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Three essays on the role of frictions in the economy

Meradj Morteza Pouraghdam

► **To cite this version:**

Meradj Morteza Pouraghdam. Three essays on the role of frictions in the economy. Economics and Finance. Institut d'études politiques de paris - Sciences Po, 2016. English. NNT : 2016IEPP0007 . tel-03498781

HAL Id: tel-03498781

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Institut d'études politiques de Paris
ECOLE DOCTORALE DE SCIENCES PO
Programme doctoral en Sciences économiques

Département d'Économie

Doctorat en Sciences économiques

Three Essays on the Role of Frictions in the Economy

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defended on March 25th 2016

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Acknowledgment

Though only my name appears on the cover of this dissertation, many people have contributed to its production. I owe my gratitude to all those people who have made this dissertation possible and because of whom my PhD experience has been one that I will cherish forever.

My deepest gratitude is to my advisor, Professor Etienne Wasmer, for his continuous support of my research and for his patience and motivation. I have been amazingly fortunate to have an advisor who gave me the freedom to explore on my own and at the same time the guidance to help me recover when my steps faltered. This freedom taught me how to question thoughts, an asset that I shall rely on in the future.

Besides my advisor, I would like to thank my thesis committee: Professor Edouard Challe, Professor Jozef Konings, Professor Cyril Monnet and Professor Guillaume Plantin, for their insightful comments, encouragement and criticisms, which incentivized me to widen my research from various perspectives.

Countless interactions with numerous distinguished researchers made this journey an enriching one. I am very much grateful to all of them, but especially to Professor Luca Benati for his constant support and insights, Professor Amar Bhidé, Professor Nobuhiro Kiyotaki, Professor Sahar Parsa and Professor Larry Weiss for their input and insights in the current work.

Through this journey I dwelled briefly in numerous research institutes for which their hospitality is greatly acknowledged especially to Rodolphe Blavey, Benoît Mojon, Julien Mathéron, Jenifer Burckett-Picker, Scott Roger and Jan Vlcek.

This work would not have been realized without the work of my co-authors, Elisa and Garence. I am very much grateful to them for all the discussions and debates that we had.

I use this opportunity to thank my family and friends for supporting me in constructing this piece. But first and foremost, I thank the One, to whom I owe all that I have: life, health, the willingness to think, strength and all the wonderful gifts.

I am very much grateful to my amazing parents for all the moral support that they have provided me with throughout my life. I cannot thank them enough and I hope that I will be able to repay a small fraction of this debt in the future. I also deeply thank my siblings for their constant support.

I am very much thankful to Elisa, my co-author and my friend. Our very first encounter was thanks to DSGE models. Since then I have benefited a lot from our exchanges on a wide range of topics. I cherish all our conversations, ideas and financial news exchanges (most notably the FT) and I shall look forward to the continuation of this collaboration in the future.

I am very much thankful to Garence, my co-author and my friend. Our very first encounter at the French Central Bank led to an everlasting discussion on different aspects of research in economics, law and finance, and, most notably, on research in monetary policy (especially the QE, ZLB and forward guidance). I appreciate all our exchanges and the ideas that we discussed and I shall look forward to the continuation of this collaboration in the future.

Hereby, I would like to thank all my friends and PhD colleagues who made this journey a promising one: Bill, for all your discussions especially the ones on Austrian economics and the concept of equilibrium; Dilan, for all your supportive words and encouragements in this journey; Dilyara, for all your supportive words, inspiration and criticisms; Jamil, for all the exchanges that we had on a wide range of interesting topics; Pierre for all our interesting discussions especially the ones on mathematics and economics; Jean-Louis, for our coffee break discussions about elections; Jessica, for all your supportive words and inspirations and our interesting discussions on law, political landscapes and corporate finance; Riccardo, for our interesting discussions especially on job polarization. And last, but not least I thank Andrea M., Alexis L., Asmae E., Assia E., Camilo U., Camille H., Clara W., Clément B., Dylan G., Eiji Y., Elizabeth B., Etienne L., Eve S., Flavien F., Florent S., François G., Gabriel S., Guillaume C., Guillaume L., Guillaume V., Guillaume W., Lilia A., Liza A., Marion G., Maxime S., Morgane L., Nadia K., Nicolas B., Odran B., Quentin V., Sarah D., Sandra N., Thibaut D., Urszula S., Valeria R. and Xavier F., for all your inputs throughout this journey.

Trois essais sur le Rôle du Désaccord en Économie

Résumé

Cette thèse se compose de trois études sur *le rôle du désaccord en économie*. Dans le premier chapitre, j'étudie l'impact des incertitudes judiciaires sur le rôle du désaccord dans le marché financier. Je donne des arguments expliquant que les incertitudes judiciaires pourraient augmenter la fragilité du secteur bancaire. Dans le deuxième chapitre, j'étudie la volatilité due au désaccord dans le marché du travail. J'argumente que les chocs technologiques n'expliquent qu'une petite partie de la variation observée dans la création d'emploi. Le troisième chapitre est consacré au désaccord sur le marché des prêts où je montre comment le droit des faillites pourrait intensifier le problème d'aléa moral entre une entreprise débitrice et ses créanciers.

Chapitre 1) L'impact des incertitudes judiciaires sur le marché financier

Depuis le début de la crise, les banques ont payé plus que 190 milliards de dollars d'amendes en raison d'actes sanctionnés par des régulateurs financiers. Une bonne part des pénalités visait à sanctionner les mauvaises conduites qui ont conduit à la crise des prêts hypothécaires ou "*subprime crisis*".

Notre connaissance autour des effets de ces amendes est bien limitée et ce sujet, aussi important qu'il soit, est quasiment négligé en recherche. Ce chapitre essaye de compléter cette lacune en étudiant l'impact de la possibilité du paiement des amendes aux régulateurs sur l'équilibre générale de l'économie.

Premièrement, j'ai commencé par documenter, de la manière la plus approfondie et détaillée possible, la nature de ces amendes à savoir leurs sommes et leurs collecteurs, etc. Ces amendes sont normalement envisagées par les banques et j'utilise cette information afin de développer un modèle statique et puis un modèle dynamique pour investiguer l'impact de ces amendes sur l'équilibre

général de l'économie. Procédant ainsi, je développe un concept judiciaire que je nomme " les incertitudes judiciaires".

La définition des incertitudes judiciaires renvoie à la capacité d'observation des régulateurs d'irrégularités commises par les banques et la possibilité de mettre en place des pénalités pour y faire face. Cette capacité d'observation n'est pas parfaite, donc les banques pourraient trouver ex-ante des opportunités pour commettre des irrégularités. Ces opportunités ex-ante d'irrégularités augmentent dans une situation où les banques savent qu'elles sont capables de payer les pénalités que l'on aurait assigné. L'incertitude liée à la capacité imparfaite d'observation par régulateurs est intitulée *the monitoring problem*, et celle liée à la pénalité *the enforceability problem*. J'introduis ces concepts dans un modèle avec frictions financières.

Afin d'étudier l'impact de ces incertitudes judiciaires, on a besoin d'un modèle doté d'un mécanisme financier. Deux classes de mécanismes financiers sont fréquemment utilisées en littérature macro-financière.

L'accélérateur financier fait référence au mécanisme par lequel les évolutions des conditions de financement ont des effets réels via le montant de la dette et donc la structure de financement de la firme. Il y a plusieurs problèmes conceptuels avec l'accélérateur financier qui ne permettent pas d'utiliser tel mécanisme pour étudier l'impact des incertitudes judiciaires. Cet accélérateur est concentré principalement sur les firmes et pas sur les institutions financières. En outre, dans ce mécanisme, les créiteurs audient l'entreprise qu'en état de faillite. C'est-à-dire, tant que les créiteurs reçoivent des intérêts sur leurs investissements (prêts octroyés aux firmes), ils n'auraient pas intérêt à auditer (ou d'exercer leur capacité d'observation). Quant aux emprunteurs, ils peuvent se déclarer en défaut de paiement sur leurs dettes sincèrement et tout simplement. Ce qui n'est pas tout à fait cohérent avec la notion d'incertitudes judiciaires.

Le deuxième mécanisme fréquemment utilisé est le canal du capital bancaire où les banques utilisent des fonds propres, des dettes interbancaires et des dépôts de ménages pour acheter des actions émises par les entreprises. Ce mécanisme nous permet d'introduire l'impact des incertitudes mentionnées dans le contexte suivant : les institutions financières devraient payer la totalité de la rémunération des actifs aux ménages. Or, conserver une fraction de cette rémunération pour soi, ce qu'est considéré comme une irrégularité.

Si la banque a la possibilité de conserver cette fraction et fait défaut (c.-à-d. cesser le paiement aux ménages), la banque pourrait fournir *ex-ante* la totalité des actifs disponibles, moins la fraction considérée comme la rémunération pour soi, comme des garanties supplémentaires afin d'emprunter de l'argent. Cette fraction de rémunération est la clé. Si cette fraction baisse, la banque devrait fournir une plus grande partie de ses actifs comme garantie afin d'emprunter et vice-versa. Les incertitudes judiciaires influencent cette fraction et je donne des arguments qu'elles l'augmentent.

Le niveau de cette fraction est déterminé comme un point d'équilibre à l'intersection entre les courbes de l'offre et la demande de crédit par les créditeurs et les banquiers respectivement dans le modèle statique. En présence de la possibilité de payer des amendes et l'observation imparfaite par des régulateurs, les créditeurs savent qu'ils pourraient récupérer une partie plus grande des actifs qu'avant. Donc ils autorisent l'augmentation de cette fraction.

Dans le modèle, les banquiers suivent un programme de maximisation de leur fonction objectif, c.-à-d. la valeur espérée des dividendes, sous une contrainte d'incitation au détournement d'une part de la rémunération des intérêts renforcée par les incertitudes judiciaires. En effet, cette contrainte devient relaxée en présence de ces incertitudes car les banquiers devraient fournir de moins de garantie pour emprunter.

Ensuite, j'introduis ces éléments dans un modèle dynamique afin d'analyser les propagations d'un choc financier exogène. Le choc utilisé est un choc de marge des actifs. Le modèle que j'ai utilisé est calibré pour un environnement où les frictions sur les marchés financier et interbancaire sont du même ordre de grandeur, c'est-à-dire le marché interbancaire est imparfait et ressemble bien à celui de la période après-crise.

La simulation de ce modèle nous montre que la capacité d'observation des régulateurs détermine la stabilité ou la fragilité du secteur bancaire. Le coût du capital n'augmente pas beaucoup dans une économie avec des incertitudes judiciaires mais le taux de retour de l'économie à l'état stationnaire baisse. Par exemple le taux de retour de l'économie à l'état stationnaire (après avoir subi un choc externe de niveau moyen) dure en moyenne 7 – 12 trimestres. Je donne des arguments que cela est en raison de changement de qualité des actifs en présence des incertitudes judiciaires. Finalement, je regarde si le modèle simulé pourrait reprendre les fluctuations du cycle économique après la crise financière et il le fait bien. En outre je donne des arguments détaillés pour l'analyse

des programmes de bien-être social en présence des incertitudes judiciaires.

Chapitre 2) La volatilité du marché du travail et les chocs macroéconomiques (avec Elisa Guglielminetti)

La volatilité des variables macroéconomique a été bien baissée depuis 1985. Toutefois, il est bien documenté que le marché du travail est marqué par un degré élevé de volatilité. Dans ce papier, j'essaye d'identifier les sources de cette volatilité élevée de manière structurelle. Ainsi, J'utilise un vecteur autorégressif (*Time Varying Parameter SVAR*) avec volatilité stochastique pour investiguer les propriétés de la création d'emploi aux Etats-Unis et leurs variations dans le temps. Afin d'étudier cette volatilité deux étapes sont nécessaires:

- 1) La nécessité d'un modèle DSGE dans lequel on introduit une friction du marché du travail telle que les modèles d'appariement (*search and matching models*)
- 2) Le calcul des volatilités avec un vecteur autorégressif aux paramètres et variances variant dans le temps.

La première étape est nécessaire afin de mieux comprendre les mécanismes et les enjeux de l'économie et la friction sur le marché du travail. Le modèle proposé, on utilise l'approximation du premier ordre pour trouver la solution du problème général au voisinage de l'état stationnaire déterministe du modèle. Dans le cadre de cette étude, l'approximation au premier ordre est suffisante pour simuler ce genre de modèle.

Afin de calculer les effets des chocs macroéconomiques sur la volatilité de la série temporelle de création d'emplois, un modèle de vecteur autorégressif structurel aux paramètres et volatilités variant dans le temps a été utilisé (i.e. TVP-SVAR). Différentes méthodes d'identification ont été proposées dans la littérature imposant certaines restrictions sur la forme structurelle de la matrice d'identification \hat{z} .

La méthode de restriction des signes à court terme et à long terme ont été adoptées dans ce travail. Cette méthode est basée sur les signes des fonctions de réponses des variable d'intérêts (PIB réel, Taux des fonds fédéraux, Nombre de postes vacants, Inflation) aux chocs exogènes (choc de productivité, choc de politique monétaire, choc des prix, choc de demande) . Par exemple, si le choc de politique monétaire augmente le nombre de postes vacants, on met un signe positif pour l'élément de la matrice d'identification qui correspond à la réaction des postes vacants au choc

monétaire. Pour obtenir ses signes, on utilise le modèle développé de l'étape (1).

Après avoir construit la matrice d'identification, on estime un modèle autorégressif à paramètres variant dans le temps (TVP-SVAR) avec la méthode d'estimation Bayésienne. Au vu des résultats, un choc technologique semble expliquer moins de 40% des fluctuations observées de la volatilité de la création d'emplois après les années 1980 et ils indiquent que la volatilité dépend largement des chocs de demande et de prix. Les postes vacants (autrement dit, la création d'emploi) réagissaient négativement aux chocs technologiques jusqu'au début des années 90 et on retrouve la même tendance pour la période récente. Ce résultat est très important pour les autorités publiques car il remet en question la création d'emplois suite à de nouvelles technologies.

Chapitre 3) Le droit des faillites et sa relation avec le niveau de demande des clauses restrictives financières dans un contrat (avec Garence Staraci)

L'endettement est la principale source de financement externe des entreprises. Lorsqu'une entreprise débitrice n'apparaît plus en mesure de faire face à ses engagements, l'entreprise peut être liquidée. Ce processus est mené par le juge et encadré par le droit des faillites. Les modalités de gestion des défaillances d'entreprises sont un enjeu essentiel pour les entreprises.

En considérant la loi sur la faillite américaine (notamment Chapitre 7, i.e. liquidation judiciaire et 11 le redressement judiciaire), on comprend que la gestion de défaillances a été bien évoluée pendant les 20 dernières années. Après la réforme de 1978 la loi est exercée de plus en plus en faveur des entreprises en état de défaillance. Toutefois, après les années 2000 il est clair que le droit des faillites est devenu de plus en plus en faveur des créiteurs. Les juristes donnent des arguments que le redressement judiciaire n'existe quasiment plus.

En raison de ces changements, une commission d'enquête aux États-Unis a commencé un débat afin de changer la loi de 1978 pour donner des pouvoirs supplémentaires aux juges et aux entreprises débitrices. En opposition à cette commission, le syndicat qui s'occupe du marché des prêts (le *Loan Syndication and Trading Association, LSTA*) argue que ces changements en faveur des entreprises débitrices augmenteraient fortement le coût du capital ou le taux de rentabilité du contrat (i.e. *contract spread*), mais n'explique pas comment. Ce chapitre essaye de faire un lien entre le droit des faillites et le coût du capital en étudiant le niveau de demande des clauses restrictives dans un contrat. Je donne une nouvelle interprétation des clauses restrictive par rapport à la littérature.

Le concept va être illustré par l'exemple suivant.

L'endettement est la principale source de financement externe des entreprises et les entreprises ont toujours la tentative de s'endetter de plus en plus. Un endettement excessif érode la valeur des prêts des créanciers. Ainsi, les créanciers mettent en place des clauses restrictives financières (qui s'appellent *loan financial covenants*) afin de contrôler le comportement de l'entreprise. Imaginons un environnement où la loi de défaillance est exercée en faveur des entreprises débitrices, cela influencerait le comportement d'endettement en général. Les créanciers font face à cette situation en augmentant le nombre de clauses restrictives dans le contrat car ils comprennent que leurs positions seraient encore affaiblies si l'entreprise devait se trouver en état de défaillance. Ici, on voit bien la relation entre le nombre de clauses restrictives et le droit de faillite. Toutefois, pour le taux de rentabilité on devrait examiner le point d'équilibre entre le nombre des clauses restrictives dans un contrat et le taux de rentabilité du contrat (i.e contract spread) conditionné à l'exercice du droit de faillite.

Il y'a deux courbes de demande des clauses restrictives qui déterminent ce point d'équilibre, celle émanant des créanciers et celle émanant des débiteurs. Si les créanciers mettent en place des clauses restrictives dans le contrat, le taux de rentabilité du contrat devrait augmenter afin de compenser les coûts associés avec une clause restrictive supplémentaire. Ainsi, la courbe de demande des clauses restrictives des créanciers est une fonction croissante du taux de rentabilité. Cependant, les débiteurs ont du mal à accepter un contrat cher (c'est-à-dire un contrat avec un taux de rentabilité élevé) avec beaucoup de clauses restrictives. Donc la courbe de la demande des clauses restrictive pour les débiteurs est une fonction décroissante du taux de rentabilité. L'intersection de ces deux courbes nous donne le point d'équilibre entre le nombre des clauses et le taux de rentabilité.

Les changements dans le droit de faillite ont dû déplacer juste la courbe de la demande des créanciers, car les créanciers sont normalement préoccupés par ces changements. Par conséquent, l'hypothèse que je vais essayer de valider empiriquement est celle-ci : si le droit de faillite devient de plus en plus en faveur des entreprises, les créanciers mettent en place de plus en plus de clauses restrictives (c'est-à-dire cherchent à obtenir un contrôle renforcé sur le comportement des débiteurs). Mais en même temps ils prennent en compte la contrainte de participation des débiteurs en

baissant le taux de rentabilité. En conséquence, le changement dans le droit de faillite n'augmente pas le taux de rentabilité du contrat automatiquement.

Afin de valider cette hypothèse, j'ai construit une nouvelle base de données pour montrer l'évolution du droit de faillite pour le secteur manufacturier et pour créer des variables d'approximation qui nous permettent de voir si le droit a été pratiqué en faveur des créiteurs ou des débiteurs. Ces variables d'approximation ont été utilisées comme des variables instrumentales pour expliquer l'endogénéité du nombre des clauses restrictives dans un contrat. Je valide l'hypothèse susmentionnée et je montre qu'une clause restrictive additionnelle baisse le taux de rentabilité par 23 points de base.

Three Essays on the Role of Frictions in the Economy

Abstract

In this thesis I have investigated three aspects of market frictions. Chapter 1 is about financial frictions, i.e. frictional forces prevailing in the financial markets. I investigate how monitoring and legal fines imposed on banks affect financial fragility. Chapter 2 explores the frictional labor market, i.e. frictional forces that prevent the smooth matching process between employees and employers in labor markets. In this chapter I investigate the sources of fluctuations in labor market volatility. Chapter 3 investigates the asymmetrical information in lending markets and how bankruptcy law could potentially affect this asymmetrical information between a borrower and its lenders.

Chapter 1: Monitoring, Legal Fines and Financial Fragility

In Chapter 1, I have investigated the implications of legal fines and partial monitoring in a macro-finance model. This primary motivation of this work was the unprecedented level of fines banks faced in recent years. The research in this field is very sparse and this work is one of the few to fill in the void. I have tried investigating the implications of fines and partial monitoring in static and dynamic frameworks. There is partial monitoring in the sense that dubious behavior of intermediaries is not always observed with certainty. Moreover intermediaries can pay some litigation fees to mitigate the punishment for their conduct should they get caught. Several insights can be drawn from introducing such concepts in static and dynamic frameworks. Partial monitoring and legal fines make the incentive constraint of intermediaries more relaxed, in the sense that bankers are required to pledge less collateral to raise fund. This decrease in the asset pledgeability pushes the corporate spread down. In a dynamic set-up due to changes in asset qualities caused by such possibilities, recovery in output and credit become sluggish in response to an adverse financial shock. The dynamic implications of the model for the post-crisis period

are investigated. This paper calls for further research to broaden our understandings in how legal settlements interact with banks' behaviors.

Chapter 2: Time-Varying Job Creation and Macroeconomic Shocks

In Chapter 2 (joint with Elisa Guglielminetti) I have investigated the time-varying property of job creation in the United States. Despite extensive documentation of the US labor market dynamics, evidence on its time-varying volatility is very hard to find. In this work I contribute to the literature by structurally investigating the time-varying volatility of the U.S. labor market. I address this issue through a time-varying parameter VAR (TVP-VAR) with stochastic volatility by identifying four structural shocks through imposing robust restrictions based on a New Keynesian DSGE model with frictional labor markets and a large set of shocks. The main findings are as follows. First, at business cycle frequencies, the lion share of the variance of job creation is explained by cost-push and demand shocks, thus challenging the conventional practice of addressing the labor market volatility puzzle ([Shimer, 2005](#)) under the assumption that technology shocks are the main driver of fluctuations in hiring. Second, technology shocks had a negative impact on job creation until the beginning of the '90s. This result is reminiscent of the "hours puzzle" ([Galí, 1999](#)).

Chapter 3: Chapter 11 and Demand for Loan Covenants

In Chapter 3 (joint with Garence Staraci) I provide an additional rationale why creditors include covenants in their contracts. The central claim is that covenants are not only included as a means of shifting the governance from debtors to creditors, but also to potentially address the concerns creditors might have about how the bankruptcy law is practiced. To investigate this claim, I take advantage of the fact that covenants are nullified inside bankruptcy. This fact permits us to show that any change to the bankruptcy law affects the spread through changes that it brings to the contractual structure. The narrative of this work is that if the bankruptcy law is practiced in a more debtor-friendly fashion, creditors will put more covenants in the contract. However, creditors will instead reduce the spread to motivate borrowers' participation. We empirically validate the narrative and show that an additional covenant decreases the spread by around 26 basis points on average. The novelty of the work is that empirical research in the field of bankruptcy is scarce and this work fills in the void by bringing a novel interpretation of the law, i.e. the potential impact of the bankruptcy law on the contractual structure.

