant spatial disparities in access to finance due to land misallocation across Indian states that could lead to capital misallocation.

While the informality is a prominent feature of most developing economies, the linkages between resource misallocation, productivity growth, and informality are still debatable. Chatterjee (2011) explored the role of the informal sector on misallocation in Indian manufacturing. She found that the misallocation in the formal sector tends to be larger compared to the informal sector as formal firms may face larger distortions than informal firms, and the formal sector has lesser efficiency gains from reallocation than the informal sector. Nevertheless, she cautioned that the results are sensitive to the methodology used to measure productivity. Furthermore, Ulyssey (2017) applied a general equilibrium model as in Melitz (2003) using firm-level data for Brazil to analyze the implication of informality on output and productivity growth. He showed that lower informality can be, but is not necessarily associated with higher output, total factor productivity growth or welfare. Misch and Saborowski (2018) also presented higher levels of informality are associated with higher resource misallocation, and reducing informality could significantly contribute to the reduction in misallocation for the case of Mexico.

The main contribution of our paper is, therefore, to highlight the disparities of resource misallocation across Indian states and fill the gap in literatures in explaining

India’s resource misallocation based on states’ variation of labor and product market regulations, credit availability, and informality. We propose a new measure of sector-level misallocation defined by state based on Hsieh and Klenow (2009) framework. The objective is to test whether the allocation of resources across firms—*ceteris paribus*—is more efficient in states with more flexible labor market and less constrained credit availability.

5.3 Measuring Misallocation

In a simplified framework, we describe in this section how firm-level distortions on input and output prices affect resource allocation across firms. We follow the theoretical approach developed by Hsieh and Klenow (2009) and we use a standard model of monopolistic competition with firm heterogeneity à la Melitz (2003). Assume each state j is composed by a continuum of sectors and there is a single final good Y_j produced by a representative firm in a perfectly competitive market. Outputs of $s_j=1, \dots, S_j$ manufacturing sectors are combined using a Cobb-Douglas technology:

$$Y_j = \prod_{s=1}^S Y_{js}^{\rho_{js}} \quad (5.1)$$

With $\sum_s \rho_{js} = 1$ and $\rho_{js} = \frac{P_{js}Y_{js}}{P_jY_j}$ the share of industry s in total nominal value-added of state j .

Then, there are M_{js} firms in each of S_j industries of state j . Final output in each sector s , called Y_{js} , is a constant elasticity of substitution (CES) aggregate of output produced by each firm Y_{jsi} :

$$Y_{js} = \left(\sum_{i \in M_{js}} Y_{jsi}^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \quad (5.2)$$

Firms use Cobb-Douglas technology for producing a differentiated final good such as:

$$Y_{jsi} = A_{jsi} K_{jsi}^{\alpha_s} L_{jsi}^{1-\alpha_s}$$

Firm i in sector s combines labor L_{jsi} with capital K_{jsi} in a Cobb-Douglas fashion with efficiency A_{jsi} . Factor elasticity, α_s , measured the relative importance of each input for production and are assumed to be identical within sector and state.

Firms choose the amount of labor and capital to maximize their profits π_{jsi} :

$$\pi_{jsi} = \text{Max}_{K,L} P_{jsi} Y_{jsi} (1 - \tau_{Y,jsi}) - R_{js} (1 + \tau_{K,sji}) K_{jsi} - w_{js} (1 + \tau_{L,jsi}) L_{jsi}$$

Where P_{jsi} is the price of final good, w_{js} is wage rate, R_{js} is rental price of capital. As markets are competitive, there is a single unit cost for capital and labor within each sector and state, respectively R_{js} and w_{js} . However, firms can face market frictions that distort the unit costs of capital $(1 + \tau_{K,sji})$, labor $(1 + \tau_{L,jsi})$ and final goods $(1 - \tau_{Y,jsi})$.

As firms face a CES demand function with an elasticity of substitution between varieties $\theta > 1$ in equation 5.2, the first order condition yields the standard result that firm's output price is a fixed markup over marginal cost:

$$P_{jsi} = \frac{\theta}{1 - \theta} \left(\frac{R_{js}}{\alpha_s} \right)^{\alpha_s} \left(\frac{w_{js}}{1 - \alpha_s} \right)^{1 - \alpha_s} \left(\frac{(1 + \tau_{K,sji})^{\alpha_s} (1 + \tau_{L,jsi})^{1 - \alpha_s}}{A_{jsi} (1 - \tau_{Y,jsi})} \right)$$

In absence of market frictions, constant markup of price over marginal cost ensures that higher firm productivity is passed on fully to consumers in the form of a lower price (Melitz and Redding (2014b)). Capital-to-labor ratio is equalized across firms and firms' relative market share is a function of firms' relative efficiency.

In presence of market frictions, idiosyncratic frictions on input markets prevent firms from equalizing their capital-to-labor ratio:

$$\frac{K_{jsi}}{L_{jsi}} = \frac{\alpha_s}{1 - \alpha_s} \frac{w_{js}(1 + \tau_{L,jsi})}{R_{js}(1 + \tau_{K,jsi})} \quad (5.3)$$

The first order condition with respect of capital and labor of each firm are $MRPK_{jsi} = P_{jsi}MPK_{jsi}$ and $MRPL_{jsi} = P_{jsi}MPL_{jsi}$, such as:

$$\begin{aligned} MPRK_{jsi} &= \alpha_s \frac{\theta}{1 - \theta} \frac{P_{jsi}Y_{jsi}}{K_{jsi}} = R_{js} \frac{(1 + \tau_{K,jsi})}{(1 - \tau_{Y,jsi})} \\ MPRL_{jsi} &= (1 - \alpha_s) \frac{\theta}{1 - \theta} \frac{P_{jsi}Y_{jsi}}{L_{jsi}} = w_{js} \frac{(1 + \tau_{L,jsi})}{(1 - \tau_{Y,jsi})} \end{aligned} \quad (5.4)$$

In order to capture and synthesize all firm-level distortions, we compute revenue productivity³⁹, $TFPR_{jsi} = P_{jsi}A_{jsi}$, such as:

$$TFPR_{jsi} = \frac{\theta}{1 - \theta} \left(\frac{R_{js}}{\alpha} \right)^\alpha \left(\frac{w_{js}}{1 - \alpha_s} \right)^{(1 - \alpha_s)} \left(\frac{(1 + \tau_{K,jsi})^{\alpha_s} (1 + \tau_{L,jsi})^{(1 - \alpha_s)}}{(1 - \tau_{Y,jsi})} \right) \quad (5.5)$$

TFPR is a combination of MPRK and MPRL. The industry mean of TFPR is:

$$TF\bar{P}R_{js} = \left(\frac{R_{js}}{\alpha_s} \sum_{i \in M_{js}} \frac{(1 + \tau_{K,jsi})P_{jsi}Y_{jsi}}{(1 - \tau_{Y,jsi})P_{js}Y_{js}} \right)^{\alpha_s} \left(\frac{w_{js}}{1 - \alpha_s} \sum_{i \in M_{js}} \frac{(1 + \tau_{L,jsi})P_{jsi}Y_{jsi}}{(1 - \tau_{Y,jsi})P_{js}Y_{js}} \right)^{1 - \alpha_s}$$

In addition, the physical productivity which measures the true firm efficiency is:

$$TFPQ_{jsi} = A_{jsi} = \frac{Y_{jsi}}{K_{jsi}^{\alpha_s} L_{jsi}^{1 - \alpha_s}}$$

³⁹Since we assume that firms can face frictions in all input and output markets, we are not able to distinguish between input and output distortions from equations 5.3 and 5.4.

As we do not directly observe firm-level prices, we use the CES demand assumption to approximate them: $P_{jsi} = (\frac{Y_{js}}{Y_{jsi}})^{1/\theta} P_{js}$. The measured physical productivity is then:

$$A_{jsi} = \kappa_{js} \frac{(P_{jsi} Y_{jsi})^{\theta/(\theta-1)}}{K_{jsi}^{\alpha_s} L_{jsi}^{(1-\alpha_s)}}$$

Where the scalar is $\kappa_{js} = \frac{R_{js}^{\alpha_s} w_{js}^{(1-\alpha_s)} (P_{js} Y_{js})^{\frac{-1}{\theta-1}}}{P_{js}}$.. Relative firms' productivities within each sector and state are unaffected by setting $\kappa_{js} = 1$. The industry mean of true firms' efficiency is then:

$$\bar{A}_{js} = \left(\sum_{i \in M_{js}} A_{jsi}^{\theta-1} \right)^{\frac{1}{\theta-1}}$$

To identify the degree of resource misallocation, first, we suppose that $TFPR_{jsi}$ and A_{jsi} are jointly log-normally distributed. If there is no misallocation, the distributions of $TFPR_{jsi}$ and A_{jsi} are symmetric. We look at the deviation of median firm's TFPR from the industry mean to measure the symmetry of $TFPR_{jsi}$ distribution:

$$TF\bar{P}R_{js,p50} = \left(\frac{TFPR_{js,p50}}{TF\bar{P}R_{js}} \right) \tag{5.6}$$

- If $TF\bar{P}R_{js,p50} = 1$ or $\log TF\bar{P}R_{js,p50} = 0$, median distortion is equal to industry mean. Firms' marginal products are equalized. There is no resource misallocation ($TFPR_{jsi} = A_{jsi}$).
- If $\log TF\bar{P}R_{js,p50} > 0$, median distortion is above industry mean. Median firm has a TFPR level above its optimal level from the lognormal distribution and is too small relatively to its true productivity. The distribution of TFPR has a

negative skewness. Many firms face negative price distortions that reduce their size.

- If $\log TFPR_{js,p50} < 0$, median distortion is below industry mean. Median firm is sub-optimally too big relatively to its true productivity. The distribution of TFPR has a positive skewness. Many firms receive subsidies that increase their size.

In addition, we present alternative measures of misallocation for robustness check. These measures include the variance of TFPR where larger variation of TFPR reduces productivity, and TFP gap to measure the distance between “efficient” and “observed” output. Details of these measures are described in Appendix C.1.

5.4 Data and Stylized Facts

In this section, we describe data used for the analysis of firm-level distortions in India and the impacts of labor market reforms and credit availability on misallocation.

5.4.1 Firm-level balance sheet data

We use firm-level data from the Annual Survey of Industries (ASI) which is compiled by the Central Statistical Organization (CSO) in India. It covers factories in manufacturing industries under the Factories Act, 1948: firms with employing more than 10 workers using power and those employing more than 20 workers without using power. This survey is a census of all registered manufacturing unites with 100 or more employees and a random sample of one-fifth of the remaining registered firms. The survey data is based on India’s fiscal years for the years 2003/04, 2006/07, 2008/09 and 2010/11. As firms change in the random sample over time, we do not

have panel data at firm level. The variables of interest include capital stock, labor compensation, gross output, intermediate inputs, and value-added⁴⁰.

Industry classification is crucial to compute the extent of misallocation within each sector and state. Sector classification in the ASI data changes over time (NIC-1998 in 2003/04, NIC-2004 in 2006/07 and NIC-2008 in 2008/09 and 2010/11). As NIC-2008 is equivalent to ISIC rev.4 classification at 4-digit level, we convert NIC-1998 and NIC-2004 into NIC-2008 and we keep only manufacturing industries. Then, sectors are defined at 3-digit level.

As Hsieh and Klenow (2009) and Chatterjee (2011), we set the factor shares in the Cobb-Douglas production function equal to those in the corresponding U.S. manufacturing industry in order to identify distortions in the data⁴¹. Industry capital and labor shares are from the NBER productivity database available by sector defined at 3-digit level between 1958 and 2011. We compute the average factor shares over the period and augment labor shares by a scaling of $3/2$ ⁴².

As outlier correction, we replace negative values of value-added, capital and labor compensation with missing values. We trim the 1% tails of firm productivity ($\log(TFPR_{jsi})$) by year and then the 1% tails of firm relative distortions ($\log(TFPR_{jsi}/\bar{TFPR}_{jsi})$) and firm relative productivity ($\log(A_{jsi}/\bar{A}_{jsi})$) by 3-digit

⁴⁰The variables of interest are defined as follows. *Capital stock* is the net book value of the firms' machinery, equipment and structures at the end of the year. *Labor compensation* is the sum of wages, benefits and bonuses.

Gross output is the sum of the total annual sales, trade income and other incomes such as rent or commission received. *Intermediate inputs* are the sum of total values of domestic and imported material inputs, rent paid for land on lease, mine, royalties, quarries, similar assets, total expenses for work performed by others, repair and maintenance, operating and non-operating expenditure, insurance charges and rent paid for structures, plant and machinery. *Value-added* is the difference between gross output and intermediate inputs.

⁴¹Chatterjee (2011) shows labor share in formal sector in India are below the ones observed in the US data. The US efficiency is used as benchmark of efficient allocation of resources.

⁴²We rescaled the US labor share to get closer to $2/3$ on average. This assumption is common in the literature.

industry and year. Table 5.1 presents the list of Indian states and their main characteristics. We have 20 Indian states, 41 sectors and 4 years. States have on average 64 sector-year observations.

5.4.2 State and sector characteristics in India

Data from various sources are mapped with India's state and sector characteristics, particularly to capture differences in institutional settings and pace of reforms across Indian states. First, we use the index of Employment Legislation Production (EPL) as in Dougherty (2008). We use the ordinal EPL count index, scaled from zero to one. The index captures the percentage of areas in which labor reforms occurred over the 1990s and 2000s. It was computed in 2007 and is time invariant. It is exclusively related to issues that affect the transaction costs of labor market arrangements (e.g. hiring and firing costs). Higher EPL is associated with higher labor market flexibility. As in Table 5.2, Andhra Pradesh and Gujarat are the states with the most flexible labor market (EPL=0.96), and West Bengal and Chhattisgarh are the most rigid ones (EPL=0.5). Appendix C.2 explains labor market regulations and reforms in India in more details.

Secondly, we use data from the State of India database by Center for Monitoring Indian Economy (CMIE) for computing logs of credit per capita, road density (kilometer per thousand square kilometers), rail density (kilometer per thousand square kilometers), registered and unregistered manufacturing net state domestic product (NSDP) by state and year. Credit per capita is our mean measure of state financial development or capital availability. Of which, Delhi has the highest level of credit per capita or about 1.5 times that of Bihar—the lowest one (see table ??). Road and rail density consider a proxy for infrastructure development. Unregistered manufacturing

NSDP is then proxied the size of informal sector.

Thirdly, the index of product market regulation (PMR) is drawn on Conway and Herd (2009). It reflects differences across states in terms of general regulatory practice that has a bearing on competition. The index was computed in 2006, which was based on 16 level indicators that fall into three broad regulatory areas: state control, barriers to entrepreneurship and barriers to international trade and investment. We re-scaled it from zero to three. Higher PMR means that regulatory environment is more supportive of competition. In table 5.2, Goa and Haryana have the most competitive environment. On the other hand, West Bengal and Gujarat have the most important regulatory protection from competition. More broadly, southern and north-eastern states relatively have more competitive product markets. Finally, we use the World Bank Enterprise Surveys collected in 2014. We compute the share of firms using cell phones for their business and the average share of exports in total firm sales by state. These indicators of access to electricity and trade openness are time invariant.

5.4.3 Stylized facts

Resource misallocation in India appear to be large (Figure 5.1) compared to the United States , but appears comparable to other emerging economies (Chatterjee (2011) and Misch and Saborowski (2018)). The standard deviation of TFPR and TFP gap are respectively 1.5 and 3 times higher in India in 2003 than in the U.S. in 1997. Table 5.3 provides TFPR dispersion statistics in India between 2003 and 2010. The mean-median ratio, the standard deviation, the ratio of 75th to 25th percentiles and the ratio of 90th to 10th percentiles of log TFPR slightly increase between 2003 and 2008. Nevertheless, the trend reverses for the median and standard deviation,

and the ratios return below their initial level in 2010.

Misallocation across Indian states is unevenly-distributed and may be related to state-level institutional and regulatory framework . Figure 5.2 presents the weighted average of median-mean ratio of TFPR for each state, as defined in equation 5.6, where weights are sector share in state manufacturing national state domestic product (NSDP) and states are ranked in ascending order according to EPL index. Median TFPR is above 1 in West Bengal, Chhattisgarh and Kerala (states that suggestively also have the lowest levels of EPL). These states have implemented fewer labor market reforms in 1990s and early 2000s and their labor markets were relatively rigid in 2000s (EPL=0.5). This suggests firms in these states do not have their optimal size holds back aggregate productivity growth and economic development. On the other hand, the median-mean ratio is only equal to 1 (meaning little or no misallocation) in Gujarat and Andhra Pradesh—the most advanced states in implementing labor market reforms over the 1990s and 2000s (EPL=0.96). Median TFPR is positively correlated with the degree of labor market reforms in states. However, a number of states have intermediate levels of labor market reforms with a TFPR ratio below 1 that suggests that the median firms are sub-optimally too large, perhaps due to other policies such as preferential subsidies. However, our focus will remain on the role of rigid labor laws and how this may constrain firms to less than optimal size.

States implementing the fewest labor reforms also have higher TFP gaps, as seen in West Bengal and Maharashtra (respectively 115% and 166%) in figure 5.3.

In addition to low EPL, Indian states are often characterized by a large informal sectors. If we compare states with similar size of informal sector (defined as the share of unregistered in total manufacturing NSDP ...), TFP gaps are twice higher in West Bengal and Maharashtra than in Rajasthan or Punjab. The size of informal sector is positively correlated with misallocation (figure 5.4).

5.5 Econometric Analysis

In this section we examine the drivers of misallocation, including labor market reforms and other features

5.5.1 Baseline regression

As labor market reforms are heterogeneous across states, we employ the following baseline OLS specification:

$$\begin{aligned} Misallocation_{sjt} = & \beta_0 + \beta_1 Empl.Protection_s + \beta_2 CreditperCapita_{st} + \beta_3 PMR_s \\ & + \beta_4 Informality_{st} + \Gamma Z_{st} + \phi_{jt} + \epsilon_{ikt} \end{aligned} \tag{5.7}$$

The main dependent variable is the median-mean ratio of TFPR (in logs) in state s , sector j and year t . In order to limit the effect of outliers in next regressions, we exclude observations at the state-sector-year level that have been aggregated across fewer than 20 firms.

The main coefficient of interest, β_1 , identifies the impact of exogenous labor market reforms on misallocation. EPL index captures labor market reforms made in each state in 1990s and early 2000s. Rigid labor laws disincentivize firm expansion, especially effecting the bigger firms in term of employment. We expect that states doing reforms in favor of more flexible labor markets have a leaner right-tail of TFPR distribution and a lower median TFPR, and thus expect β_1 to be negative.

Furthermore, firms can also face price distortions due to imperfect credit markets. The coefficient β_2 captures the impact of credit availability on misallocation. Firms in states with high credit per capita have an easier access to external finance thanks to better credit availability. This reduces firm-level distortions by helping more productive firms to get their optimal size. We expect a negative coefficient β_2 . India

also promoted higher competition in product markets in 1990s and early 2000s. To identify specific impact of labor market reforms from overall market liberalization, we include an index of product market regulation (PMR) computed in 2007 for each state. We expect a negative β_3 .

Informality is very large in India as in many emerging countries. The presence of a large informal sector can lead to misallocation if, for instance, firms in the formal sector decide to outsource labor-intensive activities to the informal sector (the so-called intensive margin). These firms would thus become more capital intensive than in the absence of informality, increasing misallocation (positive β_4). Conversely, the composition effect of small and unproductive firms avoiding the formal sector (or the extensive margin) would decrease measured misallocation in the formal sector (negative β_4). Considering the positive correlation between misallocation and the size of informal sector in Figure 5.4, the intensive margin seems to be dominant.

We also control for state characteristics including the size of manufacturing sector using the total number of firms (in logs), infrastructure development using road density (in logs) and the percentage of firms using cell phone for their business, human capital using expenditure on education (as ratio of aggregate disbursements), and trade exposure using the share of exports in total sales. We expect lower price distortions in states with good infrastructure, high human capital and large trade openness that favor economic exchange and development. The total number of firms also controls for sample selection. Finally, we include year-industry pair fixed effects, ϕ_{jt} , such that β_1 and β_2 are identified from the variation across states within sector at a given point in time.

5.5.2 Links between labor market regulations and informality

The link between labor market regulations and informality is complex. Tight labor regulations may constrain firms from expanding in size and gain economies of scale (Besley and Burgess (2004); Dougherty et al. (2011)), where some firms may set up a number of smaller and/or potentially unregistered firms to avoid labor regulations. In this section, we test the link between labor market regulation and informality as the following.

$$\begin{aligned} Misallocation_{sjt} = & \beta_0 + \beta_1 Empl.Protection_s + \beta_2 CreditperCapita_{st} \\ & + \beta_3 Empl.Protection_s * Informality_{st}(d) \\ & + \beta_4 CreditperCapita_{st} * Ext.dep_j(d) \\ & + \beta_5 Informality_{st}(d) + \Gamma Z_{st} + \phi_{jt} + \epsilon_{ikt} \end{aligned} \tag{5.8}$$

The interaction between EPL index and informality dummy is added to the baseline regression to empirically identify the link between labor market regulation and informality on misallocation. The dummy variable is equal to 1 if the share of unregistered net state domestic product in manufacturing is above the median across all Indian states. Loosening rigid labor laws may incentivize firms to achieve their optimal size, which may be particularly hard to achieve in states with high informality. As there is a larger proportion of small firms in the economy, relative distortions on large firms in the formal sector fall and misallocation declines. β_1 and β_3 are expected to be negative.

In addition, we test whether EPL and credit per capita can have a differentiated effect according to the relative size of informal sector or sector dependence on external finance. We use sector external dependence defined at 3-digit level from Rajan and Zingales (1998) as in Bas and Berthou (2012). We interact credit per capita and a

dummy variable equal to 1 if the sector dependence is above the median across all Indian states. In the previous regressions, we expect credit per capita could worsen misallocation, suggesting capital markets may be inefficient in India. As credit is wasted with less ease in sectors that are highly dependent on external finance, we expect that credit expansion would reduce misallocation in these specific sectors. β_2 is expected to be positive, but β_4 would be negative.

We also include several other control variables to alleviate concerns with omitted variable bias, measurement error and sample selection as in the previous set of regressions.

5.6 Empirical Results

5.6.1 Regression results

Table 5.4 presents the regression results from baseline regression. (i) Implementing labor market reforms (higher EPL) significantly shrinks misallocation as measured by median TFPR (Table 5.4, column 1) and thus shrink negative distortions on firm-level prices. As an example, if West Bengal that has the lowest EPL would have done the same reforms as Gujarat or Uttar Pradesh, relative distortions on the median firms would decrease by almost 16 percent. (ii) Product market reforms to enhance competition is associated with a reduction of misallocation. Higher credit per capita is also associated with lower misallocation, where firms can expand to its optimum as credit constraints ease. (iii) Informality worsens misallocation, suggesting that the intensive margin is in effect. States with good infrastructure like high road density, and high human capital with large expenditure on education have lower misallocation (Table 5.4, column 2). Finally, states with a large share of firms using cell phones and exports also have lower negative price distortions, suggesting good infrastructure

helps reduce misallocation.

Table 5.5 presents the regression results including interactions of labor market regulation and informality. First, we find Indian state making progress on labor market reforms significantly reduces misallocation, as less rigid employment protection legislation is associated with lower median-mean ratio of TFPR and it is only significant in states with high informality. Therefore, this confirms negative price distortions on firms shrink in states with high informality when labor markets become more flexible, and the intensive margin of informality seems to prevail for reducing misallocation after labor market reforms. Secondly, it appears that inefficient credit allocation across firms leads to misallocation, as small firms are financially constrained and do not have their optimal size. Hence, easing credit constraint tends to reduce negative price distortions on firms in all sectors. These results remain robust, even when we add other control variables in columns 2 and 3.

5.6.2 Robustness check and scenario analysis

Alternative measures of misallocation

In Appendix C.1, we present another measure of misallocation from Hsieh and Klenow (2009): TFP gap. It measures the distance between “efficient” and “observed” output from estimating TFP lost due to misallocation. If many firms face negative price distortions, TFP gap increases as TFP lost from misallocation rises.

Table 5.6 presents results when the dependent variable is the TFP gap by sector, state and year. Employment protection legislation is associated with lower TFP gap (column 1), but the impact is significant only in states with a large share of unregistered NSDP (columns 2). This confirms previous result. Credit per capita is positively related to TFP gap, excepted in sectors that are highly dependent on

external financing. As the coefficient is only significant on the interaction term, allocation seems to be optimal across firms only in sectors highly dependent on external finance. These results are robust when we add other control variables in column 3.

Olley and Pakes decomposition

Our previous measures of misallocation are based on strong assumptions including CES demand and a Cobb-Douglas production function with constant return to scale that are difficult to verify (Haltiwanger et al. (2018)). We test the robustness of our results to an alternative measure of misallocation using the productivity decomposition from Olley and Pakes (1996). The aggregate labor productivity is the sum of two components: (1) a simple average of firm-level productivity and (2) the covariance between firm-level employment and labor productivity. The simple average approximates technical efficiency and the covariance term captures the efficiency of resource allocation across firms. High covariance means that high productive firms capture large market share⁴³.