Contents

1 Chapter 1 : Introduction	1
2 The Conceptual Improvement	4
3 Legal Settlements	7
4 Some Empirical Evidence	9
5 Model	10
5.1 Static	10
5.2 Dynamic	18
5.2.1 Financial Intermediaries	20
6 Equilibrium	25
7 Imperfect Financial Markets	26
8 Simulations	27
9 Future Work	32
10 Conclusion	34
11 Chapter 2 : Introduction	68
12 Methodology	71
13 Reduced-form Evidence	74
14 Model	75
15 Structural Evidence	77
15.1 Identification Strategy	77
16 Results	79
17 Theoretical implications and future work	83
17.1 The impact of technology shocks	83
18 Open issues	85
19 Conclusions	87
20 Chapter 3 : Introduction	110
21 Corporate Bankruptcy and Its Evolving Practice	113
21.1 From Debtor To Creditor-Friendly Practices	113
21.2 Bankruptcy Law As a Liquidity Provider	114
21.3 Bankruptcy Provisions of Interest	115
21.4 Bankruptcy Data and Proxy Construction	116
22 Syndicated Debt and Covenant Intensity	119
22.1 Syndicated Loan Financing	119
23 Covenants Purpose and Intensity	120
24 The Model	121
25 Empirical Framework and Testing	126

26 Identification Strategy	126
27 Hypothesis Testing Strategy	129
28 Dataset Description	130
29 Empirical Testing and Results	132
30 Robustness	134
31 Coefficient Interpretation	135
32 Some Financial and Legal Perspective	136
33 Concluding remarks	138
References	154

List of Figures

1	Legal Settlements	36
2	Distribution of fines imposed by the Department of Justice	37
3	Distribution of fines imposed by the Security Exchange Commission (SEC)	38
4	Plot of legal fines against the Equity level	39
5	Scatter Plot of Spread against Deflated Fines	40
6	Deposit issued by banks	41
7	Changes due to possibility of paying legal settlement	42
8	Relationship between $\theta^{max} \propto \frac{1}{(1-\kappa+\kappa\pi)}$	43
9	Impulse Response Functions to a shock of 5% volatility for three specification	46
10	Impulse Response Functions to a shock of 5% volatility for three specification	47
11	Impulse Response Functions to a shock of 5% volatility for three specification	48
12	Impulse Response Functions to a shock of 5% volatility for three specification	49
13	Slow Recovery (2007Q4-2015Q1)	51
14	Cyclical Properties	52
15	Other regulatory entities imposing fines	54
16	Other regulatory entities imposing fines	55
17	Fines imposed by other plaintiffs	56
18	Welfare	67
19	Original data and median estimates of the states	98
20	Median time-varying coefficients of the reduced-form VAR	99
21	Time-varying total prediction variance (Bps)	99
22	Time-varying volatility of reduced-form shocks (Bps)	100
23	Time-varying volatility of the reduced-form shocks relative to that of GDP growth	100
24	Time-varying correlations of the reduced-form shocks (Bps)	101
25	Vacancies: time-varying response on impact	102
26	Vacancies: normalized time-varying response on impact	103
27	GDP growth: normalized time-varying response on impact	104
28	Vacancies: normalized time varying Generalized Impulse Response Functions (Bps)	105
29	Vacancies: time-varying conditional and unconditional correlations	105
30	Time-varying conditional and unconditional variance at business cycle horizon	106
31	Vacancies: Forecast Error Variance Decomposition	106
32	Model based IRFs	107
33	Model based IRFs	108
34	Strength of identification of shocks given the time series	109
35	DIP and Lift of the Automatic Stay Evolution	139
36	Adequate Protection, KERP and Release of Cash Collateral Evolution	140
37	The static Model	141
38	The Identification scheme	142
39	Forum Shopping	143
40	Forum Shopping	144

List of Tables

1	Calibration	44
2	Calibrated values for seizure rate and transfer in presence of different lack of monitoring	44
3	Scenarios	44
4	Calibrated values for seizure rate and transfer	44
5	Real and Financial variables steady-states	45
6	The correlation matrix of Business Cycles (1986Q1-2015Q1)	50
7	The correlation matrix of Simulated Time Series (Partial Monitoring Benchmark)	50
8	The moments of data from 1986Q1-2015Q1	50
9	Welfare Analysis	53
10	Regression results	59
11	The matrix of short-run restrictions	79
12	Judge Specific Regression	145
13	Descriptive Statistics	145
14	First Stage Regression (OLS)	146
15	First Stage Regression (OLS)	147
16	Bankruptcy Practice Distribution	148
17	Bankruptcy Practice Distribution	149
18	List of Financial Covenants Available in DealScan	150
19	Distribution of Covenants used given year	151

Chapter 1 : Monitoring, Legal Fines and Financial Fragility

1 Chapter 1 : Introduction

After the financial crisis the legal liabilities of banks attained records never seen before (Fig. 1). These fines were targeting banks mainly for their misappropriate financial conducts and they usually came as a surprise to the financial media. However, in the media's parlance, these fines would never hold intermediaries "accountable". Related to this some initiatives have taken place in the Congress to pass a bill known as the "Truth in the Settlement Act of 2015" urging further transparency in how such fines are imposed and calculated.

It is then natural to investigate how such fines might affect the economy given they have frequently been imposed on banks. However research work on this topic is very scarce and usually it focuses on a very narrow definition of fines or companies. The aim of this work is to fill in this void by introducing legal fines or more generally, monitoring in a dynamic framework to observe its implications.

To do this I have first briefly explained what legal fines are and how they are usually imposed. I have also explained how such fines are considered from financial stability perspective and what banks usually do to face such fines. I have then hand-collected legal fine announcements from different regulatory entities for the post-crisis period to create an aggregate legal fine time series.

By deflating these time series with the total assets or equity, I argue that the level of such fines seems to have a negative correlation with aggregate corporate spreads. By taking advantage of the fact that these fines are exogenous to any loan issuance, I have also tried investigating the matter to see the impact of such fines on the spread of a pool of loans.

To formalize how legal fines or partial monitoring affects the economy, I introduce two further concepts. There is legal uncertainty in the sense that dubious behavior of intermediaries is not always observed with certainty. I refer to this point as the “*monitoring*” concept. Moreover bankers can pay some litigation fees to mitigate the punishment for their conduct should they get caught, which I refer to it as the “*enforceability*” concept.

The argument is that both *monitoring* or *enforceability* concepts could potentially decrease the spread by relaxing the incentive constraint of bankers in lending. The way those concepts relax the incentive constraint is that they reduce the necessary level of assets required to be pledged to raise fund. This necessary level of pledging asset is jointly determined by the level of credit households (or creditors) supply and the level of credit intermediaries demand. Up to this level, bankers would not charge any spread. What legal fines (*enforceability*) or partial monitoring do, it decreases the necessary level bankers should pledge to raise fund. This leads into a reduction of spread as more asset is put to work. Since the plausible level of pledgeability is set through the demand and supply of credit, one can also think of it as the plausible moral hazard level set by the household.

On the other hand, suppose that fines were so high. This means, bankers would face a tight constraint in their activities. Since the incentive constraint is too tight the plausible moral hazard is very low and intermediaries will charge a higher spread on their loans as a means of compensation for the stringent incentives they are facing. This is why in practice, the fines are usually small, due to the trade-off between the level of spread and plausible moral hazard level. This point as elaborated further in detail later requires a deep understanding of how legal settlements interact with intermediaries balance-sheet.

Lack of monitoring has a similar impact as that of legal settlements on bankers’ incentive constraints except here, the key parameter that permits us to have a reasonable framework is, to what extent post-banking-operation assets are booked in the franchise value. The idea is the

following: less monitoring relaxes incentives of banks and this relaxation affects asset values. Lack of monitoring likewise reduces lending spreads because it increase the range of activities for which banks will gain no spread.

I have then implemented the concept introduced in a dynamic set-up to explore their equilibrium features. In presence of an adverse financial shock, legal possibilities reduce the spread as predicted by the static model. The recovery in output and credit however become more sluggish. The reason is when there is a possibility of partial monitoring or paying a fine, the plausible level of moral hazard increases, meaning there are now operations that could potentially even be detrimental to the value of assets. If assets' quality decrease due to such operations, their marginal return diminishes in the presence of an adverse financial shock, which ultimately increases the sluggishness of the recovery. This sheds light on an important topic on how the quality of assets are achieved. If assets' qualities are achieved with tough regulations, recovery takes a faster pace at a higher spread and vice versa.

The contributions of the paper is that I have tried bringing further insight to the literature by substantially improving our understanding of how legal fines or their presence might impact the economy. The concept that I am bringing is that legal fines or partial monitoring “relax” the incentive constraint (in this case the bankers). It comforts the creditors if they know following a financial misconduct there will be legal punishment. This affects how they will set the level of moral hazard that can be committed by bankers. Hence legal fines may not even be disciplinary at all as opposed to the conventional thinking that they are. I also argue that partial monitoring and legal fine implications are not clear-cut for the welfare. It depends whether legal uncertainties directly affect the equilibrium consumption level.

This simple way of modeling legal fines and partial monitoring affords a tractable static and recursive formulations of the model. It is not designed to incorporate realistic details of how legal fines are actually imposed; instead my goal is to simply capture the most basic features of imposing legal fines (such as being anticipated in advance) and trace out its consequences. Thus the model sidesteps the deeper reasons why such fine provisions exist, how they are calculated or which regulator imposes them, or even the exact quantitative implications of fines over the business cycle. But modeling such concerns greatly complicate the model, a point discussed further in details later.

So I opt for a simpler approach of not modeling the legal fines or its exact quantitative implications but to instead argue its consequences in terms of how it improves conceptually the way we think about fines.

The work follows by providing some definitions of legal fines and some empirical evidences on the relationship between the growth of legal settlements and spread changes. Section (4) is where I have tried formalizing the empirical relationship, both in a static and dynamic framework. In Section (5) the model is simulated to show its properties. The work is then concluded with a section on potential futures works (5).

2 The Conceptual Improvement

To see the contribution of the paper, here I briefly explain the macro-finance literature. The literature on financial friction has developed over the course of the past two decades ¹. In essence there are two major friction types, friction on the demand side of the credit and friction on the supply side of the credit. These two types are usually implemented in macro models to investigate the propagation of shocks. Here I argue which of the conventional existing mechanisms is best at addressing the legal uncertainty concept.

Financial friction in macroeconomic models started by implementing the famous costly-state-verification mechanism of [Townsend \(1979\)](#); there are entrepreneurs and creditors (not necessarily banks). The underlying mechanism is the following: entrepreneurs have investment opportunities but their net-worth is not enough to cover the entire investment. Creditors extend loans by engaging entrepreneurs in a contract. Before specifying the terms of the contract it is necessary to explain the production phase of entrepreneurs. Entrepreneurs experience idiosyncratic shocks and if their experienced shocks falls below a certain threshold they cannot honor their debt.

These idiosyncratic shocks are privately observed by entrepreneurs in the first place so the contract should be set-up in such a way to make enough incentives for entrepreneurs to reveal the truth about their states. Revelation principle (or equivalently saying truth telling) implies two things. First it rules out the possibility of diverting returns. Second, they always reveal the truth in the bad states of the world by declaring bankruptcy. In this state creditors pay some cost,

¹For an excellent survey on the matter refer to [Brunnermeier, Eisenbach and Sannikov \(2012\)](#)

usually interpreted as bankruptcy or auditing cost to find out the true state and recoup what ever they find. Entrepreneurs in the node of bankruptcy does not get anything. Hence they will never have the incentive to misrepresent ².

The mechanism despite its neat exposition has some legal institutional flaws. The first one is that debt contract is viewed as an optimal instrument which has a disciplinary role due to its minimizing cost ability. Since auditing is costly, the best instrument would be the one that would minimize this cost to its lowest. Therefore in an optimal debt contract “no” auditing/monitoring takes place since structure of the contract is in such a way that if creditors receive their return, they have no reason to audit or monitor (i.e. making the debt contract information insensitive). A discussion of this point can be found in Admati et al (2013).

The second one is the concept of bankruptcy. Upon arrival of negatively enough shocks firms declare bankruptcy. This simplification overlooks a very rich legal literature on how bankruptcy law affects the filing of the firms and how firms might react to the law. It is a well known fact that firms are not filing on time and by the time which they file in, a substantial value of their assets has gone. Legal scholars have extensively argued the matter (Schwartz 1998; 1999 among others).

Perhaps the detailed legal concepts are not needed in macro-finance models, but what those legal concepts argue is the “presence of some form of negotiations”. By over looking the possibility of renegotiation, the incentive constraint of borrowers become tight. This means that for a firm to “declare bankruptcy” the shock must be “big” enough and it amplifies the shock more than what it should. I address this problem in my work by considering how legal fines and monitoring relax the incentive constraint ³.

²Carlstrom and Fuerst (1997) were among the very first to have generalized the costly state verification within a general equilibrium framework. However their framework was generating wrong movements between net-worth and asset prices, i.e. a fall in net-worth due to less available capital, was shifting capital supply curve to the left hence increasing the prices. This caveat has been solved by Bernanke, Gertler and Gilchrist (1999), by outsourcing the capital formation to capital producers with convex adjustment costs. The framework is then embedded in complex macroeconomic models notably in the works of Christiano et al (2010); (2014).

³An interesting work that goes deeper in the costly-state verification is the work of Haubrich (1995). Auditing albeit stochastic Mookherjee and Png (1989) or deterministic Diamond (1984a) implicitly assume that monitoring and auditing generally assumes perfect signals about the underlying state. Haubrich (1995) argues relaxing that assumption has some intriguing consequences and argues that most imperfect audits turn out to be useless and those that are useful cannot be ranked by conventional criteria such as Blackwell’s information measure. Moreover, given the structure of the debt contract, any possibility of auditing in the “no-auditing” region basically increases the return threshold which increases the leverage. Bolton and Dewatripont (2005) argue that any contract with “disconnected” audit subsets would be inefficient since an “obvious improvement is

However the core of the costly-state-verification mechanism is still based on the possibility that borrowers might still announce the lowest possible income realization instead of actual realization and pocket the difference ⁴. The dynamic implication of that on the supply side of the credit has been investigated in macro models introduced by [Gertler and Kiyotaki \(2010\)](#); [Gertler and Karadi \(2011\)](#). [Gu et al \(2013b\)](#); [\(2013a\)](#) study endogenous credit cycles in an environment where some agents have incentives to divert the return ⁵.

The deviation of this work compared to the literature are the followings. Both generation of models, i.e. financial accelerator (or friction on the demand side) or perception of fear of misconduct on the supply side of the credit do not generate any “off-equilibrium” behaviors in expectation. However, I deviate by introducing explicitly how monitoring and legal punishments affect the “on-equilibrium” behavior and how they relax the incentive constraints of bankers.

By introducing legal uncertainties, the fragility of the economy increases. It is worth mentioning how fragility is defined in the current frequently used macro-finance frameworks. In BGG, the fragility is the premium over bankruptcy governed by the auditing cost ⁶. In models by [Gertler and Kiyotaki \(2010\)](#); [Gertler and Karadi \(2011\)](#) the source of fragility is due to the fear creditors would have of banking operations. This fear, as it never realizes on the equilibrium, affects the equilibrium level of lending. In this work, I also show a third source of fragility due to the legal available by shifting to a connected subset with the same probability mass. Such shift would make it possible to increase the return and therefore to raise the “expected” audit repayments. The higher expected payment thus generated would relax the participation constraint.

⁴Models based on the concept of return diversion are widely used in partial and general equilibrium set-ups. These models usually refer to the fact that firms divert some returns as in [Azariadis and Smith \(1998\)](#) or [DeMarzo and Fishman \(2007\)](#).

⁵Another strand of literature focuses more on the banking sector embedded in macro-finance models. A natural extension was to use the costly-state-verification in the banking environment such as the work of [Hirakata, Sudo and Ueda \(2009\)](#). Now additional to entrepreneurs, bankers or financial intermediaries were also facing idiosyncratic risks. Hence a chain of contracts appear and in a sequential way, intermediaries net-worth is not enough to meet the demand and pledge collateral before household to intermediate the credit. Models such as [Brunnermeier and Sannikov \(2014\)](#) focus on a dynamic moral hazard problem embedded in a macro-finance framework to achieve asymmetrical response to shocks. Other combinations of BGG and [Gertler and Kiyotaki \(2010\)](#); [Gertler and Karadi \(2011\)](#) the work of [Christiano and Ikeda \(2011\)](#) can be mentioned, where author investigate the government policies. In terms of credit market perfection, works such as [Adrian and Song Shin \(2010\)](#); [Curdia and Woodford \(2010\)](#) have investigated the impact of financial intermediaries or in general credit imperfections for models designed for central banks. The fundamental work of [Kiyotaki and Moore \(1997\)](#), which can be categorized under the group of models designed for credit frictions on the demand side, have been implemented in macro-models and the notable examples are [Gerali et al. \(2010\)](#) and [Iacoviello \(2014\)](#).

⁶Lower steady-state spread in BGG instead can be achieved by changing the bankruptcy or auditing cost. By increasing the bankruptcy/auditing cost, in BGG the spread falls because of diminishing returns out of bankruptcy

uncertainties. This source of fragility manifests itself as a form of longer recovery rate. I argue this could be due to marginal return of assets. Regulations affect the recovery of an economy through its impact channel on the marginal return on asset. If higher quality of assets are obtained through tough regulation, since it makes the banking operations more tight, it affects the spread.

3 Legal Settlements

It is natural to ask how legal settlements are set. Karpoff and Lee (2010) have depicted the steps taken by the Securities Exchange Commission (hereafter SEC) for enforcement action. There are two time periods. There is a violation-to-revelation period, the time the violation starts taking place or the misconduct to the time that the violation gets revealed. The trigger event can be anything such as a whistleblowing. Then the initial filing of a private lawsuit takes place, which is the start of enforcement events period. In this period there will be inquiries, investigation event, wells notices. After these the initial regulatory proceedings take place which are consisted of multiple proceedings events. Finally once proceedings events are concluded with the parties, a deal gets sealed and announced. Banks are obliged to honor their legal obligations since these payments will go to those who have financially suffered.

Given this timeline the announcement of a legal fine comes right after the violation period and the period in which regulators are conducting their proceedings. Since from the trigger event to the final conclusion it takes months if not years, it is then natural to think whether or not banks (or defendants in general) set aside provisions for their “contingent legal liabilities”. It would also be interesting to see how such provisions are argued from the financial stability perspective.

From financial stability perspective, litigation costs and settlements fall within the category of “operational loss” and according to the Basel agreements banks are obliged to hold capital against their operational losses. A report by the Basel Committee for Banking Supervision (BCBS, 2014) states that “despite an increase in the number and severity of operational risk events during and after the financial crisis, capital requirements for operational risk have remained stable or even fallen for the standardized approaches.” According to the Basel regulatory capital agreements, banks need to hold capital. For example Despite a huge legal settlement in 2013, JP Morgan managed to put aside 400 billions of operational risk risk weighted asset to address potential

losses from human error, external threats, “fraud and litigation”. The same argument applies to other banks as well. Given this regulatory capital, this means usually fines are “expected” well in advance. This is a feature that I would be using in my model.

Moreover regulatory fines, lawsuits and demands for customer redress for various types of misconduct are treated as “idiosyncratic”, i.e. specific to banks themselves hence operational risk control is usually regarded as a microprudential aspect of financial stability. However, this assumption can be challenged in a sense that, in recent episodes, banks have been fined multiple times and by several regulators. To explore this I have hand-collected the data on major financial banking legal settlements from different channels (Sources such as Financial Times, Securities Exchange Commission (SEC), FDIC, Reuters, Wall Street Journal, Department of Justice), and documented to which regulatory entity they have paid the fine. For the sake of brevity, I report only three here and the rest are relegated to the Appendix.

Figures show a very striking pattern in terms of the capacity of regulatory entities for imposing fines. Department of Justice (hereafter DoJ) has imposed nearly 50 billion dollars on banks, whereas one would have thought misconducts are usually monitored by the Security Exchange Commission (SEC). SEC imposed around 4 billion at the same level of New York Financial Department. These fines are usually transferred to “Fairs Fund” aiming at redressing those who have lost money or their investment due to financial misconducts.

Several interesting facts can be argued here. First legal fines have frequently been imposed on banks by multiple regulators. Since there are multiple regulators with different incentives of enforcement and monitoring capacities, I have not explicitly introduced regulators in the model. Second legal fines are paid back to investors and finally banks put aside provisions to cover their legal liabilities. This means ex-ante banks know they will end up paying some fines ⁷. I use this piece of information in my modeling.

⁷The best survey that I have found that explicitly asks from bank managers regarding their contingent liabilities is the European “[Risk Assessment of the European Banking System 2015](#)” In the survey bankers are asked regarding their contingent liabilities and they have systematically increased their provisions in the past years.

4 Some Empirical Evidence

Investigating the impact of legal fines is a difficult task due to lack of credible data. Banks and financial intermediaries are not very keen in disclosing their legal settlements like how such settlements are financed and perhaps some hints on their gains from such misconducts, if any. Ideally one expects to have a database, where banks are subject to some legal fines (or settlements) and how such fines have affected the corporate spread they charge on the newly issued loans. Such database does not exist to the best of my knowledge. However we could still look at how in general aggregate fines can affect corporate loan spreads. The face value of such settlements are depicted in Fig 1.

The major element in which banks have paid substantial amount of fines is about subprime lending. Some of these fines came with the acquisitions intermediaries had made during the crisis (such as Bank of America acquisition of Merrill Lynch or JP Morgan and that of Bear Stearns and Washington Mutual)⁸. Market manipulation through futures (exchange or commodities) is another source of investigation for regulators. The notable case was LIBOR, the worldwide benchmark rate for overnight banking activities and short term funding (i.e. repos). LIBOR is also used as an indicator of the overall health of economy. Violation of sanctions and some activities in money laundering are another source for regulators to probe banks.

Once having compiled such aggregate quarterly time series I investigate its “correlation” with spread. Time series need to be deflated by the total assets or total equity. The plots are depicted in figures 4 and 5. For spread I have used Moody’s BAA (and other investment grades) corporate spread. The scatter plot shows there seems to be a negative relationship between the aggregate spread and deflated fines.

It can be argued that announcement made by legal and regulatory watchdogs usually come as a surprise so it is to some extent safe to assume that the variations of legal fines are exogenous. By

⁸

However those acquisitions took place with some form of government aids such as assuming a portion of the acquirees’ toxic assets, like in the case of Bear Sterns or loss sharing. According to then-secretary of Treasury, Henry Paulson, “Bank of America’s deal closely resembled Citigroup’s. The government would invest 20 Billion of TARP money in preferred stock paying an 8 percent dividend. BoFA would absorb the first 10 billion of losses on a 118 billion pool of loans and mortgage-backed securities. Losses beyond that would be split 90/10 between government and BoFA”

assuming the arrival of legal liabilities exogenously, I can investigate the correlation that it induces with the spread at loan levels. To investigate this idea, I use a rich database on loans compiled by Thomson Reuters known as DealScan. The results are brought in the appendix. Results show that in an environment, in which legal fines were frequently imposed, the loans issued by banks seem to have been falling controlling for firms and loans' characteristics.

5 Model

5.1 Static

To illustrate the point how legal uncertainties, especially legal fine affects the efficiency of the financial friction, the model developed by [Christiano and Ikeda \(2011\)](#) shall be borrowed. The model is composed of bankers and households. For simplicity the owner of banks are households (a fraction of them become bankers) and bankers have to maximize the profit and transfer this profit at the end of period to their representative household (i.e. Π). In period one agents consume c_1 with a given endowment y and make deposit d . In the second period they will get c_2 financed by the remuneration on their deposit (i.e. $R_d d$) and a profit returned by banks (i.e. π). In a perfect financial environment the amount of deposit issued by banks meets the supply without any problem. The household maximization is then given by

$$\max u(c_1) + \beta u(c_2) \text{ where } u(c) = \frac{c^{1-\sigma}}{1-\sigma} \quad (1)$$

$$c_1 + d \leq y \text{ and } c_2 \leq R_d d + \Pi \quad (2)$$

The optimization yields the conventional inter-temporal condition of consumption (or the Euler equation) and the level of deposit will be $d = y - c_1$. Going through the maximization one can show that c_1 falls as rate on deposit increases, which also holds for the case of log-utility ($\sigma = 1$). On the bank's balance sheet, there is deposit issued (demanded) by banks d_b , net-worth N and assets s . The assumption is that the bank pledges its net-worth to issue securities. Therefore the following accounting identity must hold: $s = N + d_b$. Banks make a profit of $\Pi = R_k s - R_d d_b$. The demand of deposit is simply the maximization of the profit function $\max_{d_b} \Pi$. They charge R_k on assets issued. One can think of assets on the banks balance sheet as firms securities, which these

securities determine the level of capital firms would have to produce. It can be shown that in this environment where deposit markets are clearing (i.e. $d = d_b$) and securities markets are clearing (i.e. $s = N + d_b$) then it has to be that ⁹:

$$d^* = \frac{y (\beta R_k)^{\frac{1}{\sigma}} - N R_k}{(\beta R_k)^{\frac{1}{\sigma}} + R_k} \quad (3)$$

$$0 \leq d \leq y$$

However, when there is financial friction it creates a wedge between the amount of deposit issued and amount of deposit supplied. This wedge manifests itself in the equilibrium level of deposit. The friction here is now bankers have an incentive to divert a fraction of their assets for their personal gains in the following way

$$\underbrace{R_k (d_b + N) - R_d d_b}_{\text{The franchise value of the firm}} \geq \underbrace{\theta (d_b + N) R_k}_{\text{Diversion threshold}} \quad (4)$$

The RHS of the equation 4 can be best thought as a default threshold. Diversion increases the default threshold in expectation. It is worth mentioning that in equilibrium no diversion takes place since equilibrium condition resembles to the situation where the franchise value would be equal to the default threshold, leaving the banker indifferent between honest working (i.e. keeping its franchise value) or absconding a fraction of fund and run away. However the fear of such default changes the equilibrium level of deposit, i.e. d . Rearranging the incentive compatibility constraint in the following way gives us:

$$(1 - \theta) N R_k \geq [\theta R_k - (R_k - R_d)] d_b \quad (5)$$

$$d_b = \frac{(1 - \theta) N R_k}{[R_d - (1 - \theta) R_k]} \quad (6)$$

The level of deposit issued by bank is then defined by equation 6. d_b is a decreasing function of R_d for the bank and is defined over $((1 - \theta) R_k, R_d]$. d_b would be $(\frac{1-\theta}{\theta}) N$ when $R_k = R_d$ and then it would become a decreasing function. When $R_k = R_d$, i.e. when there is no spread, demand

⁹Derivations are relegated to the Appendix.

becomes elastic and will no longer become reactive to the rate. The function is depicted in the Figure - 6 and 7. The maximum level of diversion which could take place, i.e. θ^{max} is pinned down by the no spread region. When $R_k = R_d$ with clearing condition for the deposit market we have:

$$\left(\frac{1-\theta}{\theta}\right)N = \frac{y(\beta R_k)^{\frac{1}{\sigma}} - NR_k}{(\beta R_k)^{\frac{1}{\sigma}} + R_k} \Rightarrow$$

$$\left(\frac{1}{\theta} - 1\right) = \frac{\frac{y}{N}(\beta R_k)^{\frac{1}{\sigma}} - R_k}{\underbrace{(\beta R_k)^{\frac{1}{\sigma}} + R_k}_B} \Rightarrow \theta^{max} = \frac{1}{1+B}$$

Corollary : (Christiano and Ikeda, 2011) A necessary and sufficient condition for the spread, $R_k - R_d > 0$ to exist in equilibrium is to have $\theta > \theta^{max}$.

Proof : In the Appendix.

The existence of a positive premium depends on how large θ is relative to θ^{max} . Thus the difference between θ and θ^{max} measures how efficient the equilibrium is. The larger the relative difference, the larger the spread that bankers will charge. However any changes that increase the θ^{max} decreases the relative difference between θ and θ^{max} which yields into a lower spread, which is interpreted as relaxing the incentive compatibility constraint. We consider several different set-ups to investigate how the lower bound θ^{max} changes.

(I) Possibility of legal settlement

Suppose bankers are now maximizing with respect to the following incentive constraint:

$$R_k(d_b + N) - R_d d_b \geq \theta(d_b + N)R_k + \underbrace{\pi \cdot 0 + (1-\pi)(-\theta(d_b + N)R_k)}_{\text{Legal fine}} \quad (7)$$

$$R_k(d_b + N) - R_d d_b \geq \pi\theta(d_b + N)R_k \quad 0 < \pi < 1$$

Rearranging the above incentive constraint and when $R_d = R_k$ yields the following:

$$\left(\frac{1-\pi\theta}{\pi\theta}\right)N = \frac{y(\beta R_k)^{\frac{1}{\sigma}} - NR_k}{(\beta R_k)^{\frac{1}{\sigma}} + R_k} \Rightarrow \left(\frac{1}{\pi\theta} - 1\right) = \frac{\frac{y}{N}(\beta R_k)^{\frac{1}{\sigma}} - R_k}{(\beta R_k)^{\frac{1}{\sigma}} + R_k}$$

$$\left(\frac{1}{\pi\theta} - 1\right) = \frac{\frac{y}{N}(\beta R_k)^{\frac{1}{\sigma}} - R_k}{(\beta R_k)^{\frac{1}{\sigma}} + R_k} \Rightarrow \theta_{\pi}^{max} = \left(\frac{1}{1+B}\right)\left(\frac{1}{\pi}\right) \quad 0 < \pi < 1$$

Since $0 < \pi < 1$ it follows that $\theta_{\pi}^{max} > \theta_{\pi=1}^{max}$, i.e. the lower bound for θ when there is a

possibility of legal fine increases. Graphically the changes due to legal fines are depicted in Fig. 6 and 7. What happens is that the probability of some legal settlement increases the no spread region (shaded as green in Figure 2 - first panel) since $(\frac{1-\theta}{\theta}) < (\frac{1-\pi\theta}{\pi\theta})$. Due to this increase in the no spread region the necessary θ_{π}^{max} should increase to have a positive spread. In other word, if one interprets θ_{π}^{max} the level of moral hazard, what legal fine does is that it increases the difficulty of having a moral hazard situation, by increasing the lower bound for θ_{π}^{max} . This is an improved situation compared to the case of $\theta_{\pi=1}^{max}$. Another way of interpreting θ is the necessary margin in the spirit of [Geanakoplos \(2010\)](#). Since θ is the outcome of credit supply and demand of households and bankers respectively, it can be thought that bankers are pledging $1-\theta$ to the household, which is what they would recover had bankers diverted the fraction θ . This also means in an environment in which $\theta_{\pi}^{max} > \theta_{\pi=1}^{max}$ bankers are required to pledge less. Therefore, legal fines can potentially reduce the pledgeability level for bankers, which is equivalent of saying the incentive constraint of bankers have been relaxed.

However, spread appears when the degree of moral hazard is big enough. To put in another way, θ_{π}^{max} represent in an aggregate way the plausible moral hazard that can be committed by intermediaries, i.e. it is the moral hazard level which up to that point no spread is needed. However when there are some possibilities for legal settlements, this no-spread region expands. Basically this means, many of banking activities that constitute the parameter θ_{π}^{max} would now fall in a region which it will require no spread. This can be interpreted as giving more flexibility or degree of freedom to intermediaries in terms of their banking activities because there is an implicit utility bankers are drawing from their operations. Since the no-spread region has expanded, the range of banking operations for which a spread is necessary decreases, hence leading into a reduction in spread. This reduction in spread is technically considered as an increase in the efficiency of financial friction as shown in the Corollary.

This simple framework can also shed some light on why according to some claims, fines are small. This can be observed by slightly modifying the above incentive constraint:

$$R_k(d_b + N) - R_d d_b \geq \theta(d_b + N)R_k + \pi \cdot 0 + \underbrace{(1 - \pi)(-\theta\kappa(d_b + N)R_k)\kappa}_{\text{Legal fine}} < 1 \quad (8)$$

$$R_k (d_b + N) - R_d d_b \geq \theta (d_b + N) (1 - \kappa + \kappa\pi) R_k \quad \kappa < 1$$

$$\theta_\pi^{max} = \left(\frac{1}{1+B} \right) \left(\frac{1}{1-\kappa+\kappa\pi} \right) \quad 0 < \pi < 1$$

Simulations are reported in Fig. 8, which show why fines are usually smaller than what they are perceived, since depending on different values for κ and π different multipliers for the lower bound of θ^{max} shall be obtained. From the Fig. 8 we can learn that the boundary for the plausible moral hazard shifts by a factor of 1.95 and 1.06 for values of π of 0.1 and 0.9 respectively keeping κ constant at 0.55. Basically, if one takes into account the trade-off between the plausible range of banking activities that constitute the moral hazard level and the spread, then fines should be set to achieve a middle-ground.

(II) Government intervention with legal settlements

As a point of discussion, it is worth investigating how changes to the LHS of the constraint affects the lower bound for θ^{max} . Government unconventional policies such as liquidity injection basically increases the LHS of the banker's incentive compatibility constraint. Relying on the insight borrowed from Christiano and Ikeda (2011), let's consider a situation where government purchase assets from banks, like the unprecedented policies committed by the Fed throughout the crisis initially through Troubled Assets Repurchase Program (or TARP) and other quantitative easing policies. The idea is to investigate, what level of tax-finance should be levied to replicate θ_π^{max} and its properties.

The time line is the following. In period (1) households consume and deposit given their production level net of taxes. Government collects the tax receipts and inject them directly in the first period balance-sheet of the bank. In period (2), households consume and bankers send profits to governments and households. Suppose government purchases $N_g = T$ financed by a lump-sum tax, T . The net-worth of banks becomes $\tilde{N}_g = N + N_g$ where N is the net-worth of banks as before. Banks by combining their net-worth and liabilities purchase $s = \tilde{N}_g + d_b$ securities. The profit due to household is $\tilde{\pi} = R^k (\tilde{N} + d_b) - R_d d_b$. Since government intervention does not come freely, government tries to secure its profit on the other end of the bargain, meaning that $\tilde{\pi}$ is now split between banks and government, according to a rule of thumb, $\pi_g = \omega_g \tilde{\pi}$ and $\pi_b = \omega_b \tilde{\pi}$. The

incentive constraint takes the following form

$$\pi_b \geq \theta \left(\tilde{N} + d_b \right) R_k - \delta \pi_g$$

where δ captures how strong a government is in terms of protecting its own stake in banks. The above constraint resembles to that of 7. A legal fine reduces the RHS very much like the strength of government in protecting its own stake. After solving the banker's problem we arrive at the following level of moral hazard :

$$\theta_\delta^{max} = \frac{(N + N_g)(1 - (\delta - 1)\omega_g)}{N + y} \left(1 + R_k (\beta R_k)^{-\frac{1}{\sigma}} \right)$$

Suppose the government is strong in terms of protecting its own stakes, i.e. $\delta = 1$. We have then

$$\theta_{\delta=1}^{max} = \frac{(N + N_g)}{N + y} \left(1 + R_k (\beta R_k)^{-\frac{1}{\sigma}} \right)$$

The level of moral hazard increases with N_g i.e. the more equity government injects into bank's balance sheet, it makes the lower bound for $\theta_{\delta=1}^{max}$. However what level of tax would give us the same θ_π^{max} is interesting to investigate. By equating the two θ_π^{max} and $\theta_{\delta=1}^{max}$ we arrive at the condition of

$$N_g = T = \left(\frac{1}{\pi} - 1 \right) N \Rightarrow \pi = \frac{N}{N + N_g}$$

The above equality says, if the government wants to achieve the desired $\theta_{\delta=1}^{max}$ it can do so by injecting tax-financed equity but this would then be equivalent of a framework where the probability of retrieving absconded fund decreases (i.e. it is less likely to retrieve the forgone fraction of assets). The same goal can be obtained by increasing the probability of retrieving (or clawing back the foregone fraction of funds) which is then equivalent in a framework in which government uses less tax-financed equity injection. Suppose we have a punitive government, a one that receives premium on earnings from total assets ¹⁰. This is equivalent of saying the share of government in profit increases, i.e. ω_g increases. However, in the case of a strong government,

¹⁰Indeed this was one of the ideas put forward by the Senate Banking Committee before passing the TARP bill, i.e. government should receive premium on their purchased assets or to put it differently the idea was government becomes a quasi-insurance entity for tourbled banks. This idea along side a long list of other provisions such as purchasing assets in form of tranches and tax on compensation packages crippled the bill negotiations, hence the bill failed to pass the Senate in its first pass-through.

i.e. the one that protects its stakes that bankers, if decided to default cannot default on the government's tax-financed purchases (i.e. taxpayers are protected), it would have no impact on θ .

Above the legal fine is designed exogenously. One could argue that the act of exerting legal fine is costly. This cost can be financed through taxes. Despite the fact that diversion never takes place in equilibrium, the commitment of the government in terms of injecting equity and allocating resources to retrieve the possible absconded amount, will make the probability of retrieving of the fund a function of how much resources government has. In this regard, suppose government in period (1) taxes the household, and a fraction of this is then consumed for the first period equity injection. Hence we have, $N_g \leq \nu_g T$. The cost in the second period for retrieving the fund cannot exceed from the available resources in the second period, $\pi \leq (1 - \nu_g)T$, assuming the more you spend (i.e. cost) the probability of retrieving the fund increases linearly. Let's assume the government has a utility of the form $U(g) = u(T) - \frac{1}{2}\beta\pi^2$, where government is receiving a concave positive utility from maximizing over the taxes it receives (same utility form as the household), and a concave cost function discounted in the second period and suppose the government is entitled to no profit in the second period, i.e. $\omega_g = 0$. The banker's optimization remains as before, therefore we have the following :

$$\theta_\delta^{max} = \frac{(N + N_g)}{N + y} \left(1 + R_k (\beta R_k)^{-\frac{1}{\sigma}}\right) \left(\frac{1}{\pi^*}\right)$$

$$\pi^* = \frac{1}{\beta} \left(\frac{1}{T^\sigma}\right)$$

The higher the tax, less resources would be spent on retrieving the funds. This reduces the probability but instead increases the θ_δ^{max} . This is equivalent of saying, government by a policy of injecting equity and posing legal fines, makes the lower bound for moral hazard even higher, i.e. making the financial friction more efficient.

(III) Partial Monitoring

The question for partial monitoring is interesting to investigate. Suppose without loss of generality, monitoring can be conducted costlessly. Suppose once a fraction of fund is absconded, the intermediary operates although by inflating its continuation asset. The incentive constraint of the intermediary takes the following form:

$$R_k(d_b + N) - R_d d_b \geq \theta(d_b + N)R_k + \underbrace{(1 - \pi)(\kappa(1 - \theta)(d_b + N)R_k - R_d d_b)}_{\text{Franchise value after misappropriate conduct}} \quad (9)$$

κ is the appreciation parameter. Any diversion, the remaining franchise value needs to be booked in an appreciated way ¹¹. Let's assume $\kappa > \frac{1}{1-\pi}$. Knowing the deposit supply function, the incentive constraint will be :

$$sR_k(1 - \kappa + \kappa\pi) - \pi R_d d \leq \theta sR_k(1 - \kappa + \kappa\pi)$$

knowing that $s \geq d + N$ plus $R_k = R_d$, we have then

$$s(1 - \kappa + \kappa\pi) - \pi d \leq \theta s(1 - \kappa + \kappa\pi)$$

For the sake of exposition, let's define $\xi = (1 - \kappa + \kappa\pi)$. θ^{max} in this case will be then governed by the following:

$$\theta^{max} = 1 - \frac{N}{(y + N)} \frac{\pi}{\xi} \left(\frac{y}{N} - R_k (\beta R_k)^{-\frac{1}{\sigma}} \right)$$

The interesting point is that $\frac{\partial \theta^{max}}{\partial \pi} < 0$, i.e. as monitoring capacity increases, θ^{max} falls which increases the spread. Whereas, as monitoring becomes less stringent, θ^{max} increases and makes the financial friction more efficient. This counterintuitive result can be explained in the following sense that, if the level of moral hazard decreases, then the only instrument at bankers' disposal to make profit would be the spread and therefore they will charge a higher spread if the bar on θ falls (to make the business more appealing). However, lax monitoring increases that bar and this gives them more degree of freedom which shows itself as a fall in spread.

¹¹There are many examples that intermediaries following their misappropriate conduct, appreciate their asset in their continuation franchise value. The following example illustrate the point. Intermediaries usually hold illiquid assets. The accounting rule for illiquid asset was to book the price-paid for those assets. Intermediaries would then assume profits if at the time of sale market prices were higher, and vice versa. However, in 2007 it has changed when a new accounting rule "FAS 157" was enacted. Now if a bank owned illiquid assets, it had to account for that asset in the same way it would a stock. If the market went up, intermediaries would assume a write up and if market went down they should write down. This accounting rule permitted firms to write down less and even sometimes they write up. A notable case is the one committed by Lehman Brothers in their "Repo 105" transaction. Basically, Lehman was arguing was that if the underlying collateral of their repo transaction was 105 percent more than the original amount of transaction, then instead of booking repos as liabilities, they booked them as assets, artificially inflating their balance sheets.

5.2 Dynamic

Knowing the properties of legal uncertainties from the static model, I then investigate the concept within a dynamic framework. The predictions from the static model say two points. In presence of legal uncertainties (i) the plausible range of θ increases (ii) spread decreases. We expect that the steady-state of θ in the model with legal uncertainties would be higher in a case with no legal uncertainties, which we would then expect to see a change of dynamic in the model. In the dynamic set-up I only consider the case with no government intervention.

The model relies on the framework introduced by [Gertler and Kiyotaki \(2010\)](#). The physical setup of the model is composed of firms of mass unity located on a continuum of islands. Each firm produces according to an identical Cobb-Douglas production function Y_t with capital K_t and labor L_t as inputs. Capital is not mobile but labor is mobile across islands. Because of this labor mobility, the aggregate production function can be expressed as:

$$Y_t = A_t K_t^\alpha L_t^{1-\alpha} \quad (10)$$

where α is the elasticity of capital share in aggregate production, A_t is aggregate productivity shock which follows a Markov process of order one. To motivate liquidity shortage across islands, investment opportunities arrive randomly at a fraction π^i of islands. This liquidity need by firms has been explained in details by [Kiyotaki and Moore \(2012\)](#). This investment opportunity also implies investment probability due to the law of large numbers.. The arrival of investment opportunities is *i.i.d* across time and across islands. If I_t denotes aggregate investment and δ the depreciation of capital, the law of evolution of capital would be:

$$K_{t+1} = [I_t + (1 - \delta) K_t] \quad (11)$$

Competitive producers across different islands operate a constant returns to scale technology with capital and labor. Since labor is perfectly mobile the wage satisfies the following equation:

$$W_t = (1 - \alpha) \frac{Y_t}{L_t} \quad (12)$$

The gross profit per unit of capital could then be written as:

$$Z_t = \frac{Y_t - W_t L_t}{K_t} = \alpha A_t \quad (13)$$

Aggregate output is made up of aggregate household's consumption C_t , investment expenditure and government expenditures G

$$Y_t = C_t + \left(1 + f\left(\frac{I_t}{I_{t-1}}\right)\right) I_t + G \quad (14)$$

where, $f\left(\frac{I_t}{I_{t-1}}\right) I_t$ reflects physical adjustment costs such that $f(1) = f'(1) = 0$ and $f''\left(\frac{I_t}{I_{t-1}}\right) > 0$ ¹².