Table 5.7 presents results when the dependent variable is the covariance between labor and labor productivity of firms by sector, state and year. In the first column, employment legislation protection is associated with higher covariance as expected and the coefficient is highly significant. Credit per capita does not significantly change labor misallocation. In column 2, we add the interaction terms as in previous regressions. Higher EPL means higher covariance, but the impact is significant only in states with a large share of unregistered NSDP. This finding confirms previous results and remains robust when we add other control variables in column 3. Making progress in reforms in favor of more flexible market is crucial in states with large

⁴³More details about limits of the covariance as a measure of allocative efficiency in Berthou et al. (2017).

informal sectors. It helps labor markets in the formal economy to be more efficient.

Reforms and time for implementation

Indexes for progress on labor market reforms (EPL) and product market reforms (PMR) are computed in 2006 and 2007 respectively. To be sure that our previous results capture progress in economics reforms, we replicate the exercise on data for years 2008 and 2010 as presented in Table 5.8. Compared to the baseline, the coefficient on employment protection legislation remains unchanged (column 1), as the coefficient on the interaction between EPL and the share of unregistered NSDP (columns 2 and 3). However, the coefficient on credit per capita is no longer significant (column 1) and is negative only on the interaction term with sector external dependence (column 2 and 3), which is coincide with an episode of rapid credit expansion in India post-2008 particularly a significant increase in funding of petroleum and basic metal investment during that period.

The potential economic impacts of labor market reforms

Scenario analysis suggests labor market reforms would help reduce productivity losses. The scenario analysis focuses on the potential gains from the reallocation resulting from labor reforms, particularly in states with high informality. The impact of labor reforms is calibrated by calculating the impact of shifting an Indian state to the same level of the best performer (index=1) from the estimated coefficients from Equation 5.3 in Table 5.6. The results show the TFP gap can be significantly reduced, with West Bengal and Kerala likely being the top gainers (see Figure 5.5). These findings suggest that removing structural rigidities in labor would reduce distortions and contribute to productivity gains and higher long-term growth.

5.7 Conclusion

To conclude, misallocation appears to be large in India and very heterogeneous across states. This large heterogeneity is mainly explained by differences in progress of labor market reforms and capital market efficiency. In a model with firm heterogeneity à la Melitz (2003), distortions on capital, labor and final output markets affect firm-level decision making. These distortions alter firms' marginal cost of production and change their relative size. Firm size is therefore no longer proportional to their productivity, leading to within-sector resource misallocation. These distortions can be, for instance, due to strict labor market regulations that limit firm size or significant credit constraints on small and young firms. We propose three measures of sector-level misallocation: median-mean ratio of TFPR, the variance of TFPR and a TFP gap between observed and measured TFP and quantify the impacts of labor market reforms and credit availability on misallocation across Indian states. We find that states that make more progress on labor market reforms tends to have lower misallocation. This result is especially true in states with a large informal sector. Credit availability also matters. States with high credit per capita have higher sector-level misallocation, suggesting that credits are not efficiently allocated across firms.

An important policy priority is therefore to modernize labor regulations to help improve labor market flexibility, increase formal employment and enhance capital allocation. Labor laws in India remain numerous, outdated, and restrictive, including at the sub-national level. Reforms to the Industrial Disputes Act of 1947 and restrictive clauses under the Factories Act of 1948 are key to enhance labor market flexibility and allow firms to expand and reach economies of scale. Labor laws, which currently number around 250 including both the center and states, need to be

streamlined and reduced. Labor market reforms will also help reap the full benefits of the demographic dividend and economies of scale from the new national goods and services tax. In the same vein, improving capital market efficiency and easing credit constraints to firms would be crucial to improve capital allocation to most productive firms that will eventually help boost aggregate productivity growth, particularly in states with high credit intensity.

5.8 Tables and Figures

Table 5.1: Summary Statistics – ASI database

| State | # Sector -Year Obs. | Avg # Firms per sector and year | Avg Median- Mean TFPR | Avg TFP gap |
|------------------|------------------------|------------------------------------|--------------------------|-------------|
| MAHARASHTRA | 151 | 91 | 0,99 | 1,31 |
| TAMIL NADU | 141 | 113 | 0,97 | 1,09 |
| ANDHRA PRADESH | 126 | 81 | 0,97 | 1,45 |
| GUJARAT | 121 | 91 | 1,00 | 1,08 |
| KARNATAKA | 108 | 64 | 1,01 | 1,14 |
| PUNJAB | 88 | 71 | 1,08 | 1,13 |
| WEST BENGAL | 85 | 54 | 1,22 | 1,25 |
| RAJASTHAN | 77 | 52 | 0,90 | 0,87 |
| HARYANA | 74 | 52 | 0,86 | 0,85 |
| MADHYA PRADESH | 55 | 41 | 0,96 | 1,04 |
| KERALA | 54 | 51 | 1,12 | 1,11 |
| DELHI | 51 | 42 | 0,90 | 0,89 |
| CHHATISGARH | 27 | 43 | 0,99 | 0,83 |
| ORISSA | 24 | 46 | 1,20 | 1,28 |
| UTTARANCHAL | 23 | 38 | 0,89 | 1,44 |
| JHARKHAND | 22 | 42 | 1,19 | 0,90 |
| ASSAM | 20 | 95 | 1,01 | 1,08 |
| HIMACHAL PRADESH | 20 | 33 | 0,91 | 1,48 |
| BIHAR | 15 | 55 | 1,27 | 1,06 |
| GOA | 7 | 46 | 0,73 | 1,20 |
| Average | 64 | 60 | 1,01 | 1,13 |

Table 5.2: Summary Statistics – State characteristics

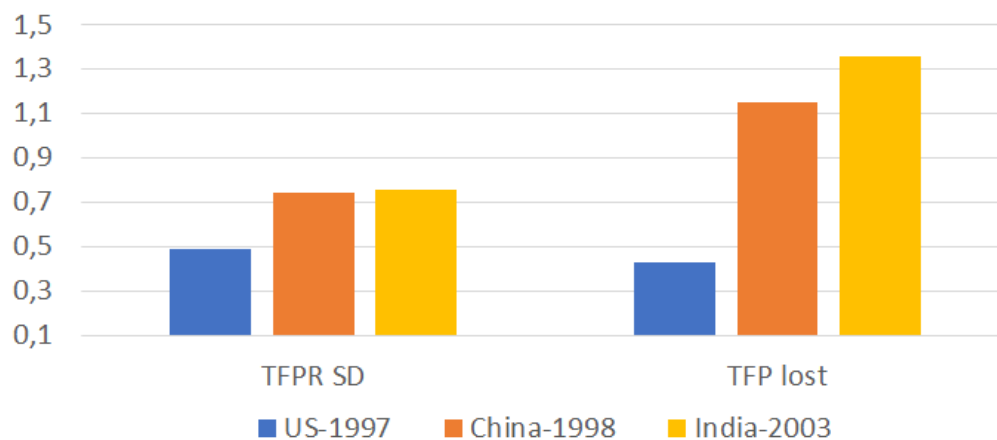
| State | EPL | ln Credit per capital | PMR | ln Rail density | ln Unregistered NSDP |
|------------------|------|--------------------------|------|--------------------|-------------------------|
| ANDHRA PRADESH | 0,96 | 9,55 | 1,27 | 2,94 | 11,21 |
| GUJARAT | 0,96 | 9,71 | 0,68 | 3,28 | 11,75 |
| HARYANA | 0,86 | 9,68 | 1,83 | 3,55 | 10,96 |
| RAJASTHAN | 0,86 | 8,97 | 0,93 | 2,83 | 11,25 |
| PUNJAB | 0,86 | 9,84 | 1,60 | 3,74 | 11,32 |
| MADHYA PRADESH | 0,82 | 8,69 | 1,34 | 2,77 | 10,73 |
| HIMACHAL PRADESH | 0,82 | 9,44 | 1,16 | 1,63 | 8,46 |
| ORISSA | 0,79 | 8,77 | 0,90 | 2,71 | 9,84 |
| KARNATAKA | 0,79 | 10,00 | 1,52 | 2,75 | 11,12 |
| DELHI | 0,75 | 11,69 | 1,70 | 4,87 | 10,79 |
| MAHARASHTRA | 0,75 | 10,69 | 1,71 | 2,89 | 12,59 |
| TAMIL NADU | 0,75 | 10,16 | 1,65 | 3,46 | 12,00 |
| UTTARANCHAL | 0,71 | 9,23 | 1,56 | 1,87 | 9,21 |
| ASSAM | 0,68 | 8,30 | 1,07 | 3,40 | 9,42 |
| JHARKHAND | 0,64 | 8,25 | 1,41 | 3,18 | 10,30 |
| KERALA | 0,64 | 9,64 | 1,10 | 3,30 | 10,82 |
| BIHAR | 0,57 | 7,70 | 1,08 | 3,58 | 10,41 |
| GOA | 0,57 | 10,13 | 2,23 | 2,92 | 8,41 |
| CHHATISGARH | 0,50 | 8,40 | 0,90 | 2,17 | 9,08 |
| WEST BENGAL | 0,50 | 9,28 | 0,29 | 3,77 | 11,56 |
| Average | 0,74 | 9,41 | 1,30 | 3,08 | 10,56 |

Table 5.3: Dispersion of firm-level TFPR (in logs) in India

| | Mean-to median | Standard deviation | Ratio P75/P25 | Ratio P90/P10 | # Firms | Share of firms with non-missing TFPR |
|------|----------------|--------------------|---------------|---------------|---------|--------------------------------------|
| 2003 | -0,10 | 0,79 | 0,94 | 1,91 | 50 600 | 0,68 |
| 2006 | -0,19 | 0,79 | 0,98 | 1,91 | 59 819 | 0,56 |
| 2008 | -0,12 | 0,79 | 1,00 | 1,94 | 50 261 | 0,59 |
| 2010 | -0,07 | 0,74 | 1,06 | 2,11 | 48 120 | 0,72 |

Source: Annual Survey of Industries (ASI). Statistics are for deviation of $\log(\text{TFPR})$ from industry-state mean. P75/P25 is the difference between the 75th and 25th percentiles, and P90/P10 the 90th vs 10th percentiles. Industries are weighted by their value-added shares.

Figure 5.1: Misallocation in US, India and China



Source: ASI databases and authors' calculations for India, China and US statistics from Hsieh and Klenow (2009)

Table 5.4: Misallocation and labor market reforms

| VARIABLES | (1) Median TFPR | (2) Median TFPR | (3) Median TFPR |
|-----------------------------|----------------------|----------------------|----------------------|
| Employ. Protec. Legislation | -0.337*** (0.071) | -0.434*** (0.087) | -0.472*** (0.087) |
| Credit per capita | -0.021 (0.015) | -0.041** (0.017) | -0.044*** (0.017) |
| Product market regulation | -0.074*** (0.024) | -0.050* (0.026) | -0.045* (0.026) |
| Unregistered NSDP | 0.039*** (0.014) | 0.057*** (0.016) | 0.062*** (0.016) |
| # Firms | -0.007 (0.017) | -0.005 (0.016) | -0.008 (0.016) |
| Road density | | -0.019*** (0.007) | -0.021*** (0.008) |
| Expenditure on Education | | -0.390 (0.443) | -0.563 (0.468) |
| % Firms using cell phones | | | -0.216** (0.109) |
| Export share | | | -0.112 (0.191) |
| Observations | 1,225 | 1,225 | 1,225 |
| R-squared | 0.332 | 0.337 | 0.341 |

Credit per capita, the number of firms, rail density, unregistered NSDP are in logs. The constant term is not reported. The outcome variable is the variance of log TFPR in column (1), the median of log TFPR in column (2) and the TFP gap in column (3). Dependent variables are defined by state, sector at 3-digit level and year. All columns include industry-year pair fixed effects. Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 5.5: Median-mean ratio of TFPR, labor market reforms and informality

| VARIABLES | (1) Median TFPR | (2) Median TFPR | (3) Median TFPR |
|--------------------------------------|------------------------------------|------------------------------------|------------------------------------|
| Employ. Protec. Legislation | -0.055 (0.099) | -0.122 (0.114) | -0.097 (0.118) |
| Credit per capita | -0.034** (0.015) | -0.031* (0.018) | -0.030* (0.018) |
| Product market regulation | | -0.019 (0.034) | -0.000 (0.035) |
| Credit per capita * Ext. dep. (Med.) | 0.026 (0.025) | 0.023 (0.025) | 0.016 (0.025) |
| EPL*Share of Unreg. (Med.) | -0.587*** (0.151) | -0.537*** (0.198) | -0.640*** (0.207) |
| Unregistered NSDP (Median) | 0.480*** (0.118) | 0.438*** (0.155) | 0.540*** (0.166) |
| # Firms | 0.012 (0.015) | 0.019 (0.015) | 0.017 (0.015) |
| Road density | | -0.015** (0.007) | -0.013 (0.008) |
| Expenditure on Education | | -0.120 (0.445) | -0.372 (0.468) |
| % Firms using cell phones | | | -0.166 (0.110) |
| Export share | | | -0.356 (0.227) |
| Observations | 1,225 | 1,225 | 1,225 |
| R-squared | 0.330 | 0.334 | 0.339 |

Credit per capita, the number of firms and unregistered NSDP are in logs. The constant term is not reported. The outcome variable is always the TFP gap. Dependent variables are defined by state, sector at 3-digit level and year. All columns include industry-year pair fixed effects. Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 5.6: TFP gap, labor market reforms and informality

| VARIABLES | (1) TFP gains | (2) TFP gains | (3) TFP gains |
|---|---------------------|-----------------------------------|-----------------------------------|
| Employ. Protec. Legislation | -0.126 (0.190) | 0.267 (0.287) | 0.258 (0.278) |
| Credit per capita | 0.007 (0.031) | 0.013 (0.040) | 0.025 (0.041) |
| Product market regulation | -0.032 (0.057) | 0.068 (0.068) | 0.095 (0.074) |
| Credit per capita * Ext. dep. (Med.) | | -0.102* (0.056) | -0.109* (0.057) |
| EPL*Share of Unregist. (Med.) | | -0.972** (0.453) | -1.082** (0.438) |
| Unregistered NSDP (Median) | -0.112** (0.048) | 0.653* (0.355) | 0.805** (0.352) |
| # Firms | 0.211*** (0.037) | 0.203*** (0.037) | 0.193*** (0.037) |
| Road density | | | 0.026 (0.022) |
| Expenditure on Education | | | -1.390 (1.072) |
| % Firms using cell phones | | | -0.096 (0.303) |
| Export share | | | -1.189** (0.478) |
| Observations | 1,225 | 1,225 | 1,225 |
| R-squared | 0.354 | 0.357 | 0.361 |

Credit per capita, the number of firms and unregistered NSDP are in logs. The constant term is not reported. The outcome variable is always the TFP gap. Dependent variables are defined by state, sector at 3-digit level and year. All columns include year-industry pair fixed effects. Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 5.7: Covariance between labor and labor productivity as measure of misallocation

| VARIABLES | (1) Cov(L, VA/L) | (2) Cov(L, VA/L) | (3) Cov(L, VA/L) |
|--------------------------------------|---------------------|----------------------|----------------------|
| Employ. Protec. Legislation | 0.376*** (0.091) | 0.060 (0.127) | -0.016 (0.142) |
| Credit per capita | -0.007 (0.016) | 0.009 (0.019) | 0.019 (0.020) |
| Product market regulation | 0.016 (0.028) | -0.060* (0.034) | -0.100** (0.040) |
| Credit per capita * Ext. dep. (Med.) | | 0.013 (0.028) | 0.023 (0.028) |
| EPL*Share of Unreg. (Med.) | | 0.748*** (0.222) | 0.966*** (0.247) |
| Unregistered NSDP (Median) | 0.017 (0.022) | -0.571*** (0.175) | -0.758*** (0.197) |
| # Firms | 0.052*** (0.016) | 0.057*** (0.016) | 0.052*** (0.016) |
| Road density | | | 0.012 (0.009) |
| Expenditure on Education | | | -0.136 (0.522) |
| % Firms using cell phones | | | 0.046 (0.107) |
| Export share | | | 0.272 (0.245) |
| Observations | 1,225 | 1,225 | 1,225 |
| R-squared | 0.224 | 0.233 | 0.237 |

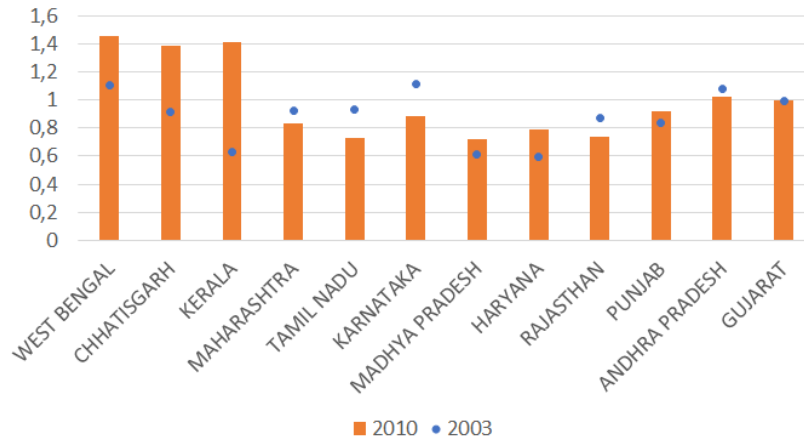
Credit per capita, the number of firms and unregistered NSDP are in logs. The constant term is not reported. The outcome variable is always the covariance between firm-level wage bill and labor productivity (VA/wage bill). Dependent variables are defined by state, sector at 3-digit level and year. All columns include industry-year pair fixed effects. Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 5.8: Restricting sample to years 2008 and 2010

| VARIABLES | (1) Median TFPR | (2) Median TFPR | (3) Median TFPR |
|--------------------------------------|----------------------|---------------------|--------------------|
| Employ. Protec. Legislation | -0.337*** (0.125) | -0.054 (0.167) | -0.160 (0.217) |
| Credit per capita | -0.018 (0.018) | -0.002 (0.023) | 0.005 (0.026) |
| Product market regulation | | | 0.001 (0.053) |
| Credit per capita * Ext. dep. (Med.) | | -0.023 (0.039) | -0.041 (0.040) |
| EPL*Share of Unreg. (Med.) | | -0.594** (0.247) | -0.599* (0.322) |
| Unregistered NSDP (Median) | 0.032 (0.034) | 0.494** (0.193) | 0.514** (0.261) |
| # Firms | 0.029 (0.021) | 0.026 (0.021) | 0.030 (0.021) |
| Road density | | | -0.017 (0.013) |
| Expenditure on Education | | | -0.377 (0.701) |
| % Firms using cell phones | | | -0.185 (0.199) |
| Export share | | | -0.430 (0.350) |
| Observations | 553 | 553 | 553 |
| R-squared | 0.284 | 0.293 | 0.307 |

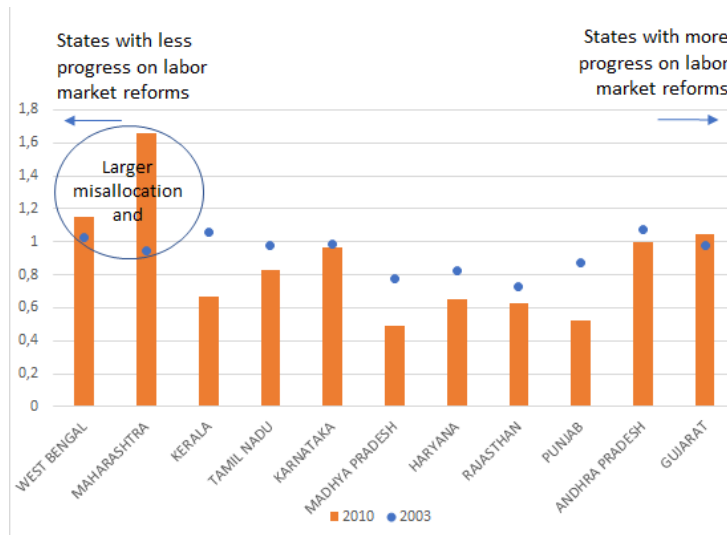
Credit per capita, the number of firms and unregistered NSDP are in logs. The constant term is not reported. The outcome variable is always the TFP gap. Dependent variables are defined by state, sector at 3-digit level and year. All columns include industry-year pair fixed effects. Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Figure 5.2: Median TFPR by state



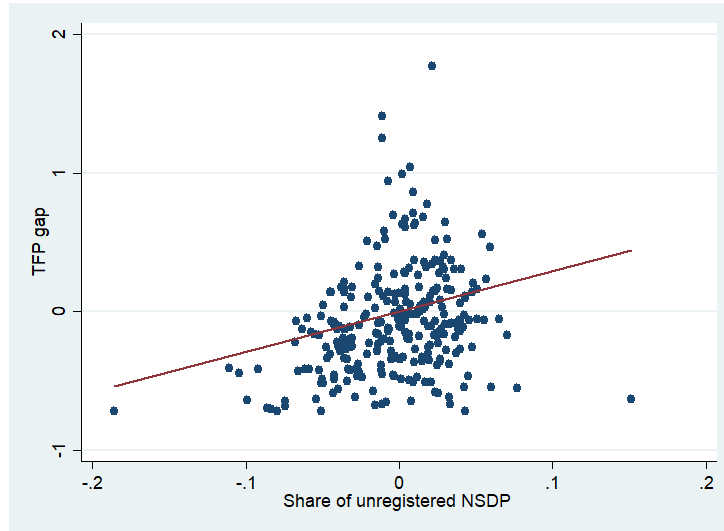
Source: ASI databases and authors' calculations for India, China and US statistics from Hsieh and Klenow (2009) Note: States are ranked in ascending order according to EPL.

Figure 5.3: India: Distribution of TFP lost by State



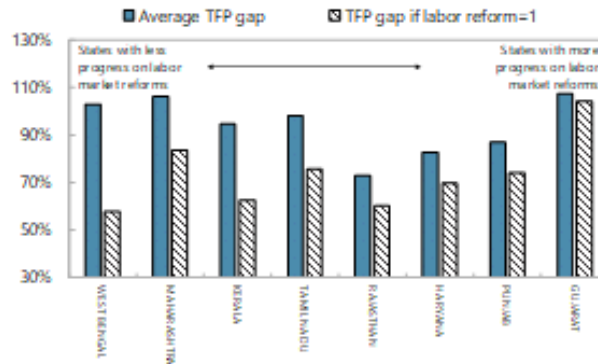
Source: ASI databases and authors' calculations for India, China and US statistics from Hsieh and Klenow (2009)

Figure 5.4: Correlation between misallocation and the size of informal sector



Source: ASI databases and IMF staff calculations Notes: TPF gap and share of unregistered NSDP are the residuals after correction for year-sector fixed effects. TFP gap is from equalizing TFPR within industries. The size of informal sector is measured by the share of unregistered in total manufacturing NSDP.

Figure 5.5: India: Distribution of TFP gap in States with High Informality (in %)



Source: ASI databases and IMF staff calculations

6 Conclusion

Aggregate productivity is one of the major sources of economic growth and directly depends on how efficiently firms use available resources. In this dissertation, each of the chapters studies the link between firm-level and aggregate productivity in presence of firm heterogeneity. First, I theoretically show how trade shocks, institutional and market imperfections modify firm decision-making. Secondly, I quantify their impact on aggregate dynamics in developed and emerging economies. The objective is to emphasize that firms with high potential growth are able to finance their investment, hire well-educated employees and have access to intermediate inputs at the best value for money in order to meet demand and to take opportunities to grow faster. The growth of high productive firms is essential to support economic growth.

In the first chapter, we decompose the impact of unilateral and bilateral trade liberalization on labor productivity in presence of resource misallocation. Theoretically and empirically, we show that both export and import expansions boost aggregate productivity, but only export demand reallocates activity towards more productive firms in presence of price distortions. Moreover, market and institutional frictions dampen the ability of economies to react to and gain from trade shocks.

In the second chapter, I look at the impact of firm outsourcing strategy on aggregate TFP growth. In theory, a lower marginal cost of foreign inputs improves aggregate productivity growth as it allows firms in the mid-to-top productivity distribution to rise their sales. It can correct the initial misallocation if these firms are initially constrained due to market and institutional frictions. Empirically, I study the impact of China's trade liberalization in the early 2000s on French aggregate productivity growth. I find that raising imports of intermediate inputs significantly contributes to aggregate TFP growth in France through a higher allocative efficiency

of market shares across firms.

In the third chapter, I study how labor market reforms and credit availability explain resource misallocation in India. More labor market flexibility and credit expansion reduce misallocation in Indian states, but informal sector also play a key role that needs to be further explored. Economic indicators in emerging and developing economies are based on data from the formal sector, but a large share of economic activities is not registered. Informality modifies behaviors of firms in the formal sector and the interactions between formal and informal activities remain poorly understood.