Household's preference function is a standard New Keynesian utility function with external habit formation in consumption and dis-utility part from working. The expected discounted value of preference is given by

$$\mathbb{E}_t \sum_{i=0}^{\infty} \beta^i \left(\ln(C_{t+i} - \gamma C_{t+i-1}) - \frac{\chi}{1+\varepsilon} L_{t+i}^{1+\varepsilon} \right) \quad (15)$$

where β is the discount factor, χ is the weight of dis-utility from working, ε is the inverse Frisch elasticity of labor supply and γ denotes the external habit.

To introduce financial intermediaries in a tractable framework, there is a representative household with a continuum of members of measure unity. Within the household there are $1-f$ workers and f bankers. f is an *i.i.d.* draw that determines whether the household members are bankers or workers. This *i.i.d.* probability by the law of large numbers is also the fraction of bankers within the household's member.

Households deposit funds in banks (i.e. financial intermediaries). Deposits are riskless one period securities. Households may also hold riskless one period government debt, which is a perfect substitute for bank deposits. Households maximize their utilities with respect to the following budget constraint:

$$C_t + D_{ht+1} + T_t = W_t L_t + R_t D_{ht} + \Pi_t \quad (16)$$

where D_{ht} denotes the quantity of riskless debt held, R_t is the gross return on riskless debt, Π_t

¹²These restrictions make the aggregate production function of capital goods producers decreasing returns to scale in the short-run and constant returns to scale in the long-run.

is the net distribution from ownership of both banks and non-financial firms and T_t is lump sum tax. The right hand side of the above equation represents the current aggregate consumption, the purchases of next periods riskless debt and lump sum taxes which should be financed from the revenue earned on supplying labor, income from depositing funds at banks and the distributed net profit.

Capital producers operate in a national market, they make new capital using input of final output and subject to adjustment costs. They sell new capital to firms on investing islands at the price Q_t^i . Given that households own capital producers the objective of a capital producer is to choose I_t such that:

$$Max \mathbb{E}_t \sum_{t=\tau} \Lambda_{t,\tau} \left\{ Q_\tau^i I_\tau - \left[1 + f \left(\frac{I_t}{I_{t-1}} \right) \right] I_t \right\} \quad (17)$$

From profit maximization and by specifying a quadratic adjustment cost, the price of capital goods is equal to the marginal cost of investment goods production as follows:¹³

$$Q_t^i = \left(1 + \frac{\psi}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 \right) + \psi \frac{I_t}{I_{t-1}} \left(\frac{I_t}{I_{t-1}} - 1 \right) - \mathbb{E}_t \psi \Lambda_{t,t+1} \left(\frac{I_{t+1}}{I_t} \right)^2 \left(\frac{I_{t+1}}{I_t} - 1 \right) \quad (18)$$

, where ψ is the investment adjustment parameter.

5.2.1 Financial Intermediaries

Financial intermediaries, or bankers raise deposits from depositors and extend them to firms. Banks extend loans by purchasing firms' securities and there are no friction between them¹³. To finance lending in each period, banks raise funds from households who are also workers. At the beginning of the period, each bank raises deposits d_t from households in the retail markets, which are to be remunerated at riskless rate R_{t+1} . With an interbank borrowing b_t^h and deposit d_t they issue equity (to firms) s_t^h at price Q_t^h , where h stands for the type of island the intermediary is situated.

Financial intermediaries face different risks. First is the liquidity risk. There are two types of islands and the investment opportunities arrive randomly with an exogenous probability for investment π^i . Bank who are located on the island with the newly arrived investment opportunities

¹³For a framework which studies a model of [Gertler and Karadi \(2011\)](#) à la [BGG \(1999\)](#) refer to [Rannenberg \(2012\)](#).

face liquidity risks since they have to finance both the current and newly arrived investments. Second, the effect of this liquidity risk is severe due to limited market participation in the spirit of [Allen and Gale \(1997\)](#). This is because banks are allowed to lend loans only to firms on the same island and they cannot raise more funds from depositors due to the limited market participation. Hence to finance their existing and newly arrived investment projects, banks on the investment island need to borrow funds from an interbank market.

Since bankers are financially constrained they will continue accumulating assets and wealth. In presence of no motivation for paying dividends, they may find it optimal to accumulate wealth up to a point where their financial constraint would no longer be binding. To rule out this situation, with an *i.i.d.* probability $1 - \sigma$ bankers become workers, which gives an average survival rate of $\frac{1}{1-\sigma}$. Upon exiting a banker transfers retained earnings to the household and becomes a worker. Therefore, in each period $(1 - \sigma) f$ workers become bankers, keeping the number in each occupation constant. Each new banker also receives a start-up fund from the family it belongs, to start the banking business. This start-up transfer is funded from the total assets of the family¹⁴.

Bankers are subject to an endogenous constraint for raising funds. The constraint comes from a fear that bankers might divert funds from their assets for their personal use. Asset diversion is practically simpler compared to deposit diversion since bankers need to service their deposit on a regular basis. Hence deposit diversion cannot remain undetected according to [Calomiris and Kahn \(1991\)](#). The operation of the bank can be summarized in the following way: first intermediaries raise deposit and intermediate them to firms through a perfect equity contract. Second the pay dividends at the end of the period to their family households, which enters into their budget constraint. Bankers will therefore try to optimally choose a balance-sheet configuration composed of deposits, assets, interbank borrowing and net-worth to reach an end of period dividend, by maximizing the dividend with respect to the financial constraint. Suppose the bank's franchise value is designated by $V_t(s_t^h, b_t^h, d_t)$ a function of s_t^h securities purchased, b_t^h interbank borrowing and d_t deposit. The financial constraint can be written:

¹⁴This exogenous birth and death of intermediaries is widely used for example in the work of [Bernanke, Gertler and Gilchrist \(1999\)](#).

$$V_t(s_t^h, b_t^h, d_t) \geq \underbrace{\theta_t (Q_t^h s_t^h - \omega b_t^h)}_{\text{The possible divertable amount}} \quad (19)$$

θ_t is the adverse financial shock and its steady state value governs the amount that can be diverted. It captures the perception of fear explained above. Bankers have the possibility to divert θ of this fraction as in [Diamond \(2004\)](#), i.e. fraction that bankers can divert without leaving any tracks of their actions. The shock represents an aggregate financial shock as in [Dedola, Karadi and Lombardo \(2013\)](#), which can be viewed as involving the loss of confidence in the financial sector where depositors believe that it is more attractive for bankers to divert fund. Another similar interpretation of the same shock can be margin shock in the spirit of [Geanakoplos \(2010\)](#). It can be considered as a margin shock, since the constraint is binding in all states and this means that $(1 - \theta)$ is the quantity that measures the pledgeability of the intermediary's assets as in a simple debt contract (which is also what would creditors recover if firm actually diverts). ω represents the interbank market efficiency where if it attains the value of 0 it says the interbank market is completely rigid. This situation resembles well to the collapse of the interbank market during the recent financial crisis.

Bankers solves an optimization problem by maximizing $V_t(s_t^h, b_t^h, d_t)$ with respect to the financial constraint (i.e. Eq 19). Therefore

$$V_{t-1}(s_{t-1}^h, b_{t-1}^h, d_{t-1}) = \mathbb{E}_{t-1} \beta \frac{U_c(t)}{U_c(t-1)} \sum_{h=i,n} \pi^h \left((1 - \sigma) n_t^h + \sigma \text{Max}_{d_t} \left(\text{Max}_{s_t^h, b_t^h} V_t(s_t^h, b_t^h, d_t) \right) \right)$$

with respect to $V_t(s_t^h, b_t^h, d_t) \geq \theta_t (Q_t^h s_t^h - \omega b_t^h)$ (20)

The maximization program makes sure bankers will be indifferent to the island location (i.e. π^h) since the expectation operator is on the location where liquidity risk is amplified. In the dynamic set-up, the expected discounted value of the value function appears in the participation constraint. However, for the class of models in which the expected discounted value appears in the implementation or participation constraint, it is shown by [Kydlan and Prescott \(1977\)](#) that the usual Bellman equation properties are not satisfied. An insightful work of [Marcet and Marimon \(2011\)](#) argue that it is possible to obtain a recursive formulation for a general class of contracting

problems involving incentive constraint. The derivation for a simpler set-up is relegated to the Appendix.

The above problem can be solved by guess and verification process by proposing a linear function of the following form:

$$V_t(s_t^h, b_t^h, d_t) = \nu_{st}s_t^h - \nu_{bt}b_t^h - \nu_t d_t \quad (21)$$

where, ν_{st} is the marginal value of assets t , ν_{bt} is the marginal cost of interbank debt and ν_t is the marginal cost of deposit.

The timing is the following : the aggregate shock is realized, depositor put deposits up to a point to make sure bankers would not have any temptation of diverting assets. This amount is equivalent to the exact level of deposit demanded by the bankers, since they know they cannot demand more since the fear of diversion is strong and depositors may not give anything at all. Bankers then learn on which island they will be located, i.e. they will learn about their liquidity risk. Since bankers have already maximized the end of period dividend with respect to their financial constraint and their island's location, the optimal level of loans will be extended. On the equilibrium no diversion takes place however the fear of diversion affects the equilibrium behavior.

In Eq. 19 there is no monitoring of any kind. To make the impact of monitoring more tangible, we could simply extend the financial constraint by taking into account what could happen following a diversion. Suppose the act of diversion is not always monitored and if it is caught then the franchise value reduces to zero (*à la* Gu et al 2013a; 2013b¹⁵). This is equivalent of loss of reputation or the value of loss rents from future business due to revelations of diversion (Diamond, 1991) Suppose, the probability of being observed is π . Then the incentive constraint changes to the following:

$$V_t(s_t^h, b_t^h, d_t) \geq \theta_t (Q_t^h s_t^h - \omega b_t^h) + \pi \cdot 0 + \underbrace{(1 - \pi) V_t((1 - \theta_t) s_t^h, (1 - \omega \theta_t) b_t^h, d_t)}_{\text{In the event of not getting caught}} \quad (22)$$

¹⁵Authors take into account a simple model where credit arises when one agent needs to deliver the consumption good of the second agent in the second sub-period. This raises a limited commitment problem. They argue that this problem could be observed partially. They also go one step further by endogenizing the probability of getting caught (by minimizing a cost function for auditing firms). However the behavior of auditing firms is not that trivial, since in many cases they provide services other than auditing to their clients.

The right hand side of the incentive constraint has now increased compared to that of 19 where $\pi = 1$, which means the constraint has become more stringent. Bankers now have a higher temptation than before to divert more funds. The right hand side can also be interpreted as a default limit. For imperfect monitoring (i.e. $\pi < 1$) the no-spread expands for intermediaries. I emphasize that on the equilibrium no diversion or monitoring takes place however the probability of monitoring affects the on-equilibrium behavior.

The incentive constraint can be extended to take into account a situation where intermediaries ought to pay a legal fine over their action to creditors. Suppose the legal enforcement is strong enough to recover the diverted amount in the form of a legal fine. The diverted amount cannot be recovered with the probability π^r and with $1 - \pi^r$ it can be recovered. In this node the banker will lose its reputation however the question for creditors is whether anything can be recovered. Legal enforcement changes the the incentive constraint in the following way:

$$\begin{aligned}
V_t(s_t^h, b_t^h, d_t) \geq & \theta_t (Q_t^h s_t^h - \omega b_t^h) + \pi \left(\underbrace{\pi^r \cdot 0}_{\text{Not recovering}} + \underbrace{(1 - \pi^r) (\theta_t (\omega b_t^h - Q_t^h s_t^h))}_{\text{Recovering the diverted amount}} \right) \\
& + (1 - \pi) V_t((1 - \theta_t) s_t^h, (1 - \omega \theta_t) b_t^h, d_t) \tag{23}
\end{aligned}$$

The ability to recover the diverted fund basically decreases the possible divertable amount. The constraint says in expectation bankers can divert more but then depending on the legal enforcement the diverted amount must be returned back to the system. What legal enforcement in the form of a legal fine does to the on-equilibrium behavior is that now since creditors know with a probability they will get back the diverted amount, they will lend higher than before and the moral hazard between depositors and bankers decreases. However this is introduced with an uncertainty. This additional level of uncertainty affects the dynamics of the model.

At equilibrium, total securities issued on investing and non-investing islands correspond to aggregate capital acquired by each type

$$S_t^i = I_t + (1 - \delta) \pi^i K_t \tag{24}$$

$$S_t^n = (1 - \delta) \pi^n K_t \quad (25)$$

Using the above identities, we could infer that $S_t = K_{t+1}$.

We have argued above in order to rule out the condition which the financial constraint of bankers will no longer be binding, some banks terminate their operations (or they die) and some start operating. The evolution of the aggregate net-worth of a bank located in island h is given by

$$N_t^h = N_{et}^h + N_{nt}^h$$

where N_{et}^h and N_{nt}^h represent the aggregate net-worth of existing and newly arrived banks on island h . Net-worth of the existing banks is given by

$$N_{et}^h = \sigma [Z_t + (1 - \delta) Q_t^h] S_{t-1} - R_t D_{t-1}$$

The family transfers to each newly arrived banks a fraction $\frac{\xi}{1-\sigma}$ of the total value of assets of exiting entrepreneurs, implying:

$$N_{nt}^h = \xi [Z_t + (1 - \delta) Q_t^h] S_{t-1}$$

Therefore the aggregated net-worth of a bank located on island h is given by

$$N_t^h = N_{et}^h + N_{nt}^h = \pi^h [(\sigma + \xi) [Z_t + (1 - \delta) Q_t^h] S_{t-1} - R_t D_{t-1}] \quad (26)$$

The balance-sheet of the entire banking system is the following conventional identity:

$$D_t = \sum_{h=i,n} (Q_t^h S_t^h - N_t^h) \quad (27)$$

6 Equilibrium

Labor market clearing condition requires that:

$$(1 - \alpha) \frac{Y_t}{L_t} E_t U_c(t) = \chi L_t^\phi \quad (28)$$

Because of Walras' Law, once the market for goods, labor, securities and interbank loans is cleared, the market for riskless debt will be cleared automatically.

$$D_{ht} = D_t + D_{gt} \quad (29)$$

where D_{gt} is supply of government debt. These equilibrium conditions complete the description of the model.

7 Imperfect Financial Markets

In this work I only consider imperfect interbank markets i.e. $\omega = 0$. This implies to symmetric frictions in wholesale and retail financial market and the bank's ability in diverting becomes independent of the source of financing. The FOC conditions of the problem (20) where constraint is Eq. (22) are :

$$\nu_{bt} (1 + \eta_t^2 \bar{\lambda}_t) - \nu_t (1 + \pi \bar{\lambda}_t) = \theta_t \omega \bar{\lambda}_t \quad (30)$$

$$\lambda_t^h = \frac{\frac{\nu_{st}}{Q_t^h} - \nu_{bt}}{\theta_t (1 - \omega) - \left(\eta_t^1 \frac{\nu_{st}}{Q_t^h} - \eta_t^2 \nu_{bt} \right)} \quad (31)$$

$$Q_t^h s_t^h \leq \frac{1}{\theta_t (1 - \omega) - \left(\eta_t^1 \frac{\nu_{st}}{Q_t^h} - \eta_t^2 \nu_{bt} \right)} \left[(\eta_t^2 \nu_{bt} - \theta_t \omega) n_t^h - (\theta_t \omega - \eta_t^2 \nu_{bt} + \pi \nu_t) d_t \right] \quad (32)$$

where $\eta_t^1 = 1 - (1 - \pi)(1 - \theta_t)$ and $\eta_t^2 = 1 - (1 - \pi)(1 - \omega \theta_t)$. By substituting $\omega = 0$ in the Eq. (30) it yields:

$$\nu_{bt} (1 + \eta_t^2 \bar{\lambda}_t) - \nu_t (1 + \pi \bar{\lambda}_t) = \theta_t \omega \bar{\lambda}_t \Rightarrow \nu_{bt} = \nu_t \quad (33)$$

It means the marginal cost of raising interbank loans and deposits are equal across all islands (regardless of island type). Another implication of this equality is that the interest rate of the interbank bank market would be equal to the interest rate on the loans raised from the depositors i.e. $R_t = R_{bt}$. Another interesting implication is that, since interbank loans and deposits become perfect substitutes, bankers cannot divert from interbank loans. Since this perfect substitution has disciplinary role for bankers as stated by [Calomiris and Kahn \(1991\)](#). The results hold regardless of the value of π . The excess value of assets defined by $\mu_t^h = \frac{\nu_{st}}{Q_t^h} - \nu_t$. Since the quantity of assets are higher in investing island than non-investing one, the price of asset is higher in non-investing island respectively i.e. $Q_t^i < Q_t^n$ and likewise $\mu_t^i > \mu_t^n \geq 0$. From the FOC conditions it can be shown that leverage increases as the incentive constraint becomes binding.

8 Simulations

The model is parameterized to hit the following two targets, a spread of 100 basis point and an average leverage of 4 (asset over net-worth) across all intermediaries. The persistence of adverse financial shock is set as 0.66 and its standard deviation to 5%. The habit formation is calibrated to be 0.75. The survival rate of bankers is calibrated to be 0.972 which is roughly equivalent to a 10 years life span. Depreciation of capital is calibrated to hit the 10 percent annual rate of capital depreciation. The share of government expenditure is 20 percent. The convexity of capital adjustment cost is chosen to be 10. Also it is assumed that the probability of investment opportunity arrival is 25 percent (or once in a quarter). The calibrated values are tabulated in Table-4.

The seizure rate (i.e. θ) and transfers to new bankers is a function of how diversion is observed. If the behavior of intermediary in absconding a fraction of fund is always observed, then less amount can be diverted (in expectation). Whereas intuitively, if there is an imperfect observation, we should observe higher seizure rates. In line with such expectations, as monitoring decreases the seizure rate increases. The seizure rate here, as discussed extensively in the static section, refers to the situation where θ increases as a reflection of a more efficient financial friction. The calibrated θ changes as one takes into account legal enforcement however the final divertable amount decreases since a fraction of it can be recovered. For this purpose I consider the impulse response function of different scenarios. In Table 2 we observe as the level of monitoring decreases the possibility of diversion increases. The other scenarios are tabulated in Table 4 with three scenarios: 1) perfect monitoring where $\pi = 1$, 2) lack of monitoring where $\pi = 0.75$, 3) lack of monitoring with legal enforcement with $\pi = 0.75$ and $\pi^r = 0.85$. If monitoring technology is perfect, less amount can be diverted and other cases θ is set higher.

The impulse response functions are drawn following a 5 percent change in the financial shock and are reported in 9 - 12. The dynamic of the shock works in the following way : since the retail market opens after the realization of the shock, depositors lend up to the amount to make the banker indifferent between honest and dishonest working. Credit shortage affects the lending behavior of bankers, hence, bankers cut back their loans to alleviate the fear raised in creditors. When loans are cut back, the asset prices fall. However despite lower credit extension, the expected

returns must increase in order to permit the bankers operating their business.

For the cases of partial monitoring and legal fine, we expected spread to be lower compared to the case of perfect monitoring. As it is exhibited in 10, legal uncertainties basically increase the lower bound for the moral hazard, relaxing the constraint which leads into a lower spread, since spread is the only element which bankers can charge to make profit. However, the dynamic framework also sheds more light on the dynamics of output, credit and leverage, which are explained in the following.

Leverage increases while output falls leading to a countercyclical leverage-output movement. An increase in leverage despite having an adverse financial shock seems somewhat counter-intuitive but there are good rationales for it. From the model as it is shown as the incentive constraint binds, leverage increases. He and Krishnamurthy (2011; 2013) have shown that leverage *rises* during crisis time ¹⁶. Another explanation can be due to a steady-state leverage target. Suppose a firm has 100 in their assets, 10 as in their equity (net-worth in this framework) and 90 in their debt (which is deposit in this framework). This balance-sheet has a leverage ratio of 10. A 2 percent drop in the asset value leads to an asset level of 98 and since it is conventional to think that debt value does not change, the equity is then reduced to 8. The leverage is now $\text{Asset}/\text{Equity} = 12.25$, which is slightly higher than 10, so asset side must be reduced by 18 to obtain a leverage ratio of 10. Hence the leverage dynamic comes from the *target value* for leverage ratio ¹⁷. However, the leverage has a very similar dynamics across different specifications ¹⁸. Hence for this we have to

¹⁶The prediction is due to a mix of general equilibrium effects in their model. Their reasoning is that intermediaries retain a good portion of their risky exposure themselves. “For example, in the recent crisis this means that while MBS gets shuffled around across different parts of intermediary sector, in the end it is the intermediary sector that retains most of the MBS. Households don’t suddenly bypass intermediaries and purchase subprime MBS in their direct investment portfolios.” Moreover, negative shocks to intermediary sector, deplete their equity faster than their debt. Equity are junior than debt in terms of their priority in the capital structure. So in an environment where they may be financing frictions, equity frictions are higher than that of debt frictions. The two points combine to imply that when there are negative shocks the intermediary holds assets using more debt and less equity which increases the leverage. Ang, Gorovvy and van Inwegen (2010) have also documented a rise in leverage across financial intermediaries during recent episodes except for the hedge funds.

¹⁷The debate on whether leverage is procyclical or countercyclical is a subtle one. Adrian and Shin (2010; 2013) argue that leverage is procyclical in a sense that leverage falls as balance-sheet shrinks. However, Brunnermeier and Sannikov (2011) He and Krishnamurthy (2011; 2013) have proposed models featuring a countercyclical leverage. Countercyclical leverage is based on the fact that investors have log utilities. Within such specification leverage is high when the risk premium is high.

¹⁸Leverage can be procyclical, i.e. when times are good it increases and when times are bad it drops. This way of modeling the leverage is basically known as risk based leverage constraints

understand better the constituencies of leverage in this model.

Leverage is a function of seizure rate, marginal cost of raising fund, marginal value of asset and monitoring capacity (for the case of lack of monitoring) and legal enforcement (for the case of legal enforcement). The interpretation which can be derived from the impulse response function is that assets which are less subject to diversion have higher marginal value of return. Hence there is an element of *asset quality*.