On the topic of firm integration in the global value chain, it seems very promising to understand how firm-level outsourcing strategy changes aggregate dynamics. Our world is more and more globalized and large companies operate at a world scale. However, trade integration also changes production process of smaller firms. Better understanding of how globalization and input-output linkages across firms drives economic growth seems crucial to design adequate market reforms that help all firms to fully benefit from globalization.

Finally, trade integration in developed and developing economies have not always yielded expected gains and the topics continue to be largely discussed in the public debate. Understanding better economic features that prevent gains from trade remains challenging. In the first and second chapters, we build conclusion for European economies that are well integrated and with relatively well-designed infrastructures. It would be interesting to test mechanisms on other economies with different economic features (large informal sector, poor infrastructure, low quality institution...). Furthermore, we suppose full employment in our framework, but the impact of trade on unemployment and inequality is crucial to fully assess welfare gains from trade.

References

- J. Ahn. Is the trade slowdown contributing to the global productivity slowdown? new evidence. IMF World Economic Outlook Chapter 2, 2016.
- M. Amiti and A. Khandelwal. Import competition and quality upgrading. *Review of Economics and Statistics*, 92, 2013.
- M. Amiti and J. Konings. Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia. *American Economic Review*, 97(5):1611–1638, December 2007.
- C. Arkolakis, A. Costinot, and A. Rodriguez-Clare. New trade models, same old gains? *American Economic Review*, 102, 2012.
- D. H. Autor, D. Dorn, and G. H. Hanson. The china shock: Learning from labor-market adjustment to large changes in trade. *Annual Review of Economics*, 8(1): 205–240, 2016. doi: 10.1146/annurev-economics-080315-015041.
- K. Bagwell and S. Lee. Trade policy under monopolistic competition with firm selection. *Stanford University, Mimeo*, 2016.
- E. Bartelsman, J. Haltiwanger, and S. Scarpetta. Cross-country differences in productivity: the role of allocation and selection. *American Economic Review*, 103, 2013.
- M. Bas and A. Berthou. The unequal effects of financial development on firms’ growth in india. Working papers, CEPPII, Paris, 2012.

- F. Bellone, K. Kiyota, T. Matsuura, P. Musso, and L. Nesta. International productivity gaps and the export status of firms: Evidence from France and Japan. *European Economic Review*, 70(C):56–74, 2014.
- R. Bems and R. C. Johnson. Demand for value added and value-added exchange rates. *American Economic Journal: Macroeconomics*, 9(4):45–90, October 2017.
- S. Ben Yahmed and S. Dougherty. Domestic regulation, import penetration and firm-level productivity growth. *Journal of International Trade & Economic Development*, 2017.
- K. Benkovskis. Misallocation of Resources in Latvia: Did Anything Change During the Crisis? Dec. 2015.
- N. Berman, P. Aghion, P. Askenazy, G. Clette, and L. Eymard. Credit constraints and the cyclicity of r&d investment: Evidence from france. *Journal of the European Economic Association*, 10(5):1001–1024, 2012.
- N. Berman, A. Berthou, and J. Héricourt. Export dynamics and sales at home. *Journal of International Economics*, 96(2):298 – 310, 2015.
- A. Bernard, S. Redding, and P. Schott. Multiproduct firms and trade liberalization. *Quarterly Journal of Economics*, 126, 2011.
- A. B. Bernard, J. B. Jensen, and P. K. Schott. Survival of the best fit: Exposure to low-wage countries and the (uneven) growth of u.s. manufacturing plants. *Journal of International Economics*, 68, 2006.
- A. B. Bernard, A. Moxnes, and K. H. Ulltveit-Moe. Two-sided heterogeneity and trade. Working Paper 20136, National Bureau of Economic Research, May 2014.

- A. Berthou, C. Jong Hyun, K. Manova, and C. Sandoz. Productivity, misallocation and international trade. *Unpublished*, 2017.
- T. Besley and R. Burgess. Can labor regulation hinder economic performance? evidence from india. *The Quarterly Journal of Economics*, 19(1):91–134, 2004.
- J. Blaum, C. LeLarge, and M. Peters. The Gains from Input Trade in Firm-Based Models of Importing. (21504), Aug. 2015.
- N. Bloom, M. Draca, and J. Van Reenen. Trade induced technical change: The impact of chinese imports on innovation, diffusion and productivity. *Review of Economic Studies*, 83:87–117, 2016.
- C. Broda and D. Weinstein. Globalization and the gains from variety. *Quarterly Journal of Economics*, 121, May 2006.
- A. Burstein and J. Cravino. Measured aggregate gains from international trade. *American Economic Journal: Macroeconomics*, 7(2):181–218, April 2015.
- P. Bustos. Trade liberalization, exports, and technology upgrading: Evidence on the impact of mercosur on argentinian firms. *American Economic Review*, 101(1): 304–40, February 2011.
- T. Chaney. Distorted gravity: The intensive and extensive margins of international trade. *American Economic Review*, 98(4):1707–1721, 2008.
- U. Chatterjee. Resource misallocation and efficiency in developing countries. Ph.d. dissertation, the University of California at Berkeley, 2011.
- D. Chor and K. Manova. Off the cliff and back? credit conditions and international

- trade during the global financial crisis. *Journal of International Economics*, 87, 2012.
- P. Conway and R. Herd. How competitive is product market regulation in india? an international and cross-state comparison. *OECD Journal: Economic Studies*, pages 1–25, 2009.
- J. De Loecker and F. Warzynski. Markups and firm-level export status. *American Economic Review*, 102(6):2437–71, 2012.
- S. Demidova. Productivity improvements and falling trade costs: Boon or bane? *International Economic Review*, 49(4):1437–1462, 2008.
- S. Demidova and A. Rodriguez-Clare. The simple analytics of the melitz model in a small open economy. *Journal of International Economics*, 90, 2013.
- S. Dhingra. Trading away wide brands for cheap brands. *American Economic Review*, 103(6):2554–2584, 2013.
- S. Dhingra and J. Morrow. Monopolistic competition and optimum product diversity under firm heterogeneity. *Journal of Political*, forthcoming, 2016.
- S. Dougherty. Labour regulation and employment dynamics at the state level in india. Working Papers 264, OECD Economics Department, Paris, 2008.
- S. Dougherty, V. Frisancho, and K. Krishna. Employment protection legislation and plant-level productivity in india. Working Paper 17693, NBER, 2011.
- S. Dougherty, V. Frisancho, and K. Krishna. State-level labor reform and firm-level productivity in india. *India Policy Forum*, 10(1):1–56, 2014.

- G. Duranton, E. Ghani, A. G. Goswami, and W. Kerr. The misallocation of land and other factors of production in india. Working Papers 7221, World Bank, Washington D.C., 2015.
- C. Edmond, V. Midrigan, and D. Y. Xu. Competition, markups, and the gains from international trade. *American Economic Review*, 105, 2015.
- P. Epifani and G. Gancia. Trade, markup heterogeneity and misallocations. *Journal of International Economics*.
- F. Foley and K. Manova. International trade, multinational activity, and corporate finance. *Annual Review of Economics*, 7, 2015.
- L. Fontagné and G. Santoni. Firm-level allocative inefficiency: Evidence from france. *Cepii WP*, 2015.
- L. Fontagné and A. D’Isanto. Chaînes d’activité mondiales :Des délocalisations d’abord vers l’Union européenne. *Insee Première*, 2013.
- L. Foster, J. Haltiwanger, and C. Syverson. Reallocation, firm turnover, and efficiency: Selection on productivity or profitability? *American Economic Review*, 98, 2008.
- E. Gamberoni, C. Giordano, and P. Lopez-Garcia. Capital and labour (mis)allocation in the euro area: Some stylized facts and determinants. (349), Sept. 2016.
- P. K. Goldberg, A. K. Khandelwal, N. Pavcnik, and P. Topalova. Imported intermediate inputs and domestic product growth: Evidence from india. *The Quarterly Journal of Economics*, 125(4):1727–1767, 2010.

- G. Gopinath and B. Neiman. Trade adjustment and productivity in large crises. *American Economic Review*, 104(3):793–831, March 2014. doi: 10.1257/aer.104.3.793. URL <http://www.aeaweb.org/articles?id=10.1257/aer.104.3.793>.
- G. Gopinath, S. Kalemli-Ozcan, L. Karabarbounis, and C. Villegas-Sanchez. Capital allocation and productivity in south europe. *Quarterly Journal of Economics*, 132(4):1915–1967, 2017.
- P. Gupta, R. Hasan, and U. Kumar. Big reforms but small payoffs: Explaining the weak record of growth in indian manufacturing. *India Policy Forum*, 5(1):59–123, 2008.
- L. Halpern, M. Koren, A. Szeidl, et al. Imported inputs and productivity. *American Economic Review*, 2015.
- J. Haltiwanger, R. Kulick, and C. Syverson. Misallocation measures: The distortion that ate the residual. Working Paper 24199, NBER, 2018.
- A. Harrison, L. Martin, and S. Nataraj. Learning versus stealing: How important are market-share reallocations to india’s productivity growth? *World Bank Economic Review*, 27, 2013.
- E. Helpman, O. Itskhoki, and S. Redding. Inequality and unemployment in a global economy. *Econometrica*, 78, 2010.
- C.-T. Hsieh and P. J. Klenow. Misallocation and manufacturing tfp in china and india. *The Quarterly Journal of Economics*, 124(4):1403–1448, 2009.
- D. Hummels, R. Jørgensen, J. Munch, and C. Xiang. The wage effects of offshoring: Evidence from danish matched worker-firm data. *American Economic Review*, 104(6):1597–1629, June 2014.

- C. Jones. The facts of economic growth. volume 2, chapter Chapter 1, pages 3–69. Elsevier, 2016.
- C. I. Jones. *Misallocation, Economic Growth and Input-Output Economics in Advances in Economics and Econometrics*. Cambridge University Press, 2013.
- R. Kapoor. Creating jobs in india’s organized manufacturing sector. *The Indian Journal of Labour Economics*, pages 349–375, 2015.
- H. Kasahara and J. Rodrigue. Does the use of imported intermediates increase productivity? Plant-level evidence. *Journal of Development Economics*, 87(1): 106–118, August 2008.
- D. Kaufmann, A. Kraay, and M. Mastruzzi. The worldwide governance indicators: Methodology and analytical issues. *World Bank Policy Research Working Paper*, 5430, 2010.
- A. Khandelwal, P. Schott, and Wei. Trade liberalization and embedded institutional reform: Evidence from chinese exporters. *American Economic Review*, 103(6): 2169–95, 2013.
- M. A. Leon-Ledesma and D. Christopoulos. Misallocation, access to finance, and public credit: Firm-level evidence. *Asian Development Review*, 32(2):119–143, 2016.
- T. Libert. Misallocation before, during and after the great recession. Working Paper 658, Banque de France, Paris, December 2017.
- A. Lileeva and D. Trefler. Improved access to foreign markets raises plant-level productivity for some plants. *The Quarterly Journal of Economics*, 125(3):1051–99, 2010.

- P. Lopez-Garcia, F. di Mauro, N. Benatti, C. Angeloni, C. Altomonte, M. Bugamelli, L. D'Aurizio, G. B. Navaretti, E. Forlani, S. Rossetti, D. Zurlo, A. Berthou, C. Sandoz, E. Dhyne, J. Amador, L. D. Opromolla, A. C. Soares, B. Chiriacescu, A.-M. Cazacu, and T. Lalinsky. Micro-based evidence of eu competitiveness: the compnet database. Ecb working paper, 2014.
- K. Manova. Credit constraints, heterogeneous firms, and international trade. *Review of Economic Studies*, 80, 2013.
- K. Manova and Z. Yu. How firms export: Processing vs. ordinary trade with financial frictions. *Journal of International Economics*, 100, 2016.
- J. Martin and I. Méjean. Low-wage countries' competition, reallocation across firms and the quality content of exports. *Journal of International Economics*, 93, 2014.
- T. Mayer, M. Melitz, and G. I. P. Ottaviano. Market size, competition, and the product mix of exporters. *American Economic Review*, 104, 2014.
- M. Melitz. The impact of trade on aggregate industry productivity and intra-industry reallocations. *Econometrica*, 71(6):1695–1725, 2003.
- M. Melitz and S. Redding. Heterogeneous firms and trade. volume 4, chapter Chapter 1, pages 1–54. Elsevier, 2014a.
- M. Melitz and S. J. Redding. Missing gains from trade? *American Economic Review*, 104(5):317–21, May 2014b.
- V. Midrigan and D. Y. Xu. Finance and misallocation: Evidence from plant-level data. *American Economic Review*, 104(2):422–58, 2014.