When assets are less subject to diversion, following an adverse financial shock, they will have a higher marginal value. This is a reward for having higher quality asset. The marginal cost of raising fund increases too, since the steady-state of an economy where there is a general sense of perfect monitoring (which can be interpreted as a safe economy) is lower. On the contrary, in an economy where assets are subject to more diversion, the steady-state value of raising funds and value of assets are high to hit the same steady-state leverage target.

In a perfect monitoring framework, assets have a higher marginal value, and recession can be mitigated with a faster recovery. Whereas when there is lack of monitoring, low asset quality dampens the recovery of the economy and compared to the case of perfect monitoring, there is a lag of 12 quarters for the recovery of capital stock, credit and asset and a lag of 5 to 7 quarters for output. Another interesting point is that legal enforcement does not change the response very much. The calibrated probabilities of recouping the diverted asset is 15% and it still makes the recovery more sluggish (by 2 quarters). Legal uncertainties, i.e. the monitoring problem and the enforceability problem may decrease the spread but inherently increase the uncertainty of the economy by affecting the marginal return on asset and deposit. This fragility most likely manifest itself in the form a prolonged recovery in output, investment and credit.

Several insights can be drawn from the impulse response functions (i) in presence of legal uncertainties, the steady-state of θ , i.e. plausible moral hazard problem increases, as a sign of a relaxed incentive constraint of intermediaries, (ii) leverage is countercyclical since the incentives are binding (iii) in an economy where monitoring is perfect, the steady-state of θ is low, leading into a higher spread but instead the marginal value of asset is higher, as a reward for having high quality asset (iv) depending on the quality of asset, the recovery then differs, which can be viewed [\(Adrian and Shin, 2013\)](#).

at the fragility of the economy. If the asset's quality increases by imposing tougher regulations (broadly modeled here as stringent monitoring and legal fines) it could mitigate the slow recovery but it increases the spread.

It is customary in macroeconomics literature to see whether the model is able to replicate some moments of the data. However, the purpose here was not primarily to investigate the exact business cycle properties given the simple structure of the model, nevertheless it worth investigating the matter.

The financial data for the U.S. commercial banking sector are obtained from the Federal Reserves database. Data construction is explained in the Appendix. Data are one-sided HP filtered. The filtered data show some evidence on the counter-cyclical of leverage and output, not very strong although significant. Leverage and the net-worth are also strongly counter-cyclical (as leverage increases, net-worth falls). Leverage increase when output falls in the model. Leverage also mildly follows the movement in the spread, as in the model (since more return on capital enables banks to expand their balance sheet) The correlation matrix of the HP-filtered data are reported in 6.

To observe the model's performance, the benchmark of partial monitoring with two additional shocks is considered. The shocks are productivity and a net-worth shock affecting the banks located on the investment islands (since the incentive constraint is only binding for these banks). Some of the correlation properties observed in the data are reasonably replicated by the model as tabulated in Table 7. The correlation of assets with other variables generally performs poorly. The reason is that, in this class of models, assets are technically the available stock of capital in the economy, hence it may not necessarily reflect the aggregate assets time series for commercial banks.

However absent rigidities in the model it is normal to get strong correlations among variables. Such lack of rigidities also play its role in increasing the relative volatility of variables compared to that of the data. The moments are reported in Table 8. Spread in the model is far more volatile than in the data, which highlights the importance of the necessity of having a monetary policy rule, a vital mechanism absent in the framework.

Moreover, the model technically captures an environment in which interbank market is not operating. This resembles more like the post-crisis period. Figure 13 clearly shows the interbank

lending among commercial banks has completely frozen and has not recovered since then. Taking this observation, the idea would be whether the model is able to replicate, output, investment and liabilities post-crisis since the model captures a situation where interbank market is frozen.

The model is then simulated and the generated series are one sided-HP filtered with a smoothing parameter of 1600. The replicated results are reported in Figure 14. Despite the simple set-up of the model, simulation follows the trend of the time series of interest reasonably well, especially the one for credit.

The welfare implications of the model can be investigated. Welfare can be calculated using a recursive form for the utility function :

$$W_t = U(C_t, L_t) + \beta \mathbb{E}_t(W_{t+1}) \quad U(C_t, L_t) = \ln(C_t - \gamma C_{t-1}) - \frac{\chi}{1 + \varepsilon} L_t^{1+\varepsilon}$$

The model is then solved with the second order approximation for welfare analysis. Higher order approximation is needed because of certainty equivalence at first order that does not yield into any welfare results. To obtain welfare, the model is then simulated enough to obtain the empirical expectation of W_t . Results are tabulated in Table 9.

The welfare implication of different benchmarks are very similar except for a small improvement for the legal and partial monitoring cases. The reason is due to how θ basically affects the steady-state of C . θ as argued is the plausible moral hazard which is determined by the supply and demand of credit functions. Hence, in equilibrium, creditors will extend up to a point that would make the banker indifferent between his honest and dishonest working, which boils down to the question whether diversion reduces the long-run value of C . If one interacts θ with C obviously consumption falls, as it is shown for a simpler case in the Appendix. However that requires the assumption that θ means perishing a fraction of asset, which does not take in the equilibrium.

A final point is to calculate the difference between the empirical mean and the steady-state value. As it can be seen in Table 9 the empirical mean is higher than that of the steady-state for all benchmarks. This basically means households prefer the stochastic environment more than the deterministic one. This point has been nicely highlighted in the work of Lester et al (2014). Authors argue, even though households prefer smoothing stream of consumption and leisure, welfare can be increasing in the volatility of an exogenous shock, if factor supply is sufficiently elastic. This is certainly an element worthy of investigation for other classes of models with financial frictions.

9 Future Work

This work considered a framework to investigate how partial monitoring and legal fines affect the economy. The monitoring were exogenous and they were calibrated to hit certain steady-states. However monitoring itself might be time varying. This point has been highlighted in the work of [Coffee Jr \(2011\)](#), whom argues there is a “legal business cycle” ¹⁹. This is certainly a promising avenue of research given the recent regulatory initiative taken by different regulator in the aftermath of the crisis.

Much work is needed in terms of broadening our understanding of the interaction of legal settlements and intermediaries’ balance sheet. Legal settlements are subject to tax deduction since intermediaries would book them as expenses. Federal tax rules allow companies to deduct from their tax returns as an ordinary cost of doing business, any settlement payments that are construed (explicitly or not) as restitution or compensation. The majority of cases announced in the past include some form of restitution that is eligible for a tax deduction ²⁰ This raises two important questions. First is the disciplinary role of the fine, and how large those fines should be. This paper argues that the design of those fines should be in such a way not to make intermediaries’ incentives too tight but at the same time inducing a higher marginal return on assets. Making legal fines too big would have dubious effects on the lower bound for the plausible moral hazard as depicted in [Fig. 8](#).

However to address the disciplinary role of legal fines, a deeper understanding of intermediaries’

¹⁹

The author traced regulations both in Sarbanes- Oxley and Dodd-Frank Act and argues, in the new episode of crises, regulation follows a sine curve, which he calls it “regulatory sine curve”. Author argues that his “fundamental premise is that a “Regulatory Sine Curve” governs the intensity of the oversight exercised by financial regulators. By this phrase, it is meant both that (1) regulatory intensity is never constant, but rather increases after a market crash, and then wanes as (and to the extent that) society and the market return to normalcy, and (2) the public’s passion for reform is short-lived and the support it gives to political entrepreneurs who seek to oppose powerful interest groups on behalf of the public also wanes after a brief window of opportunity. This same pattern may characterize other forms of regulation ... but important differences exist.”

²⁰“The total value of tax deductions when you subtract the SEC totals and likely settlement terms leaves Bank of America with around \$12 billion in deductibles out of the \$16.6 billion settlement deal it made with the Justice Department last August, though possibly more. Its total cost of settlements, therefore, could be reduced to around \$12.4 billion, based on a 35 percent tax rate. Similarly, JPMorgan Chase can deduct at least \$7 billion of its \$13 billion deal last November, and Citigroup can put at least \$3 billion of its \$7 billion deal last July against its taxes. This makes the total amount on which deductions can be taken as a result of settlements related to the wrongdoing that led to the 2008 financial crisis at least \$44.1 billion, which translates into potential tax savings of about \$15 billion” ([Newsweek, Oct 27, 2014](#)).

corporate structure is necessary. The following example delineates the complexity. If a bank settles a desirable level of legal liability with its regulators, the shareholders might reward the firm by a better compensation package, which ultimately sends a positive signal to the market, which exerts positive pressure on the stocks of that bank. Sometimes the disciplinary action has a peer effect. However measuring the peer effect of legal fines is very difficult, albeit a plausible channel of investigation. The second question is, what happens in the aftermath of the legal settlement. Our knowledge on how banks finance such fines and which part of their balance sheet is more under strain and tension due to those fines is limited, which calls for further research.

The other promising line of research is to investigate the government and regulators' probing activities and its interaction with intermediaries. There are two points. The first concern is how such probings affect the asset quality. In the dynamic simulations, the marginal return on asset decrease in presence of an adverse financial shock and legal uncertainties. As I explained, assets which are subject to a higher moral hazard have less marginal return. However, what would happen to other asset layers? My conjecture is that assets which are subject to higher moral hazard possibilities (or more regulatory probes) are more illiquid, since there are no markets for it. This illiquidity either makes the firm to undergo a massive firesale to reduce its inventory or to commit financial window-dressing ²¹.

²¹A prominent example is the Lehman Brothers and their "Repo 105" financial conduct. Lehman was struggling with their pool of illiquid collateralized instruments (CDOs, ABS, RMS etc). Back then market had become very observant of intermediaries' leverage ratio. Hence Lehman was doing its best to reduce its leverage to keep its rating. However, since that pool was dubious, there was no buyer (not to mention how it had been synthesized through securitization), instead Lehman with its financial "Repo 105" reduced its "liquid" inventory by recording a repo transaction as a sale. They did that with an overcollateralization of nearly 5 percent (above the normal market range in that time). By doing this, they reduced their inventory level (meaning for a week they booked them off balance sheet), increasing their cash and paying-off their liability obligations, hence a reduction in leverage, without touching their illiquid inventory. The alchemy was in what they had on their inventory, which was a combination of dubious illiquid securities and high grade securities. They were able to lend off or book them off balance sheet momentarily and claiming that they had been sold. None of the Lehman's examiners, like SEC as part of the Consolidated Supervised Entity (CSE), or the Federal Reserve Bank of New York through their banking operation division spotted such transactions.

Regulatory probes decrease the quality of assets and make it harder to sell them. However it is very rare to have a collapse originally induced because of regulatory probing. As an example, Stanford Financial Group can be mentioned that regulatory investigation and massive fraud revelation made the company collapse and put it under receivership.

The other complexity, which I have not addressed is that in the U.S. the institutions which are perceived as being systemically important have different regulators not to mention different auditors. This point has clearly been shown in Figure 3. To give a detailed example, Fannie and Freddie, their regulator was the Office of Federal Housing Enterprise Oversight. The Federal Housing Oversight is the one which sets the capital requirement of the Fannie and Freddie and in the run up to crisis, the U.S. Treasury had hard-time with the GSE's regulatory body that Fannie and Freddie were undercapitalized, although now they are basically part of the government ²². Bank of America's direct overseer was Federal Reserve Bank of Richmond, a point which later breed into more disputes between the Bank of America and the Fed ²³. After crisis other systemic banks have fallen on the hands of the Fed but the statutory obligations of the FDIC and S.E.C are very different and each of these institutions have their own balance sheet and their own income statements ²⁴. This requires further understanding of such nexus of regulations and intercacies.

10 Conclusion

In this paper I have investigated the implications of legal fines and partial monitoring in a macro-finance model. There is partial monitoring in the sense that dubious behavior of intermediaries is not always observed with certainty. Moreover they can pay some litigation fees to mitigate the punishment for their conduct should they get caught. Several insights can be drawn from introducing such concepts in static and dynamic frameworks. Partial monitoring and legal fines make the incentive constraint of intermediaries more relaxed, in the sense that bankers are required

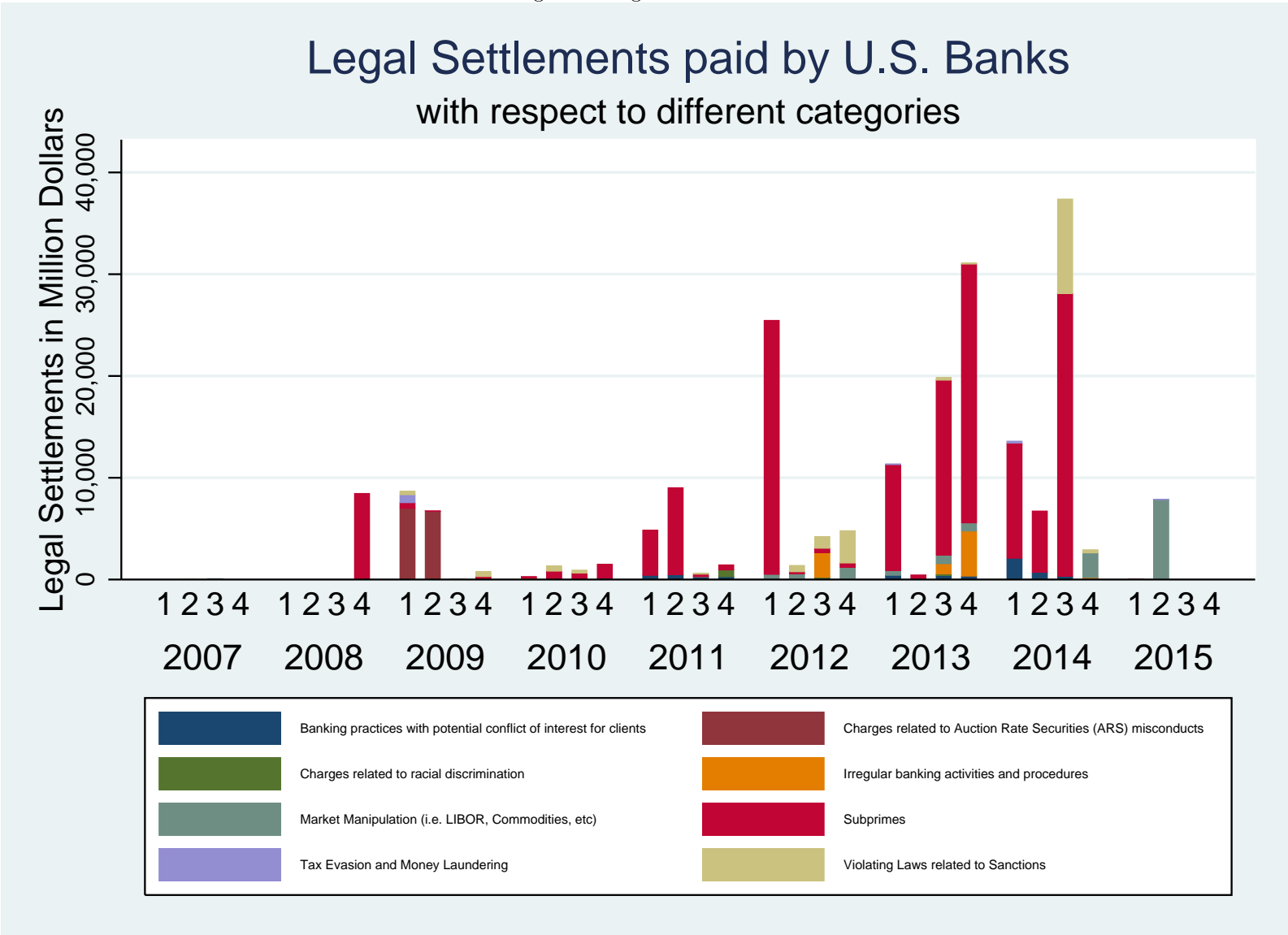
²²These enterprises were enjoying an especial status before crisis, such that they were privately owned entities with an implicit guarantee of the government. They had shareholders and paying out dividends. Although in 2004 they got caught in a financial scandal, they managed to curtail its reverberating effect. However, once government during the financial crisis activated its implicit guarantee, they are now publicly owned enterprises.

²³Before Lehman's collapse, Bank of America was one of the probable buyers of the ailing comapny. Given it has just finished a transaction of Countrywide Financial and Fed had given them some promise to relieve and grant them some capital regulatory requirement. Instead the Federal Reserve Bank of Richmond, had been putting pressure on BoFA to redo its capital plan and cut its dividend.

²⁴An interesting framework has been formulated by [Boot and Thakor \(1993\)](#). The merit of the framework is that authors argue that there is uncertainty about the regulator's ability in monitoring bank's choice of assets. This uncertainty makes regulator's to make some reputation as a capable overseer. This uncertainty distorts regulator's bank closure policy and inflates the liability of deposit-insurance fund. The idea of regulator's having uncertainty in what intermediaries choose for their asset configuration certainly deserves further scrutiny.

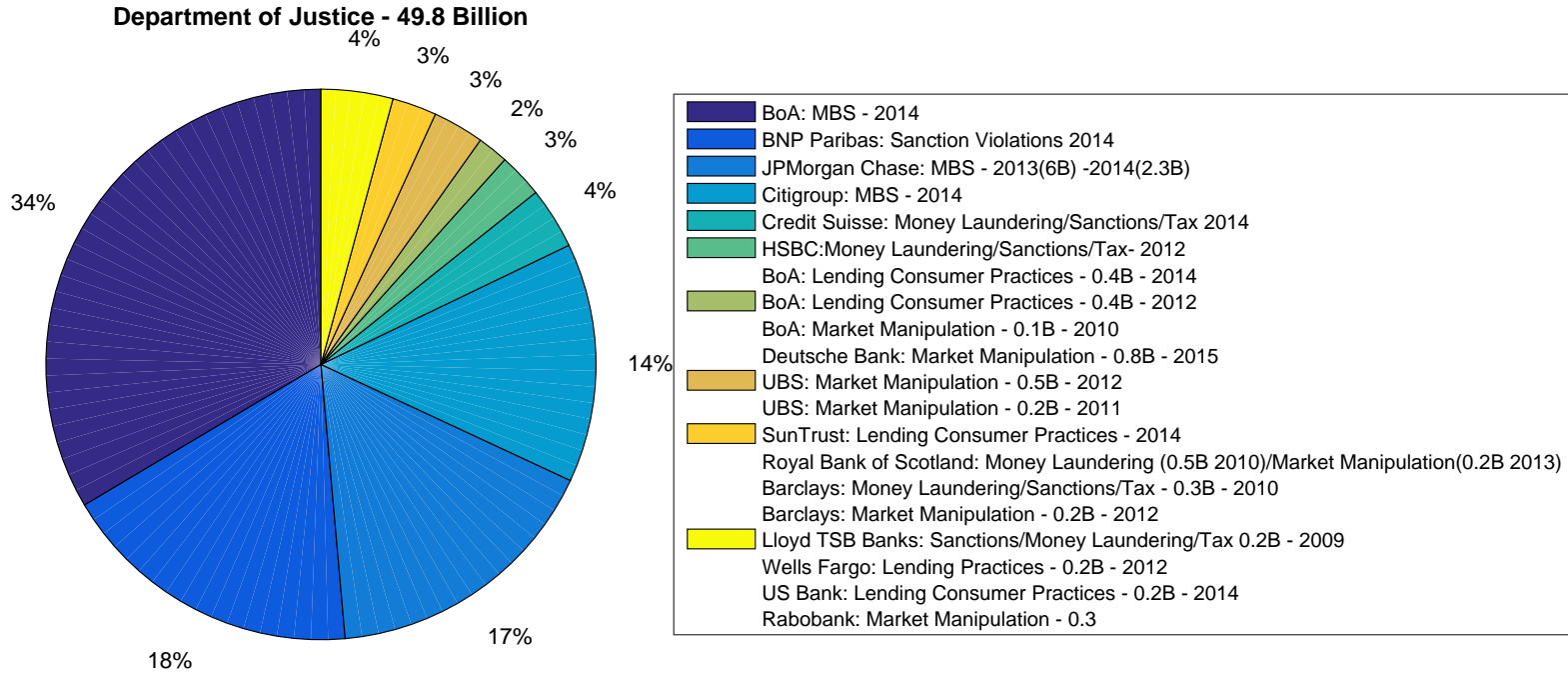
to pledge less collateral to raise fund. From the static model I have demonstrated that this degree of pledgeability is set through the demand and supply function of credit. Partial monitoring and legal fines decrease this degree since creditors can recoup more in case if intermediaries do not honor their agreement. The reduction of pledgeability can be interpreted as setting a higher plausible moral hazard level. Reduction in the degree of collateral needed to be pledge leads into a reduction of spread. In a dynamic set-up due to changes in asset qualities caused by such possibilities, recovery in output and credit become sluggish in response to an adverse financial shock, in this paper a margin shock. I have then investigated the welfare implications and I have argued depending on the interpretation of the incentive constraint, welfare changes accordingly. I have also investigated the ability of the model in replicating some salient features of the business cycles. The model is doing reasonably well in replicating investment, output and credit post-crisis business cycle properties however much more work is needed for spread and leverage since the model's generated time series are more volatile than the actual series.

Figure 1: Legal Settlements



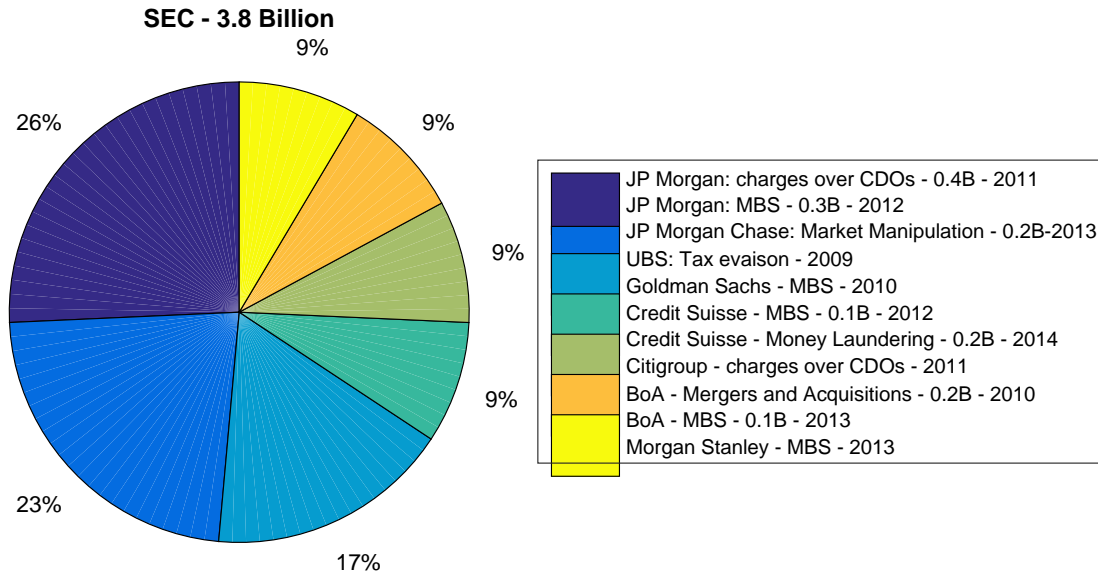
Legal Settlements paid by U.S. banks with respect to different categories. 1,2,3 and 4 refer to Q1, Q2, Q3 and Q4. Data are depicted according to the quarter which the announcement of the fine broke out through official channels such as SEC, FDIC and DoJ websites. The categorization is based on the reason stated in the announcement for which the fine is designed for.

Figure 2: Distribution of fines imposed by the Department of Justice

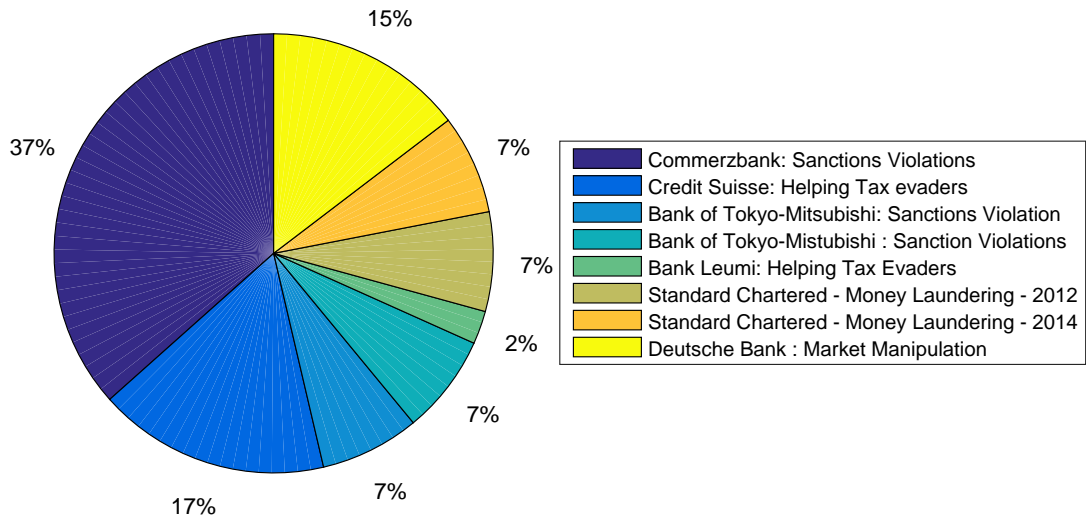


Over the period of 2009 to 2015, Department of Justice (hereafter DoJ) imposed nearly 50 billions on various banks for their financial misconducts. The largest shares are due to Bank of America, BNP Paribas and JP Morgan.

Figure 3: Distribution of fines imposed by the Security Exchange Commission (SEC)

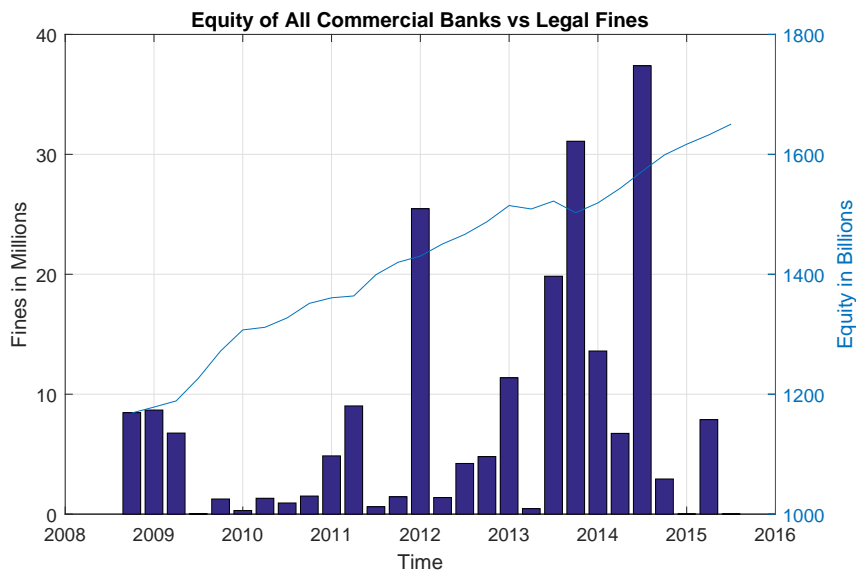


New York Department of Financial Services - 4.1 Billion

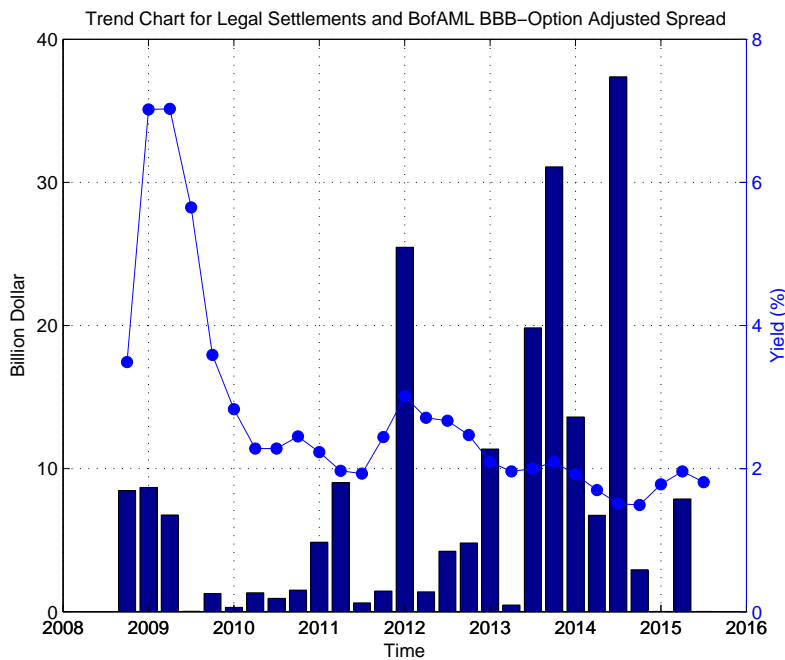


Security Exchange Commission (SEC) has imposed several charges amounting to a total of 3.8 billion dollars. New York Department of Financial Services has also imposed fines up to 4.1 Billion dollars.

Figure 4: Plot of legal fines against the Equity level

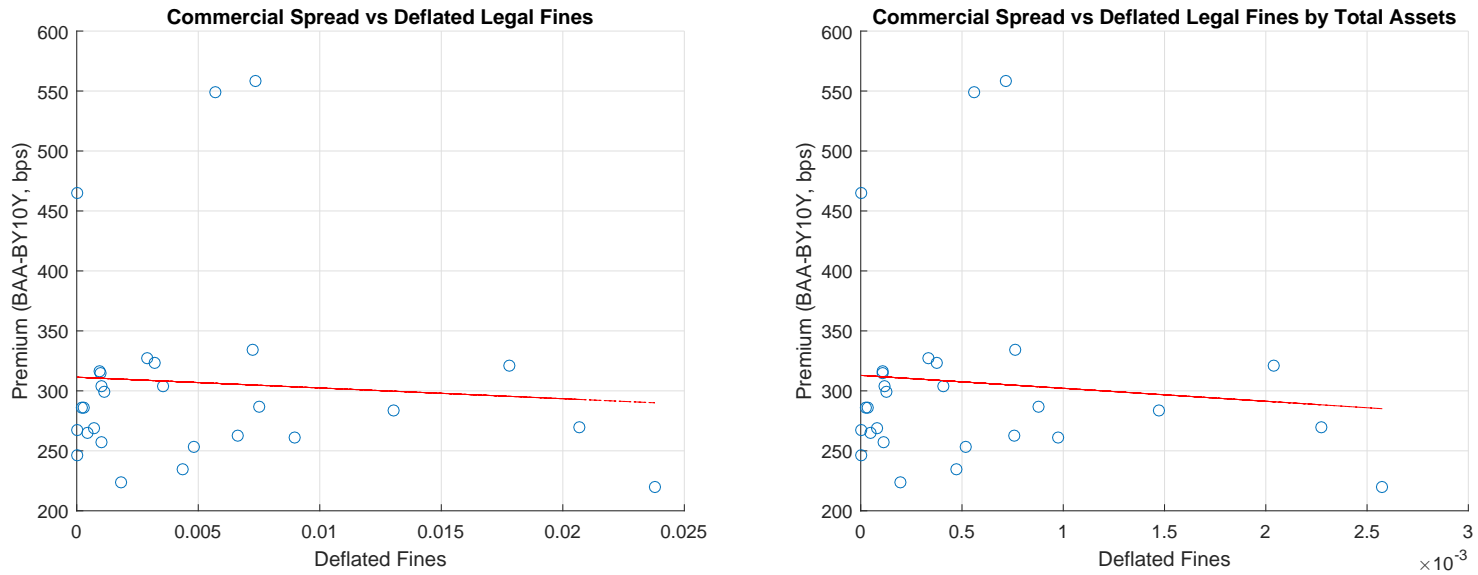


Plot of legal fines against the Equity level (Equity is defined as Assets net of Liabilities)



Corporate spread measures the difference between the 10-Year Moody's Aaa-rated corporate bond yield and 10-Year US Treasury yield. Legal settlements are in Billion dollars paid by banks (bar graph). Time series are between 2008Q3 - 2015Q3 and are obtained from the Federal Reserve of St. Louis Database and Legal settlements are compiled from different sources.

Figure 5: Scatter Plot of Spread against Deflated Fines



Scatter plots of growth of legal settlements paid by banks between 2008Q3 - 2015Q3 with respect to the spread throughout the same period, Moody's BAA Corporate Bond Yield relative to 10 Year-Treasuries. Data for corporate spreads are retrieved from Federal Reserve of St. Louis Database and Legal settlements are compiled from different sources. Fines are deflated with the aggregate equity of banks (left panel) and by total assets (right panel).

Figure 6: Deposit issued by banks

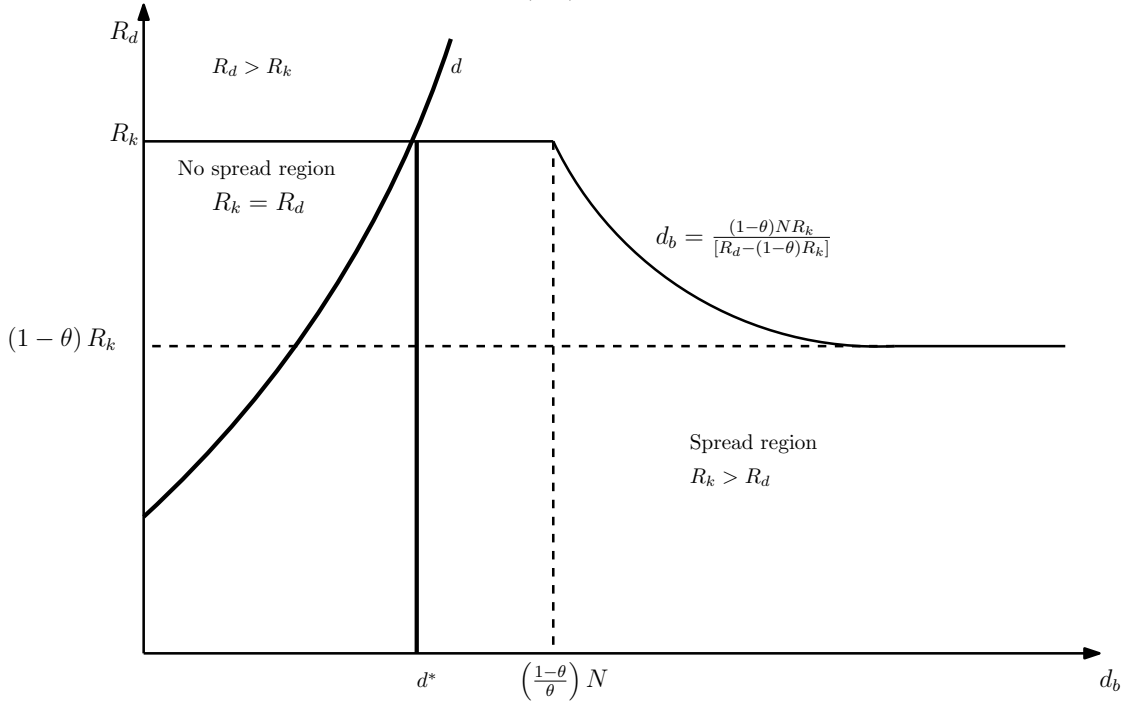
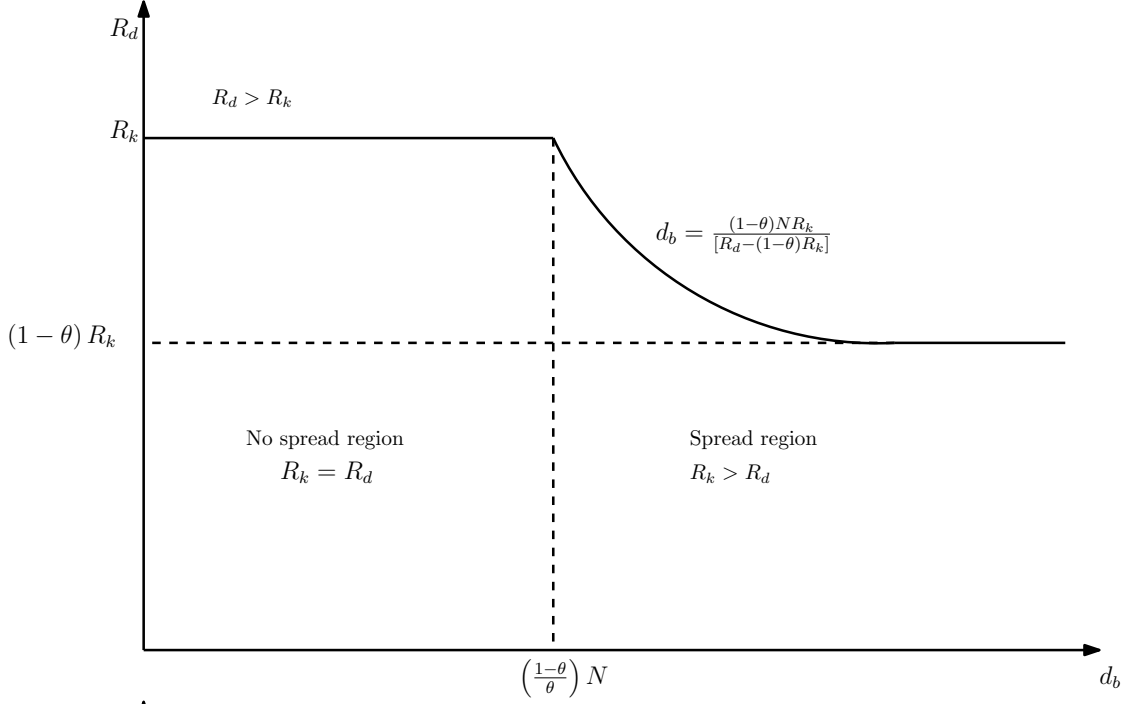


Figure 7: Changes due to possibility of paying legal settlement

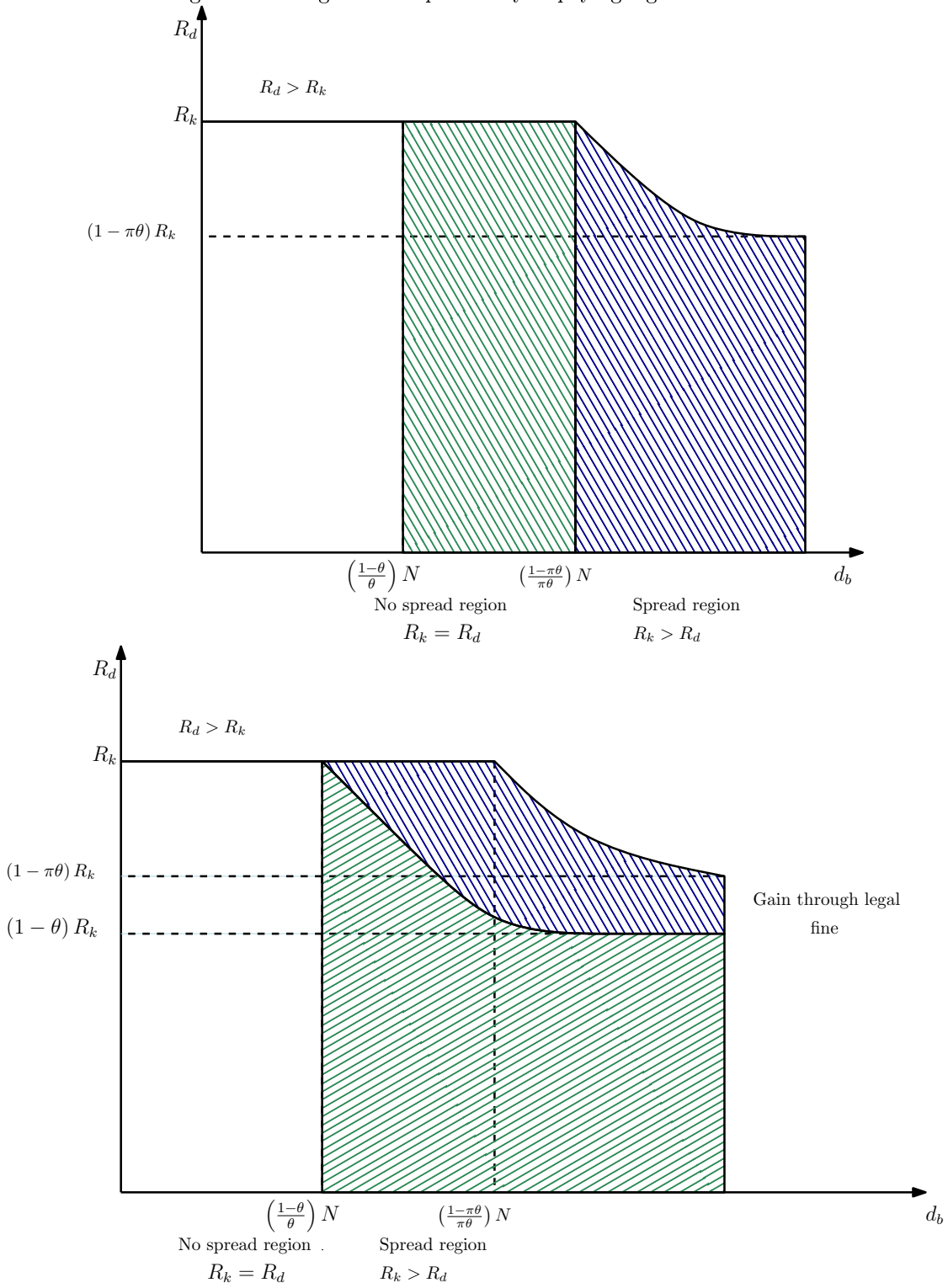
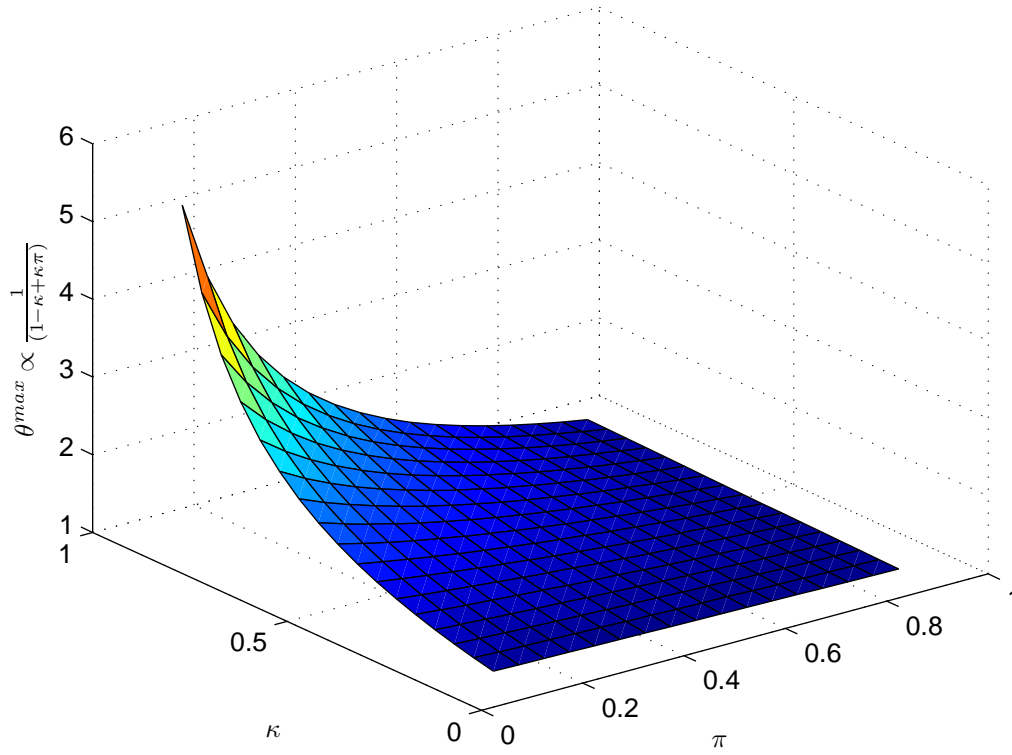


Figure 8: Relationship between $\theta^{max} \propto \frac{1}{(1-\kappa+\kappa\pi)}$

Changes in Boundary for Plausible Moral Hazard Level



Parameters	Values	Description	
α	0.33	Capital share in production	(1)
β	0.99	Discount factor	
γ	0.75	Habit formation in consumption	(2)
δ	0.025	Capital depreciation	
χ	5	Relative utility weight of labor	
ε	0.1	Inverse Fischer elasticity of labor	(3)
ψ	11	Capital adjustment parameter	(4)
σ	0.972	Bank surviving rate	
π^i	0.25	Investment opportunities	
$\frac{g}{y}$	0.2	Share of government expenditure	
ρ_θ	0.66	Persistence of adverse financial shock	
ϵ_θ	0.05	Volatility of the shock	

The calibrated values are in agreement with choices of the literature, (1) share of capital in production, in the range of 0.33-0.4 , (2) Habit formation, the posterior value of estimations on the U.S. data as reported by [Christiano, Motto and Rostagno \(2014\)](#), (2) Labor supply elasticity, the inverse Fischer elasticity is usually small between 0 and 0.5 as reported by [Trigari \(2009\)](#) (3) Curvature, investment adjustment cost, the posterior value of estimations on the U.S. data as in [Christiano, Motto and Rostagno \(2014\)](#).