- F. Misch and C. Saborowski. Resource misallocation and productivity: Evidence from Mexico. Working Paper 18/112, IMF, Washington D.C., 2018.
- S. Olley and A. Pakes. The dynamics of productivity in the telecommunications industry. *Econometrica*, 64, 1996.
- S. Osotimehin. Aggregate productivity and the allocation of resources over the business cycle. *Unpublished, University of Virginia*, 2016.
- S. Osotimehin and L. Popov. Misallocation and intersectoral linkages. 2018 Meeting Papers 561, Society for Economic Dynamics, 2018.
- N. Pavcnik. Trade liberalization, exit, and productivity improvements: Evidence from Chilean plants. *Review of Economic Studies*, 69, 2002.
- R. Rajan and L. Zingales. Financial dependence and growth. *American Economic Review*, 88(3):151–174, 1998.
- D. Restuccia and R. Rogerson. The causes and costs of misallocation. *Journal of Economic Perspectives*, 31(3):151–174, 2017.
- M. Tito and R. Wang. Exporting and frictions in input market: Evidence from Chinese data. *Unpublished*, 2017.
- G. Ulysseay. Firms, informality and development: Theory and evidence from Brazil. *American Economic Review*, *Accepted*, 2017.
- H. Vandenbussche and C. Viegelaahn. Input reallocation within firms. Working Papers Department of Economics 545917, KU Leuven, Faculty of Economics and Business, Department of Economics, July 2016.

Appendices

A Productivity, (Mis)allocation and Trade

Table A.1: Summary Statistics

Panel A. Country-Sector-Year Level

| | Years | # Sector-Years | Avg # Firms per Sector-Year | In Aggregate Productivity | | In Average Productivity | | Covariance Term | | ln (Exports) | ln (Imports - Own-Sector Imp Inputs) |
|---------------------------|-----------|----------------|-----------------------------|---------------------------|--------|-------------------------|--------|-----------------|--------|--------------|--------------------------------------|
| | | | | Mean | St Dev | Mean | St Dev | Mean | St Dev | | |
| AUSTRIA | 2000-2011 | 178 | 68 | 4,29 | 0,53 | 4,23 | 0,52 | 0,06 | 0,09 | 8,06 | 6,67 |
| BELGIUM | 1998-2010 | 254 | 709 | 4,07 | 0,56 | 3,87 | 0,48 | 0,20 | 0,17 | 8,26 | 6,92 |
| ESTONIA | 1998-2011 | 157 | 218 | 1,96 | 0,58 | 1,63 | 0,60 | 0,33 | 0,22 | 4,93 | 3,70 |
| FINLAND | 1999-2011 | 233 | 573 | 4,06 | 0,56 | 3,88 | 0,52 | 0,18 | 0,20 | 7,10 | 5,65 |
| FRANCE | 1998-2009 | 231 | 3 559 | 4,03 | 0,47 | 3,85 | 0,44 | 0,19 | 0,15 | 9,14 | 8,05 |
| GERMANY | 1998-2011 | 274 | 721 | 4,50 | 0,40 | 4,39 | 0,38 | 0,11 | 0,09 | 9,91 | 8,62 |
| HUNGARY | 2003-2011 | 164 | 1 484 | 1,58 | 0,64 | 1,06 | 0,55 | 0,53 | 0,31 | 6,88 | 5,62 |
| ITALY | 2001-2011 | 218 | 4 356 | 3,53 | 0,43 | 3,25 | 0,44 | 0,28 | 0,09 | 9,17 | 7,75 |
| LITHUANIA | 2000-2011 | 179 | 263 | 1,86 | 0,61 | 1,38 | 0,58 | 0,48 | 0,23 | 5,01 | 4,17 |
| POLAND | 2005-2011 | 128 | 709 | 2,30 | 0,80 | 2,12 | 0,79 | 0,18 | 0,15 | 8,12 | 6,65 |
| PORTUGAL | 2006-2011 | 110 | 1 637 | 2,76 | 0,63 | 2,48 | 0,59 | 0,28 | 0,12 | 7,14 | 6,18 |
| SLOVAKIA | 2001-2011 | 182 | 109 | 2,11 | 0,63 | 1,97 | 0,57 | 0,14 | 0,20 | 6,60 | 5,26 |
| SLOVENIA | 1998-2011 | 232 | 216 | 2,30 | 0,58 | 2,20 | 0,54 | 0,10 | 0,17 | 6,06 | 4,74 |
| SPAIN | 1998-2011 | 271 | 3 192 | 3,46 | 0,44 | 3,15 | 0,38 | 0,31 | 0,15 | 8,39 | 7,42 |
| Mean (across countries) | | 201 | 1 272 | 3,06 | 0,56 | 2,82 | 0,53 | 0,24 | 0,17 | 7,48 | 6,24 |
| St Dev (across countries) | | 52 | 1 416 | 1,03 | 0,11 | 1,12 | 0,11 | 0,14 | 0,06 | 1,51 | 1,47 |
| St Dev (in panel) | | | | 1,13 | | 1,19 | | 0,22 | | 1,74 | 1,97 |

This table provides summary statistics for the variation in aggregate productivity (CompNet) and trade activity (WIOD) across country-sector-year triplets in the 1998-2011 panel, as well as for the variation in institutional and market efficiency (World Justice Project, OECD, World Bank) across country-years in the 1998-2011 panel.

Table A 1: Summary Statistics (cont.)

Panel B. Country-Year Level

| | Years | Rule of Law | | Corruption | | Labor Flexibility | | Market | | Creditor Protection | | Rights | | Product Regulation | |
|---------------------------|-----------|-------------|--------|------------|--------|-------------------|--------|--------|--------|---------------------|--------|--------|--------|--------------------|--------|
| | | Mean | St Dev | Mean | St Dev | Mean | St Dev | Mean | St Dev | Mean | St Dev | Mean | St Dev | Mean | St Dev |
| AUSTRIA | 2000-2011 | 1,86 | 0,05 | 1,92 | 0,22 | 3,31 | 0,12 | 6,00 | 0,00 | 1,39 | 0,00 | 0,00 | 0,00 | 1,39 | 0,00 |
| BELGIUM | 1998-2010 | 1,29 | 0,06 | 1,37 | 0,08 | 3,18 | 0,04 | 5,00 | 0,00 | 1,18 | 0,00 | 0,00 | 0,00 | 1,18 | 0,00 |
| ESTONIA | 1998-2011 | 0,94 | 0,23 | 0,83 | 0,14 | 3,71 | 0,20 | 6,25 | 0,00 | 1,63 | 0,00 | 0,00 | 0,00 | 1,63 | 0,00 |
| FINLAND | 1999-2011 | 1,94 | 0,03 | 2,41 | 0,13 | 3,92 | 0,07 | 8,00 | 0,00 | 1,49 | 0,00 | 0,00 | 0,00 | 1,49 | 0,00 |
| FRANCE | 1998-2009 | 1,39 | 0,08 | 1,37 | 0,06 | 3,32 | 0,05 | 4,38 | 0,00 | 1,11 | 0,00 | 0,00 | 0,00 | 1,11 | 0,00 |
| GERMANY | 1998-2011 | 1,65 | 0,06 | 1,84 | 0,14 | 3,05 | 0,00 | 7,50 | 0,00 | 1,19 | 0,00 | 0,00 | 0,00 | 1,19 | 0,00 |
| HUNGARY | 2003-2011 | 0,85 | 0,08 | 0,48 | 0,15 | 3,60 | 0,00 | 7,00 | 0,00 | 1,03 | 0,00 | 0,00 | 0,00 | 1,03 | 0,00 |
| ITALY | 2001-2011 | 0,48 | 0,13 | 0,31 | 0,19 | 2,85 | 0,00 | 3,00 | 0,00 | 1,23 | 0,00 | 0,00 | 0,00 | 1,23 | 0,00 |
| LITHUANIA | 2000-2011 | 0,59 | 0,17 | 0,17 | 0,11 | | | 5,00 | 0,00 | | 0,00 | 0,00 | 0,00 | | 0,00 |
| POLAND | 2005-2011 | 0,52 | 0,15 | 0,32 | 0,12 | 3,59 | 0,00 | 8,38 | 0,00 | 0,61 | 0,00 | 0,00 | 0,00 | 0,61 | 0,00 |
| PORTUGAL | 2006-2011 | 1,01 | 0,04 | 1,01 | 0,05 | 2,28 | 0,22 | 3,00 | 0,00 | 1,01 | 0,00 | 0,00 | 0,00 | 1,01 | 0,00 |
| SLOVAKIA | 2001-2011 | 0,47 | 0,11 | 0,28 | 0,16 | 3,28 | 0,10 | 8,00 | 0,00 | 1,11 | 0,00 | 0,00 | 0,00 | 1,11 | 0,00 |
| SLOVENIA | 1998-2011 | 0,98 | 0,10 | 0,94 | 0,15 | 3,15 | 0,02 | 4,50 | 0,00 | 1,11 | 0,00 | 0,00 | 0,00 | 1,11 | 0,00 |
| SPAIN | 1998-2011 | 1,19 | 0,09 | 1,19 | 0,16 | 3,25 | 0,03 | 6,00 | 0,00 | 1,07 | 0,00 | 0,00 | 0,00 | 1,07 | 0,00 |
| Mean (across countries) | | 1,08 | 0,10 | 1,03 | 0,13 | 3,27 | 0,06 | 5,86 | 0,00 | 1,17 | 0,00 | 0,00 | 0,00 | 1,17 | 0,00 |
| St Dev (across countries) | | 0,50 | 0,05 | 0,70 | 0,05 | 0,41 | 0,08 | 1,79 | 0,00 | 0,25 | 0,00 | 0,00 | 0,00 | 0,25 | 0,00 |

This table provides summary statistics for the variation in aggregate productivity (CompNet) and trade activity (WIOD) across country-sector-year triplets in the 1998-2011 panel, as well as for the variation in institutional and market efficiency (World Justice Project, OECD, World Bank) across country-years in the 1998-2011 panel.

Table A.2: Trade and Aggregate Productivity Growth: OLS First Differences

| | $\Delta = 1$ year | | | $\Delta = 3$ years | | | $\Delta = 5$ years | | |
|-------------------------|---|---|--------------------------------------|---|---|--------------------------------------|---|---|--------------------------------------|
| | Δ ln Agg Prod (ikt) (1) | Δ ln Avg Prod (ikt) (2) | Δ Cov Term (ikt) (3) | Δ ln Agg Prod (ikt) (4) | Δ ln Avg Prod (ikt) (5) | Δ Cov Term (ikt) (6) | Δ ln Agg Prod (ikt) (7) | Δ ln Avg Prod (ikt) (8) | Δ Cov Term (ikt) (9) |
| Δ Exp Dem (ikt) | 0.116*** (0.028) | 0.034 (0.025) | 0.082*** (0.027) | 0.142*** (0.027) | 0.053* (0.027) | 0.089*** (0.018) | 0.162*** (0.032) | 0.088*** (0.031) | 0.074*** (0.019) |
| Δ Imp Comp (ikt) | 0.083*** (0.021) | 0.102*** (0.022) | -0.019 (0.019) | 0.062** (0.025) | 0.102*** (0.024) | -0.040** (0.017) | 0.078*** (0.030) | 0.108*** (0.027) | -0.030* (0.016) |
| N | 2,546 | 2,546 | 2,546 | 2,073 | 2,073 | 2,073 | 1,587 | 1,587 | 1,587 |
| R2 | 0.114 | 0.115 | 0.022 | 0.101 | 0.117 | 0.044 | 0.096 | 0.094 | 0.035 |
| Year FE, Controls | Y | Y | Y | Y | Y | Y | Y | Y | Y |

This table examines the relationship between aggregate productivity and trade exposure at the country-sector-year level. The outcome variables follow the OP productivity decomposition and are indicated in the column heading. All left and right-hand side variables are first differences over rolling 1-year, 3-year or 5-year overlapping periods. All columns include year fixed effects and the full set of controls in Table 3.3. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

Table A.3: Impact of Trade on Aggregate Productivity: Robustness

| Dep Variable: | ln Agg Prod (ikt) | ln Avg Prod (ikt) | Cov Term (ikt) | ln Agg Prod (ikt) | ln Avg Prod (ikt) | Cov Term (ikt) |
|--|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Panel A. Only Export Demand | | | | | | |
| $\hat{\text{Exp Dem}}$ (ikt) | 0.461*** (0.039) | 0.350*** (0.041) | 0.111*** (0.018) | 0.417*** (0.112) | 0.304*** (0.097) | 0.114** (0.047) |
| Panel B. Only Import Competition | | | | | | |
| $\hat{\text{Imp Comp}}$ (ikt) | 0.148*** (0.013) | 0.149*** (0.015) | -0.001 (0.005) | 0.730*** (0.150) | 0.728*** (0.142) | 0.001 (0.050) |
| Panel C. Winsorizing Outliers | | | | | | |
| $\hat{\text{Exp Dem}}$ (ikt) | 0.399*** (0.039) | 0.298*** (0.039) | 0.102*** (0.014) | 0.370*** (0.116) | 0.229** (0.104) | 0.141** (0.055) |
| $\hat{\text{Imp Comp}}$ (ikt) | 0.070*** (0.014) | 0.091*** (0.014) | -0.021*** (0.005) | 0.399** (0.179) | 0.490*** (0.161) | -0.090 (0.064) |
| Panel D. Weighting by Sectors' Initial Employment Share by Country, $L(\text{ikt}=0) / L(\text{it}=0)$ | | | | | | |
| $\hat{\text{Exp Dem}}$ (ikt) | 0.395*** (0.036) | 0.343*** (0.034) | 0.052*** (0.009) | 0.819*** (0.177) | 0.615*** (0.154) | 0.204*** (0.054) |
| $\hat{\text{Imp Comp}}$ (ikt) | 0.079*** (0.014) | 0.093*** (0.014) | -0.013*** (0.004) | 0.474** (0.197) | 0.640*** (0.190) | -0.166*** (0.061) |
| Panel E. Lagged Trade Exposure | | | | | | |
| $\hat{\text{Exp Dem}}$ (ikt-1) | 0.395*** (0.041) | 0.292*** (0.041) | 0.103*** (0.014) | 0.297*** (0.102) | 0.179* (0.092) | 0.118** (0.049) |
| $\hat{\text{Imp Comp}}$ (ikt-1) | 0.069*** (0.015) | 0.091*** (0.014) | -0.022*** (0.006) | 0.500*** (0.180) | 0.569*** (0.163) | -0.069 (0.062) |
| Ctry*Year FE, Controls | Y | Y | Y | Y | Y | Y |
| Sector*Year FE | N | N | N | Y | Y | Y |

This table examines the stability of the impact of export demand and import competition on aggregate productivity at the country-sector-year level. It replicates the regressions in Columns 1-3 and 7-9 in Table 3.5, but implements a different robustness check in each panel. Panels A and B add only one measure of trade exposure at a time. Panel C winsorizes productivity, trade, and foreign demand and supply instruments at the top and bottom 1 percentile. Panel D weights observations by the initial country-specific employment share of each sector. Panel E lags trade exposure by 1 year. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

Table A.4: Imperfect Institutions and Market Frictions: Robustness

| Institution Measure: | Rule of Law | | | (Inverse) Corruption | | | Labor Market Flexibility | | | Creditor Rights Protection | | | (Inverse) Product Market Regulation | | |
|-----------------------------------|------------------------------|-----------------------------|----------------------------|-----------------------------|-----------------------------|----------------------------|--------------------------|-----------------------------|-----------------------------|----------------------------|--------------------------|----------------------------|-------------------------------------|-----------------------------|-----------------------------|
| | In Agg Prod (ikt) | In Avg Prod (ikt) | Cov Term (ikt) | In Agg Prod (ikt) | In Avg Prod (ikt) | Cov Term (ikt) | In Agg Prod (ikt) | In Avg Prod (ikt) | Cov Term (ikt) | In Agg Prod (ikt) | In Avg Prod (ikt) | Cov Term (ikt) | In Agg Prod (ikt) | In Avg Prod (ikt) | Cov Term (ikt) |
| Exp Dem (ikt) | 1.902*** (0.429) | 1.558*** (0.359) | 0.343** (0.152) | 1.609*** (0.411) | 1.243*** (0.327) | 0.366** (0.156) | -0.530* (0.319) | -1.364*** (0.296) | 0.835*** (0.287) | 0.905* (0.516) | 0.142 (0.340) | 0.762*** (0.293) | 1.097*** (0.222) | 0.910*** (0.220) | 0.187*** (0.065) |
| Imp Comp (ikt) | -0.873** (0.353) | -0.712** (0.307) | -0.161 (0.104) | -0.859** (0.374) | -0.655** (0.313) | -0.204* (0.121) | 0.369** (0.159) | 0.491*** (0.166) | -0.122 (0.101) | 0.179 (0.242) | 0.416** (0.170) | -0.237* (0.139) | 0.602*** (0.148) | 0.701*** (0.157) | -0.093* (0.055) |
| Exp Dem (ikt) x Institution (it) | -0.7541*** (0.148) | -0.653*** (0.125) | -0.101** (0.050) | -0.510*** (0.109) | -0.422*** (0.087) | -0.088** (0.040) | 0.129 (0.081) | 0.310*** (0.072) | -0.180*** (0.064) | -0.068 (0.045) | -0.009 (0.030) | -0.059** (0.024) | -0.683*** (0.135) | -0.602*** (0.131) | -0.082*** (0.031) |
| Imp Comp (ikt) x Institution (it) | 0.177*** (0.048) | 0.138*** (0.042) | 0.039*** (0.011) | 0.140*** (0.038) | 0.107*** (0.031) | 0.033*** (0.010) | -0.031 (0.029) | -0.090*** (0.028) | 0.059*** (0.022) | 0.039** (0.019) | 0.017 (0.013) | 0.022** (0.010) | 0.085 (0.061) | 0.066 (0.060) | 0.018 (0.017) |
| N | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 | 2,777 |
| R2 | 0.727 | 0.808 | 0.549 | 0.731 | 0.821 | 0.487 | 0.896 | 0.907 | 0.431 | 0.840 | 0.904 | 0.086 | 0.856 | 0.876 | 0.642 |
| Country-Year FE, Controls | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Sector*Year FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |

This table examines the stability of the role of institutional efficiency in moderating the impact of export demand and import competition on aggregate productivity at the country-sector-year level. It replicates the regressions in Table 3.8, but adds sector-year pair fixed effects in Panel A, and examines different aspects of labor market flexibility in Panel B. Standard errors clustered by sector-year in parentheses ***, **, * significant at 1%, 5%, 10%.

Table A.5: Impact of Trade on Dispersion of Productivity and Mark-Up

| Dep Variable: | MRPK | MRPL | TFPR | PCM | MRPK | MRPL | TFPR | PCM |
|------------------------|------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|------------------------------------|
| | St Dev (1) | St Dev (2) | St Dev (3) | p80 / p20 (4) | St Dev (5) | St Dev (6) | St Dev (7) | p80 / p20 (8) |
| Êxp Dem (ikt) | -0.203*** (0.069) | 0.272*** (0.038) | 0.297*** (0.035) | 0.039*** (0.015) | 0.425*** (0.145) | 0.059 (0.082) | 0.125 (0.155) | -0.156*** (0.045) |
| Împ Comp (ikt) | 0.193*** (0.026) | 0.095*** (0.012) | 0.059*** (0.013) | -0.008 (0.005) | 0.408* (0.229) | 0.483*** (0.131) | 0.981*** (0.248) | 0.189*** (0.078) |
| N | 2,777 | 2,777 | 2,382 | 2,775 | 2,777 | 2,777 | 2,382 | 2,775 |
| R2 | 0.552 | 0.810 | 0.784 | 0.693 | 0.703 | 0.872 | 0.792 | 0.733 |
| Ctry*Year FE, Controls | Y | Y | Y | Y | Y | Y | Y | Y |
| Sector*Year FE | N | N | N | N | Y | Y | Y | Y |

This table examines the impact of export demand and import competition on productivity and mark-up dispersion across firms at the country-sector-year level. The outcome variable is the standard deviation of the marginal revenue product of capital, the standard deviation of the marginal revenue product of labor, the standard deviation of revenue-based total factor productivity, or the 80th-20th interpercentile range of the price-cost mark-up as indicated in the column heading. All columns include country-year pair fixed effects and the full set of controls in Table 3. Columns 5-8 also include sector-year pair fixed effects. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

B Input Prices, Allocation of Resources and TFP Growth: Evidence from Chinese Imports in France

B.1 Exact decomposition of sectoral TFP

Regarding to the method proposed by Osotimehin (2016), the decomposition of productivity growth is given by :

$$\frac{TFP_{st}}{TFP_{st}} = I_{IN} \quad (\text{B.1})$$

Where I_{IN} is the intensive margin and I_{EX} is the extensive margin.

By using equations (4.9), (4.13) and (4.23), I rewrite RVA, capital, labor and inputs used as function of firm-level productivity and distortions :

$$\begin{aligned} g^Y(A_i, \tau_i) &= \Omega_{it}^{\frac{\theta}{1-\theta}} (1 + \tau_{itK})^{-\frac{\alpha\theta}{1-\theta}} (1 + \tau_{itL})^{-\frac{\beta\theta}{1-\theta}} (a_{it}G_i)^{-\frac{\gamma\theta}{1-\theta}} \\ g^K(A_i, \tau_i) &= \Omega_{it}^{\frac{\theta}{1-\theta}} (1 + \tau_{itK})^{-\frac{1-(1-\alpha)\theta}{1-\theta}} (1 + \tau_{itL})^{-\frac{\beta\theta}{1-\theta}} (a_{it}G_i)^{-\frac{\gamma\theta}{1-\theta}} \\ g^L(A_i, \tau_i) &= \Omega_{it}^{\frac{\theta}{1-\theta}} (1 + \tau_{itK})^{-\frac{\alpha\theta}{1-\theta}} (1 + \tau_{itL})^{-\frac{1-(1-\beta)\theta}{1-\theta}} (a_{it}G_i)^{-\frac{\gamma\theta}{1-\theta}} \\ g^X(A_i, \tau_i) &= \Omega_{it}^{\frac{\theta}{1-\theta}} (1 + \tau_{itK})^{-\frac{\alpha\theta}{1-\theta}} (1 + \tau_{itL})^{-\frac{\beta\theta}{1-\theta}} (a_{it}G_i)^{-\frac{1-(1-\gamma)\theta}{1-\theta}} \end{aligned} \quad (\text{B.2})$$

And :

$$\begin{aligned} \Delta TFP_{st} &= \left(\frac{n_{st}}{n_{st-1}} \right)^{\frac{\theta-1}{\theta}} \left(\frac{\sum_{i \in N_{st}} g^Y(A_{it}, \tau_{it})}{\sum_{i \in N_{st}} g^Y(A_{it-1}, \tau_{it-1})} \right)^{\frac{1}{\theta}} \left(\frac{\sum_{i \in N_{st}} g^K(A_{it}, \tau_{it})}{\sum_{i \in N_{st}} g^K(A_{it-1}, \tau_{it-1})} \right)^{-\alpha} \\ &\quad \left(\frac{\sum_{i \in N_{st}} g^L(A_{it}, \tau_{it})}{\sum_{i \in N_{st}} g^L(A_{it-1}, \tau_{it-1})} \right)^{-\beta} \left(\frac{\sum_{i \in N_{st}} g^X(A_{it}, \tau_{it})}{\sum_{i \in N_{st}} g^X(A_{it-1}, \tau_{it-1})} \right)^{-\gamma} \end{aligned} \quad (\text{B.3})$$

Where

$$I_{IN} = \left(\frac{\sum_{i \in C_{st}} g^Y(A_{it}, \tau_{it})}{\sum_{i \in C_{st}} g^Y(A_{it-1}, \tau_{it-1})} \right)^{\frac{1}{\theta}} \left(\frac{\sum_{i \in C_{st}} g^K(A_{it}, \tau_{it})}{\sum_{i \in C_{st}} g^K(A_{it-1}, \tau_{it-1})} \right)^{-\alpha} \left(\frac{\sum_{i \in C_{st}} g^L(A_{it}, \tau_{it})}{\sum_{i \in C_{st}} g^L(A_{it-1}, \tau_{it-1})} \right)^{-\beta} \left(\frac{\sum_{i \in C_{st}} g^X(A_{it}, \tau_{it})}{\sum_{i \in C_{st}} g^X(A_{it-1}, \tau_{it-1})} \right)^{-\gamma} \quad (\text{B.4})$$

Then, I decompose I_{IN} in two components by using Fischer indexes: the technical efficiency (TE) and the allocative efficiency (AE) [!!! TO COMPLETED !!!]