Table 2: Calibrated values for seizure rate and transfer in presence of different lack of monitoring

Parameters	θ	ξ
Definition	Seizure rate	Transfer to Intermediaries
Scenarios of Lack of Monitoring (1)		
$\pi = 0.75$	0.47	0.0019
$\pi = 0.8$	0.44	0.0019
$\pi = 0.85$	0.41	0.0019
$\pi = 0.95$	0.38	0.0018

(1) Calibrating monitoring capacity is difficult due to lack of credible data. However if we interpret the lack of monitoring as the quality of financial sector regulation and supervision we can find some comparable measures. For example in the work of [Cihak and Tieman \(2008\)](#) authors have calculated such qualities making the use of data from the IMF (Financial Sector Assessment Program or FSAP) and World Bank. Authors analyze the data from assessments of compliance with international standards and codes aimed at identifying good supervisory practices. They then break the financial sector regulation into three sub-categories of banking, insurance and securities for each they look at regulatory governance, prudential framework, regulatory practices and financial integrity and soundness. For high income countries it ranges from 75 - 95 according to different subcategories. Here I have used those values as the calibrated value for the aggregated monitoring.

Scenarios	Perfect Monitoring (π)	Lack of Monitoring ($\pi < 1$)	Lack of Monitoring with legal enforcement ($\pi^r < 1$)
Scenario - I	$\pi = 1$	-	-
Scenario - II	-	0.75	-
Scenario - III	-	0.75	0.85

Table 4: Calibrated values for seizure rate and transfer

Parameters	θ	ξ
Definition	Seizure rate	Transfer to New Intermediaries
Scenarios		
Scenario - 1: Perfect Monitoring	0.085	0.0019
Scenario - 2: Lack of Monitoring	0.47	0.0019
Scenario - 3: Lack of Monitoring and legal enforcement	0.57	0.0019

Table 5: Real and Financial variables steady-states

Parameters	Model	Sample Average
$\frac{z}{y}$	0.22	0.24 (1)
$\frac{c}{y}$	0.58	0.59 (2)
$\frac{g}{y}$	0.20	0.16
$\frac{k}{y}$	8.71	10.9 (3)
$\phi^i = \frac{Q^i s^i}{n^i}$	4.42	6 (4)
$\frac{n}{d}$ (Equity-to-debt)	0.33	0.35 (5)
Credit Spread (AB*)		
$R_k^i - R$	112	100-204 (6)
$R_k^n - R$	480	

The sample averages are reported from [Christiano, Motto and Rostagno \(2014\)](#) and are calculated over the period of 1985:1-2008:2. (1) Investment includes residential, non-residentials, equipment, plants, changes in inventories and durable consumption source BEA. (2) Personal consumption expenditures includes non-durables, and services, source, BEA, (3) capital stock includes private non-residential fixed assets, private residential, stock of consumer durable and stock of private inventories, source BEA. Depending on the choice of time series and financial intermediaries, the steady-state of financial variables differ. Here I have selected time series corresponding to a general picture of financial activities. (4) Leverage, the sample average calculated over the period of 1985:1-2008:2 and is measured as total book value of asset of combined commercial banking and investment banking sector divided by the market value of equity of that sector, as reported by [He and Krishnamurthy \(2011\)](#). Another measure is that of the OECD under U.S. banking leverage, over the period of 1995-2012 which measures up to 6 as well. (5) OECD debt-to-equity aggregated time series on financial corporations between 1995-2012. The debt-to-equity ratio is a measure of a financial corporation's ability to finance their activities out of equity. (6) Credit spread is measured in terms of annual basis points and are reported from [Gilchrist and Zakrajšek \(2012\)](#). The reported figure is the sample average of Corporate Bond calculated over 1973:M1-2010:M9 (This is less than the GZ indicator proposed by authors).

Figure 9: Impulse Response Functions to a shock of 5% volatility for three specification

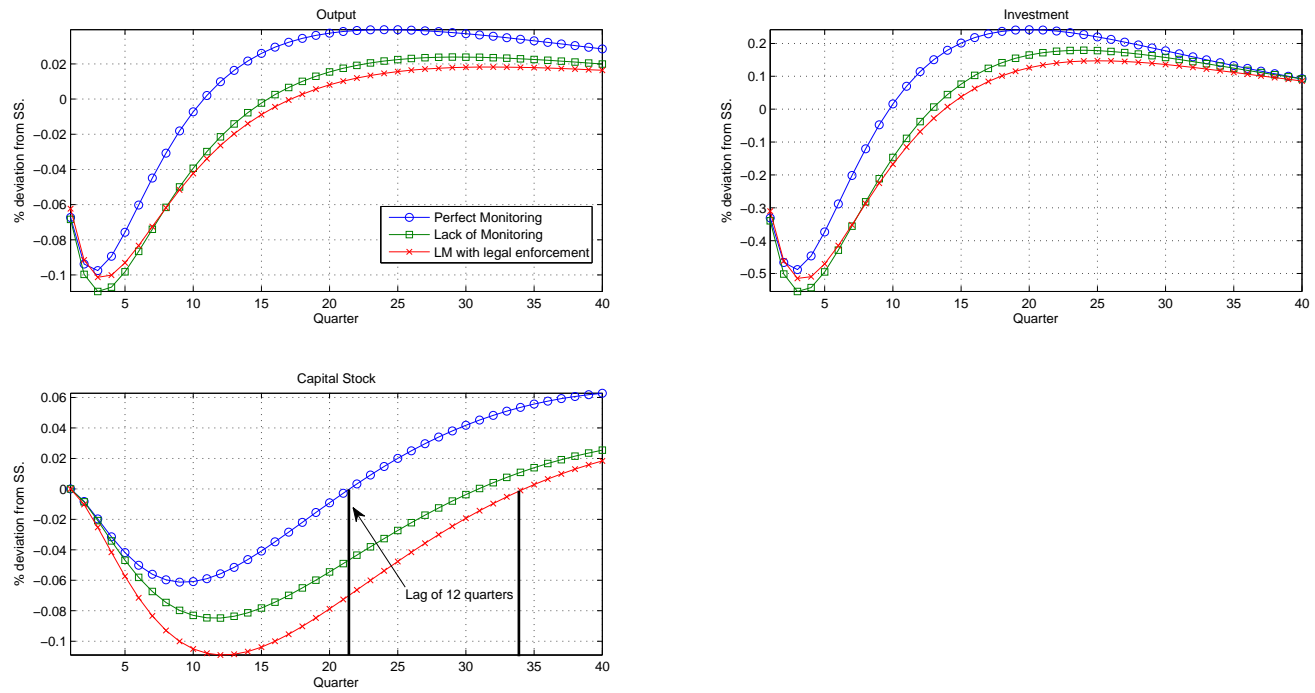


Figure 10: Impulse Response Functions to a shock of 5% volatility for three specification

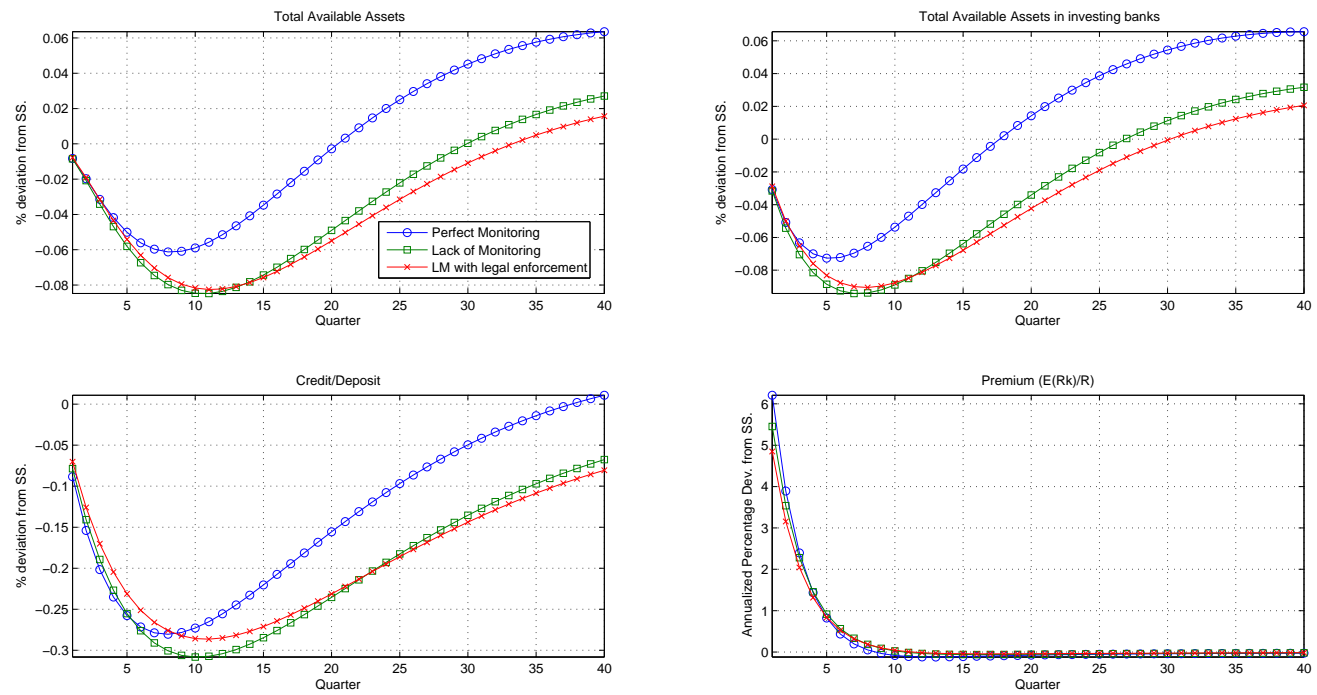


Figure 11: Impulse Response Functions to a shock of 5% volatility for three specification

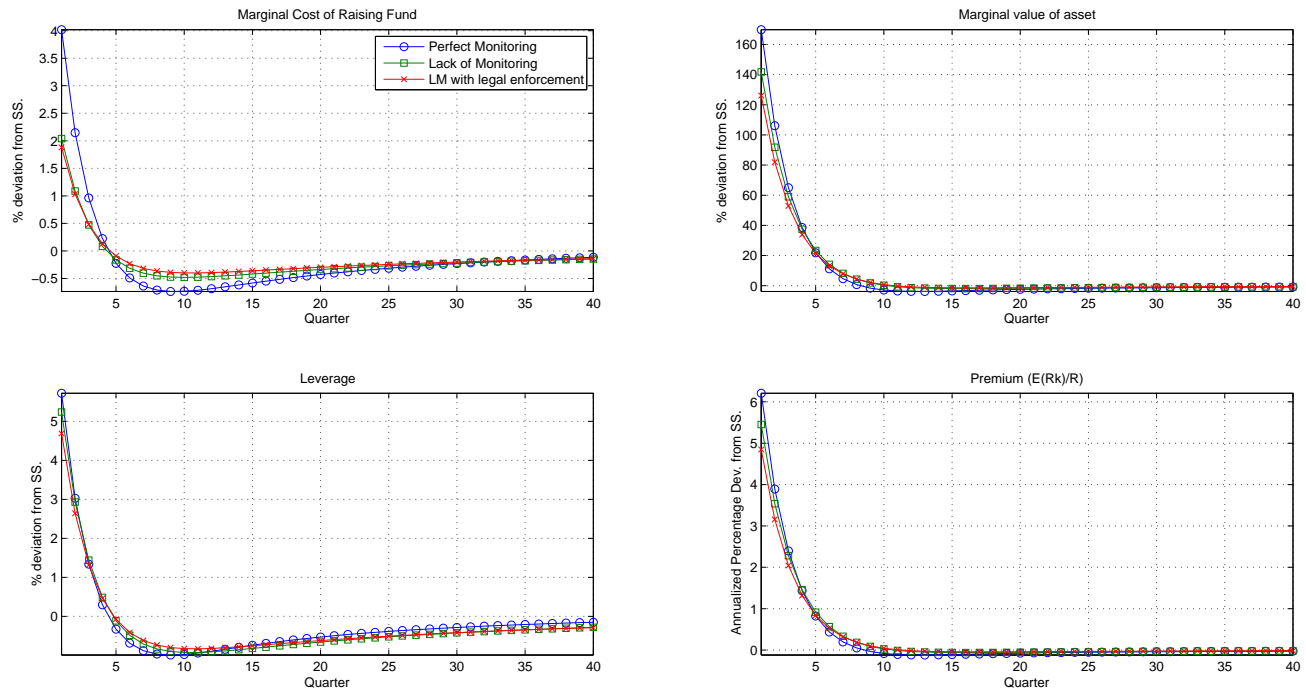
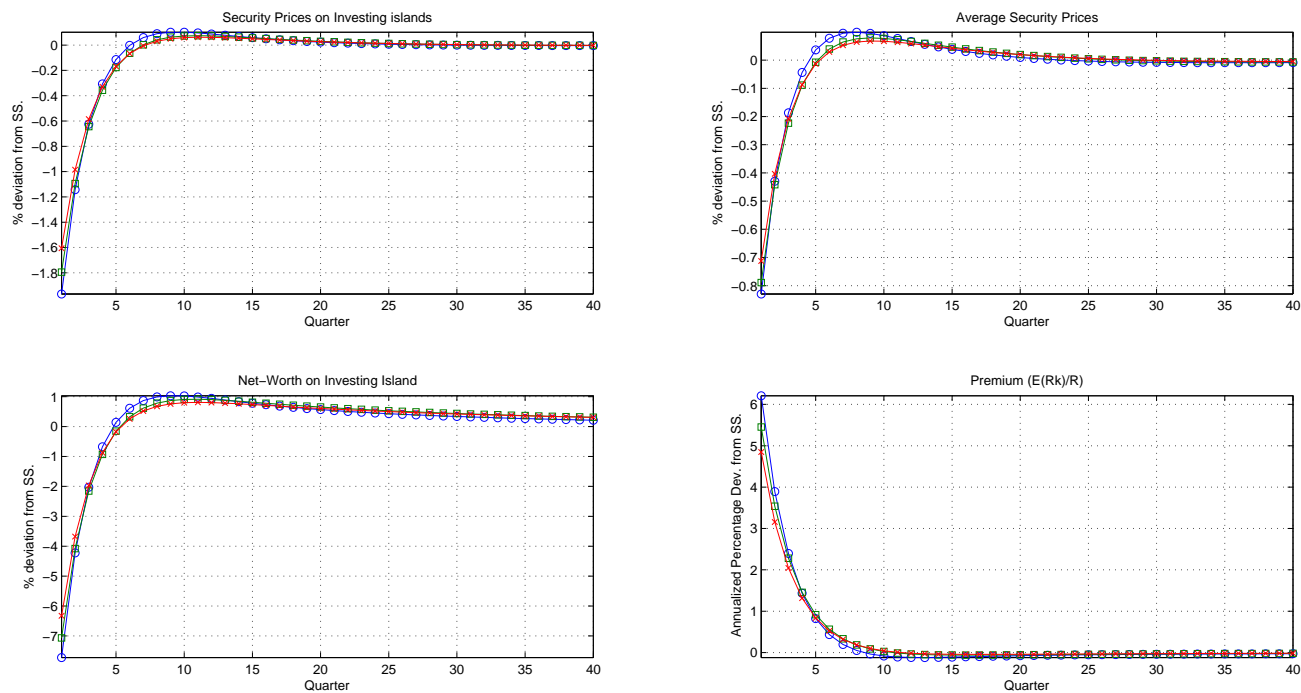


Figure 12: Impulse Response Functions to a shock of 5% volatility for three specification



Impulse response functions to a 5% financial shock. Average security prices is defined as $\mathbb{E}_t^h Q_t$ which is the average price across islands. Premium is defined as $\mathbb{E} \left(R_{k,t}^{hh'} \right) / R_t$.

Table 6: The correlation matrix of Business Cycles (1986Q1-2015Q1)

	y	i	n	s	d	$R_k^{AAA} - r$	$R_k^{BAA} - r$	$\phi = \frac{s}{n}$
y	1							
i	0.93***							
n	0.08	0.11						
s	-0.16*	-0.23***	-0.02					
d	-0.19**	-0.30***	0.1	0.39***				
$R_k^{AAA} - r$	-0.51***	-0.52***	-0.07	0.35***	0.16*			
$R_k^{BAA} - r$	-0.58***	-0.55***	-0.17*	0.48***	0.18**	0.89***		
$\phi = s/n$	-0.126*	-0.183***	-0.73***	0.66***	0.19**	0.27***	0.44***	
$\phi = (s - n)/n$	-0.128	-0.18**	-0.74***	0.65***	0.18**	0.26***	0.42***	0.98***

The definition of time series are fully explained in the Appendix. For spread two measures are used. The difference of BAA-FF and AAA-FF. For leverage two definitions are used. The first one is the total assets divided by total equity of the commercial banking. Total residuals are considered as the total equity. The second definition applies to total liabilities to equity. P-values of the test of no correlation against the alternative of non-zero correlation are reported in parenthesis. Asterisks denote statistical significance of non-zero correlation at the 1% (***) and 5% (**) and at 10%(*) confidence levels

Table 7: The correlation matrix of Simulated Time Series (Partial Monitoring Benchmark)

	y	i	n	s	d	$\mathbb{E}R_k^{hh'} - r$
i	0.96					
n	0.68	0.58				
s	-0.08	0.11	-0.41			
d	-0.92	-0.95	-0.67	0.01		
$\mathbb{E}R_k^{hh'} - r$	-0.58	-0.45	-0.94	0.39	0.51	
ϕ^i	-0.66	-0.55	-0.98	0.36	0.64	0.95

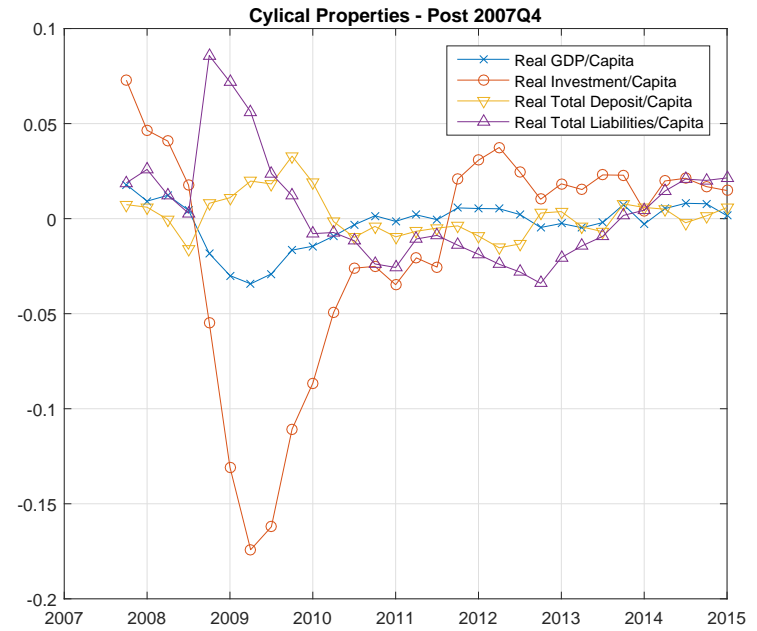
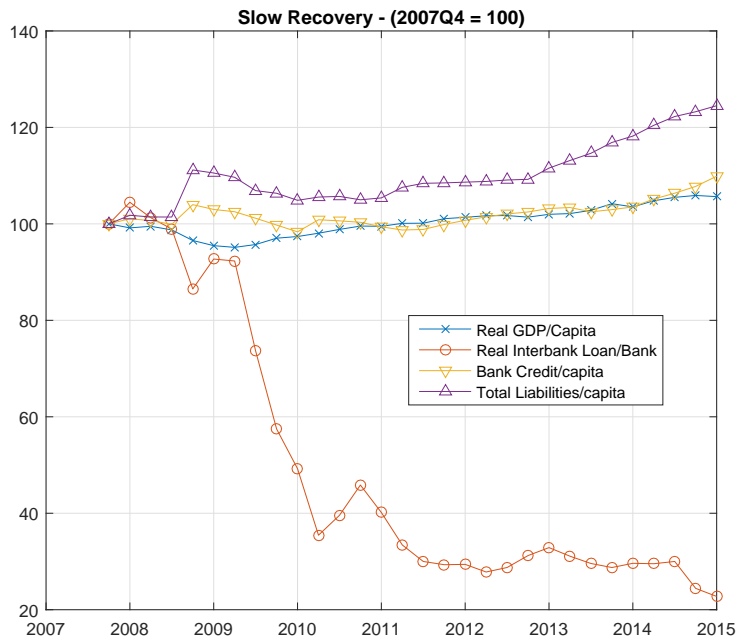
The simulated moments are the one-sided HP filtered data generated by the model. The bold signs designate the business cycle correlations that their sign respect the ones those from the correlation matrix of the U.S. data in Table 6. The benchmark is the partial monitoring augmented with two additional shocks, technology and net-worth shock to the banks located on the investment island.