B.1.1 Dispersion of firm-level wedges as measure of sector-level misallocation

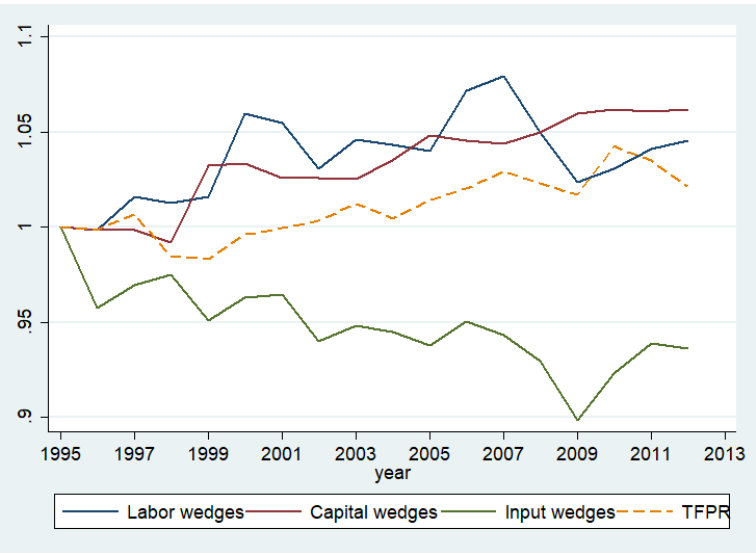
In the seminal paper by Hsieh and Klenow (2009), the dispersion of marginal revenue product of inputs is the main measure of resource misallocation. In figure A.1, overall misallocation and misallocation of capital and labor, respectively measured by the dispersion of TFPR, MPRK and MPRL, increased substantially between 1997 and 2007 in line with Libert (2017). However, the dispersion of wedges on inputs declines over the entire period with an acceleration between 2001 and 2005.

To determine in which extent the trade shock in 2001 reduces input misallocation, I regress sector-level dispersion of the different wedges on the share of Chinese imports in total imports of input:

$$WedgeSD_{kt} = \alpha + \beta ShareCN_{kt} + \Gamma N_{kt} + \phi_k + \phi_{t+ikt} \quad (\text{B.5})$$

Where $WedgeSD_{kt}$ is the standard deviation of $MRPK_{kt}$, $MRPL_{kt}$ and $MRPX_{kt}$

Figure A.1: Dispersion of firm-level productivity and input wedges in logs (Based 1 in 1995)



Notes: The dispersion of wedges is the weighted average of the standard deviation of $MRPK$, $MRPL$ and $MRPX$ by sector and year. The productivity and wedges are relative to 2-digit industry medians.

by sector K and year t . ϕ_k and ϕ_t are respectively sector and year fixed effects.

Results are in table B.1. First, the increasing share of Chinese products in total imported inputs is positively correlated with sector-level TFP as expected. In column 2, 3 and 4, the expending share of Chinese goods in total imports of intermediate inputs is negatively correlated with wedges dispersion of intermediate inputs, capital and labor, but the impact is only significant for intermediate inputs.

Table B.1: Sector-level dispersion of wedges and share of imported inputs from China

| VARIABLES | (1) TFP _{st} | (2) MRPX _{kt} (sd) | (3) MRPK _{kt} (sd) | (4) MRPL _{kt} (sd) |
|------------------------|--------------------------|--------------------------------|--------------------------------|--------------------------------|
| CN share _{kt} | 0.558*** (0.154) | -0.297** (0.118) | -0.283 (0.258) | -0.135 (0.147) |
| N _{kt} | 0.004 (0.011) | -0.002 (0.015) | -0.063 (0.066) | 0.025* (0.013) |
| Observations | 374 | 374 | 374 | 374 |
| R-squared | 0.931 | 0.897 | 0.870 | 0.855 |

TFP_{kt} is sector-level productivity. MRPX_{kt} (sd), MRPK_{kt} (sd) and MRPL_{kt} (sd) are the standard deviation of logs of $MRPX_{ikt}$, $MRPK_{ikt}$ and $MRPL_{ikt}$. They measure the dispersion of firm-level wedges computed by 2-digit sector. N_{kt} controls for sector size and sample variation. All columns include industry and year fixed effects. The constant term is not reported. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, *p<0.1

C Resource Misallocation in India: The Role of Cross-State Labor Market Reform and Financial Development

C.1 Alternative Measures of Misallocation

C.1.1 Variance of TFPR

With the expression of TFPR in equation 5.5, we can express industry TFP in state j using the CES aggregator define in equation 5.2:

$$TFP_{js} = \left[\sum_{i \in M_{js}} \left(A_{jsi} \frac{TFPR_{js}}{TFPR_{jsi}} \right)^{\theta-1} \right]^{\frac{1}{\theta-1}} \quad (C.1)$$

As $TFPR_{jsi}$ and A_{jsi} are jointly lognormally distributed, we decompose the aggregate TFP as in Hsieh and Klenow (2009):

$$\log TFP_{js} = \frac{1}{-1} \log \left(\sum_{i \in M_{js}} A_{jsi}^{\theta-1} \right) - \frac{\theta}{2} \text{var}(\log TFPR_{jsi})$$

The first term captures productivity gains due to technical efficiency. The second summarizes the negative effect of firm-level distortions on aggregate TFP, capturing the extent of misallocation with each sector and state.

C.1.2 TFP gap

Finally, we compute the distance between “efficient” and “observed” output for estimating TFP gap due to misallocation. We aggregate the ratio of actual sector TFP

and the efficient level of TFP (TFP*) as in equation C.1:

$$\frac{TFP_{js}}{TFP_{js}^*} = \left[\sum_{i \in M_{js}} \left(\frac{A_{jsi}}{\bar{A}_{js}} \frac{TFPR_{js}}{TFPR_{jsi}} \right)^{\theta-1} \right]^{\frac{1}{\theta-1}} \quad (C.2)$$

TFP gap which is the TFP gap from the efficient level is then:

$$TFPgap_{js} = \frac{TFP_{js}^*}{TFP_{js}} - 1$$

For measuring TFP gap at the state level, we use the Cobb-Douglas aggregator defined in equation 5.1 such as:

$$TFPgap_j = \prod_s TFPgap_{js}^{\rho_j}$$

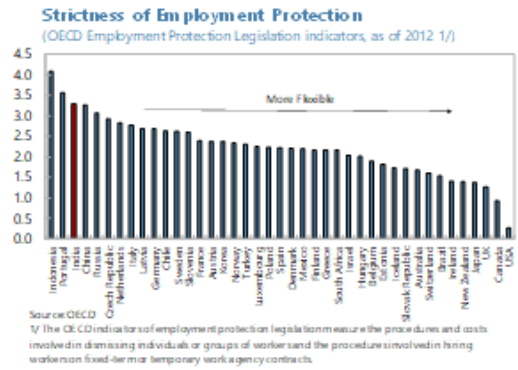
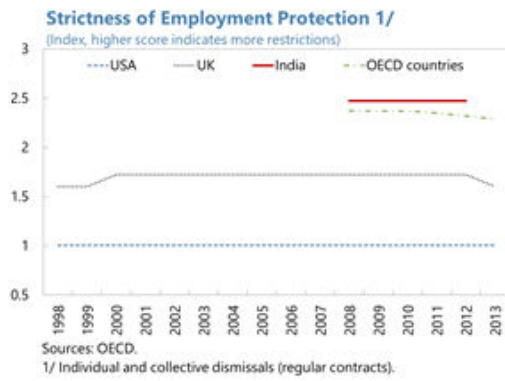
For computing TFP gap for India's entire economy, we treat the entire India as one state.

C.2 Labor Market Regulations and Reforms in India

India's labor market regulations are relatively strict, numerous, and outdated including at the sub-national level. The strictness of labor regulations, to a large extent, are attributed to Chapter V-B of the Industrial Disputes Act (IDA) that requires government approval for layoffs, retrenchments, and closures where this law applies on all factories with 100 or more workers. Labor laws at both center and states in India currently numbering around 250 laws are burdensome to businesses to operate and comply. These laws govern different aspects of the labor market such as minimum wages, resolution of industrial disputes, conditions for hiring and firing workers, and conditions for the closure of establishments. Strict labor market regulations in

India can have detrimental economic effects. India's employment protection is highly restrictive for the organized or formal sector, given particularly that it interferes significantly firms' hiring and severance decisions. High implicit costs of employment especially for large firms have induced many entrepreneurs to start small and stay small (Dougherty, 2008). Firms in the unorganized and often informal sector with fewer than 10 or 20 workers are subject to very few labor regulations and can employ casual or contract labor freely. Such high implicit costs of employment can also cause larger firms to substitute more capital for labor than the optimal allocation, given the apparently low wages that prevail in India. Some Indian states have gone ahead with labor reforms to improve labor market flexibility in recent years. Rajasthan, Madhya Pradesh and Haryana in 2014 have modified their Industrial Disputes Act to allow automatic retrenchment for a factory with less than 300 workers. Gujarat has also allowed automatic retrenchment of workers in any factory in the Specialized Economic Zones, Special Investment Regions, and National Investment and Manufacturing Zones, given that 60 days of wages are paid for every year of employment. Maharashtra in 2017 has also allowed automatic retrenchment for up to 300 workers. Pace of labor reforms has been slow. The central government in 2017 was in the process of amalgamating 44 central labor laws into four codes on (i) industrial relations, (ii) wages, (iii) social security and welfare, and (iv) safety and working conditions. While some elements of the draft code will create more flexibility (for example, industrial establishments employing more than 50 but fewer than 300 workers would not have to obtain government permission for lay-offs, retrenchment, or closure), other draft codes will likely backtrack (e.g. by increasing firing costs from to 1 months of salary). The new social security code may constitute a major reform, but it would also depend on the design of the new social security schemes by the central government. Nevertheless, to date, these labor law reforms have been put on

hold since then.



Essais en Economie Internationale
Hétérogénéité des Entreprises, Productivité Agrégée et
Efficacité de l'Allocation de Ressources

La présente thèse contribue à la littérature en économie internationale en s'intéressant à l'impact des flux commerciaux et des réformes structurelles sur la croissance de la productivité agrégée dans le secteur manufacturier en Europe et en Inde. Dans le premier chapitre co-écrit avec Antoine Berthou, Jong-Chung Chung et Kalina Manova, nous montrons que l'expansion des exportations et des importations stimule la productivité du travail, mais seule la demande à l'exportation réalloue l'activité vers les entreprises plus productives en présence de distorsions de prix. De plus, les frictions liées aux imperfections de marché et la mauvaise qualité des institutions freinent la capacité des économies à réagir aux chocs de commerce subis par les entreprises nationales. Dans le second chapitre, je trouve que l'augmentation des importations d'intrants intermédiaires depuis la Chine contribue de manière significative à la croissance agrégée de la PTF en France grâce à une plus grande efficacité de répartition des parts de marché entre les entreprises. En effet, permettre à un plus grand nombre d'entreprises d'avoir accès à des biens intermédiaires au meilleur rapport qualité-prix stimule la croissance de la productivité agrégée. Dans le troisième chapitre co-écrit avec Adil Mohommad et Piyaporn Sodsriwiboon, nous montrons que des réformes favorisant davantage de flexibilité sur le marché du travail et une meilleure allocation des crédits entre entreprises réduisent les distorsions de marché payées par les entreprises et génèrent des gains de productivité et une croissance économique plus forte à long terme en Inde.

Mots clés: commerce international, externalisation de la production, productivité agrégée, misallocation, hétérogénéité des entreprises, informalité, réformes sur le marché du travail.

Essays in International Economics
Firm Heterogeneity, Aggregate Productivity and Resource Misallocation

In this dissertation, I contribute to the literature on international economics by drawing attention to the impact of trade flows and structural reforms on productivity growth in the manufacturing sector in Europe and India. In the first chapter co-authored, with Antoine Berthou, Jong-Chung Chung and Kalina Manova, we demonstrate that growth in exports and imports boosts labor productivity, but only export demand reallocates activity towards more productive firms in presence of price distortions. Moreover, market and institutional frictions dampen the ability of economies to react and gain from trade shocks. In the second chapter, I show that the increase in Chinese imports of intermediate inputs is a significant driver of aggregate TFP growth in France as it increases efficiency in sharing market shares between firms. Allowing more firms to access intermediate goods at the best price-quality ratio stimulates aggregate productivity growth. In the third chapter, co-written with Adil Mohommad and Piyaporn Sodsriwiboon, our finding suggests that removing structural rigidities in the labor market and improving credit allocation would reduce distortions and contribute to productivity gains and long-term growth in India.

Key words: international trade, outsourcing of production, aggregate productivity, firm heterogeneity, misallocation, informality, labor market reforms.