Table 8: The moments of data from 1986Q1-2015Q1

	Entire Sample	2009Q2-2015Q1	(Partial Monitoring Benchmark)
σ_y	0.01	0.013	0.015
$\sigma_{i/y}$	4.55	4.9	3.62
$\sigma_{d/y}$	1.24	0.8	2.4
$\sigma_{R_k/y}$	0.067	0.056	0.95
	0.122	0.15	
$\sigma_{s/y}$	1.7	1.9	1.8
$\sigma_{n/y}$	1.9	1.4	18
$\sigma_{\phi/y}$	2.52	2.52	15
	2.8	2.83	

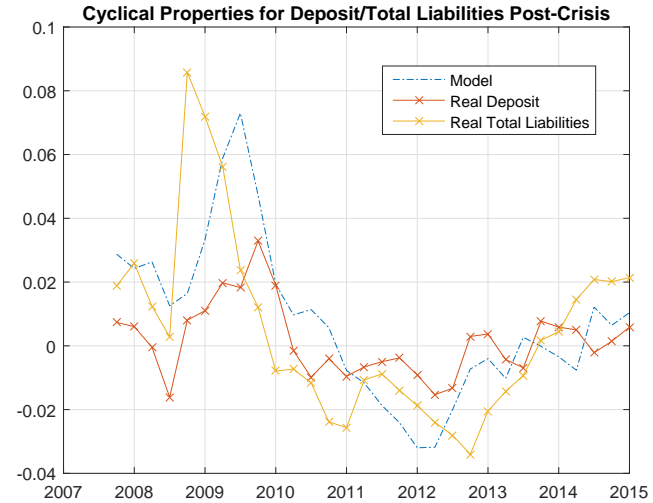
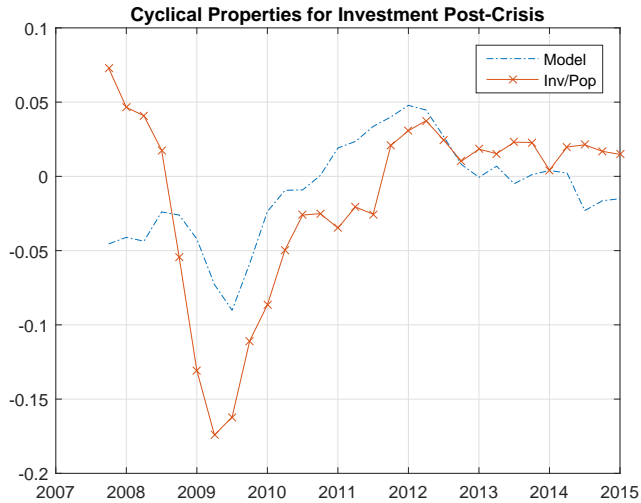
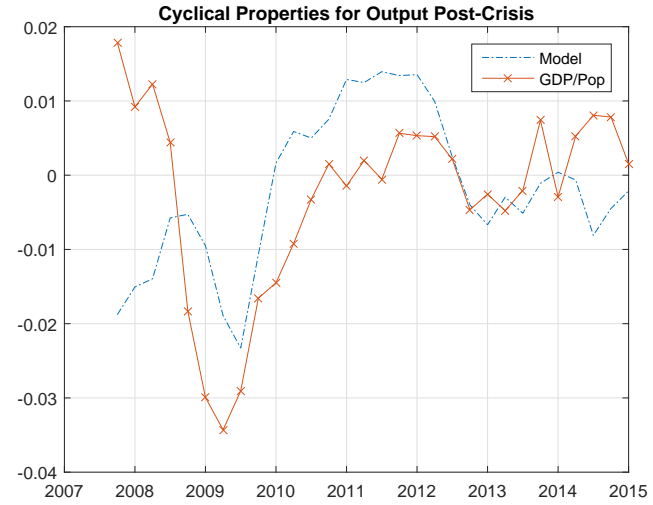
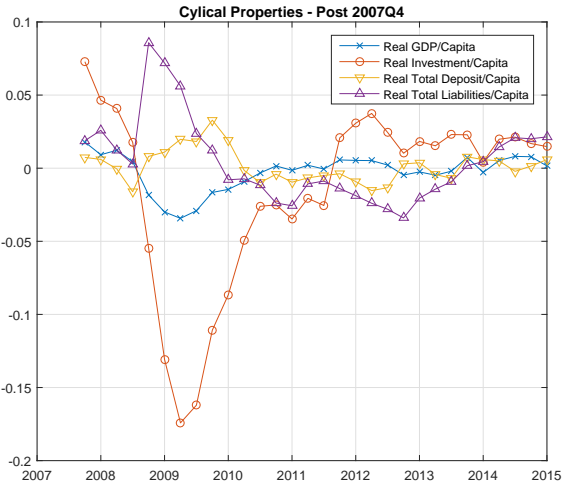
Business cycle statistics are based on the one-sided HP filtered cyclical components of quarterly time series with smoothing parameter of 1600. The relative volatility of other variables are relative to output, calculated as $std(x)/std(y)$. Model (1) is the partial monitoring case with $\pi = 0.75$.

Figure 13: Slow Recovery (2007Q4-2015Q1)



The slow recovery for the Real GDP per capita, Real Interbank Loan per Bank, Bank Credit per capita and Total Liabilities per capita. For Interbank Loan series are deflated and divided by the number of commercial banks. The cyclical properties are the one-sided HP filtered of series with the smoothing parameter of 1600.

Figure 14: Cyclical Properties



Cyclical properties replicated from 2007Q4 - 2015Q1. All series are one sided HP-filtered. Specification of shocks used for the simulation: confidence shock $\rho_\theta = 0.66$, $\sigma = 0.015$, technology shock $\rho_a = 0.66$, $\sigma_a = 0.02$, net-worth shock $\rho_n = 0.66$, $\sigma_n = 0.02$.

Table 9: Welfare Analysis

Benchmark	Perfect Monitoring	Partial Monitoring	Partial Monitoring with fines
	$(\pi = 1)$	$(\pi = 0.75)$	$(\pi = 0.75 \ \pi' = 0.85)$
$\mathbb{E}(W_t)$	-324.954	-324.6	-324.68
\overline{W}	-324.9517	-324.95	-324.95
φ	0.23	0.23	0.23

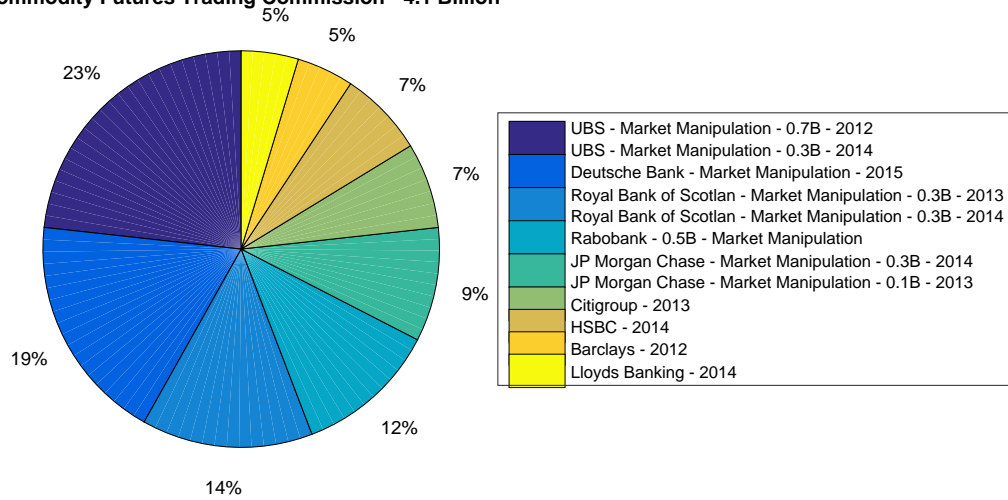
The empirical means are simulated for 100,000 draws. The simulations only consider the shock θ_t with $\rho_\theta = 0.66$ and $\sigma_\theta = 0.05$. φ is the necessary gain or loss for consumption to replicate the empirical mean of welfare, i.e.

$$\mathbb{E}(W_t) \equiv \frac{\ln((1 + \varphi)(1 - \gamma)C) - \frac{x}{1+\varepsilon}L^{1+\varepsilon}}{(1 - \beta)}$$

Appendix A: The distribution of legal fines

Figure 15: Other regulatory entities imposing fines

Commodity Futures Trading Commission - 4.1 Billion



Fannie Mae - 16.1 Billion

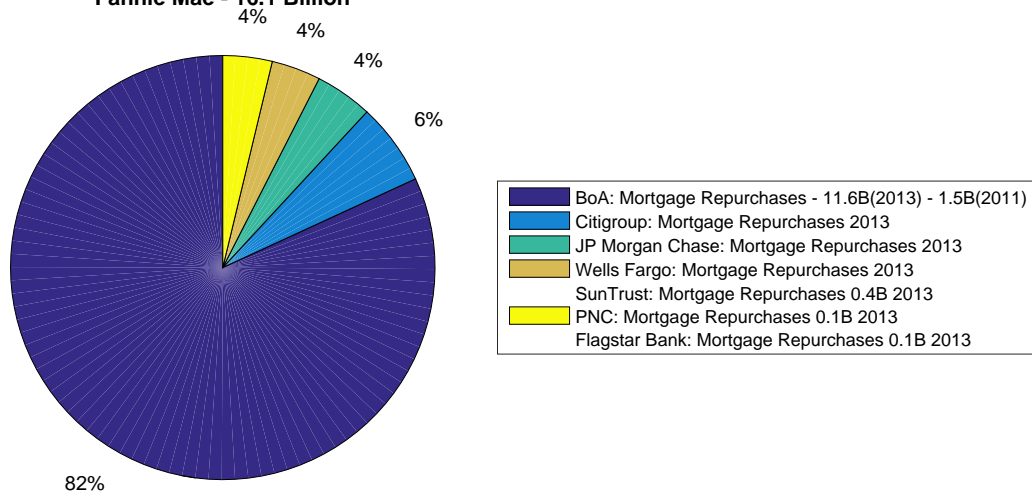
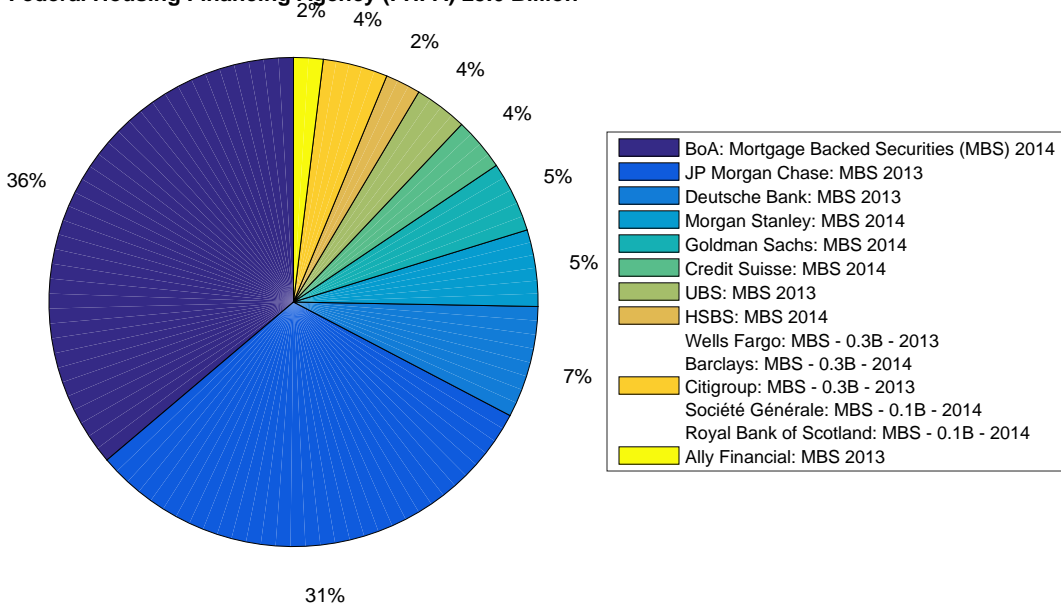


Figure 16: Other regulatory entities imposing fines

Federal Housing Financing Agency (FHFA) 25.6 Billion



Office of the Comptroller of the Currency - 10.9 Billion

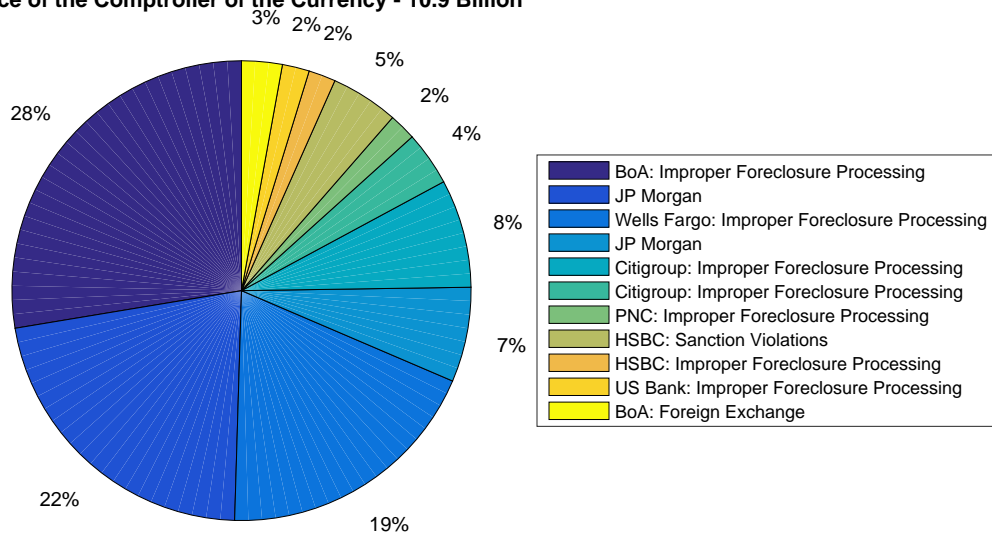
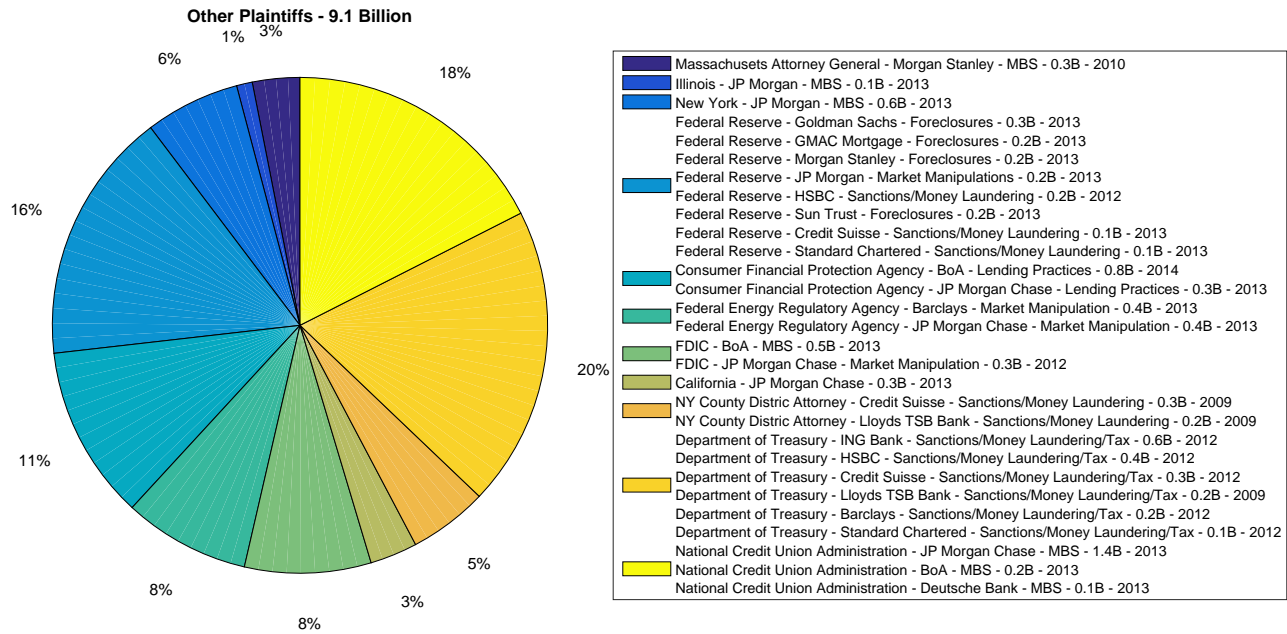


Figure 17: Fines imposed by other plaintiffs



Appendix B: Databases

Aggregate Legal Settlements : SEC, Department of Justice, Wall Street Journal, Reuters, FDIC (between 2009Q2-2015Q2)

The following data are selected for the period of 1986Q1-2015Q1.

Aggregate output : Real GDP time series from Federal Reserve St. Louis Database.

GDP Deflator: Gross Domestic Product: Implicit Price Deflator (GDPDEF) from US. Bureau of Economic Analysis

Aggregate Investment : Gross Private Domestic Investment (GPDI) US. Bureau of Economic Analysis + Personal Consumption Expenditures: Durable Goods (PCEDG) US. Bureau of Economic Analysis

Labor force : Civilian Labor Force - US. Bureau of Labor Statistics

Return on Capital on Grade AAA assets : Moody's Seasoned Aaa Corporate Bond Yield - Board of Governors of the Federal Reserve System (US)

Return on Capital on Grade BAA assets : Moody's Seasoned Baa Corporate Bond Yield - Board of Governors of the Federal Reserve System (US)

Riskless Rate: Effective Federal Funds Rate - Board of Governors of the Federal Reserve System (US)

Number of Commercial Banks : Federal Financial Institutions Examination Council (US)

Total Liabilities : Total Liabilities, All Commercial Banks (TLBACBM027SBOG) - Board of Governors of the Federal Reserve System (US)

Total Assets : Total Assets, All Commercial Banks (TLAACBW027SBOG) - Board of Governors of the Federal Reserve System (US)

Total Deposits : Deposits, All Commercial Banks (DPSACBM027NBOG) - Board of Governors of the Federal Reserve System (US)

Equity: Residual (Assets Less Liabilities), All Commercial Banks (RALACBM027SBOG) - Board of Governors of the Federal Reserve System (US)

Interbank Loan : Interbank Loans, All Commercial Banks (IBLACBW027NBOG) - Board of Governors of the Federal Reserve System (US)- Not Seasonally Adjusted

The variables for the fit are calculated in the following way:

$$\text{GDP per capita} = \text{GDP}_t / \text{Pop}_t$$

$$\text{Investment per capita} = \text{Inv}_t / \text{Pop}_t$$

To capture the growth of financial variables divided by the population.

$$\text{Real total Asset per capita} = (\text{Asset}_t / \text{GDPdef}_t) / \text{Pop}_t$$

$$\text{Real total Deposit per capita} = (\text{Deposit}_t / \text{GDPdef}_t) / \text{Pop}_t$$

$$\text{Real total Liabilities per capita} = (\text{Liabilities}_t / \text{GDPdef}_t) / \text{Pop}_t$$

$$\text{Real Equity (net-worth) per capita} = (\text{Residuals}_t / \text{GDPdef}_t) / \text{Pop}_t$$

$$\text{Interbank Loan} = (\text{Interbank}_t / \text{GDPdef}_t) / \text{NumBanks}_t$$

Two definitions of Leverage can be given:

$$\text{Leverage}'_t = (\text{TotalAssets}_t / \text{Equity}_t) \quad \text{Leverage}''_t = (\text{TotalDeposit}_t / \text{Equity}_t)$$

Spread is calculated in the following way, first rates are transformed into quarterly gross interest rate

$$\text{Federal Funds} = \left(1 + \frac{FF_t}{400}\right), \text{AAA Rates} = \left(1 + \frac{AAA_t}{400}\right), \text{BAA} = \left(1 + \frac{BAA_t}{400}\right)$$

$$\text{Spread is then defined as } \text{Spread}_t = \text{BAA}_t - \text{FF}_t$$

All level time series are logged and one-sided HP filtered. The reason of using one sided HP-filtered is that two-sided filters (like Baxter and King) takes values from y_{t-3}^{unfilt} to y_{t+3}^{unfilt} to construct y_t^{filt} . This contradicts the backward looking structure of the solutions of DSGE models.

Appendix C: Loan Regression

The regression is conducted using the DealScan loan database. I have considered loans issued after the crisis to circumvent dealing with nonlinearities induced during the crisis. I am assuming that fines imposed on banks arrive exogenously, therefore to some extent it is safe to assume the orthogonality of fines and residuals. I consider two different levels of fines. Fines imposed prior to the loan's origination i.e. f_{t-1} . Also $f_{t-1} - f_{t-2}$ to capture the drag imposed by fines in the second quarter prior to the loan's origination. To conduct the regression the following variables are used as explanatory variables in the regression.

Variables' Definition

Cash Flow Volatility: Ratio of the standard deviation of the past eight earnings changes to the average book size over the past eight quarters.

Leverage: (Debt in current liabilities + total long-term debt) divided by total assets.

Loan Size: Total facility amount (\$ millions).

Loan Spread: Measured as all-in-spread drawn: the amount the borrower pays in basis points over LIBOR or LIBOR equivalent for each dollar drawn down. This measure adds the borrowing spread of the loan over LIBOR with any annual fee paid to the bank group.

Market Value of Equity: Common Shares Outstanding Price-Close-Quarterly-End.

Market Value: Market value of equity - Book value of equity + Total Assets

Market-to-Book: (Debt in current liabilities+total long-term debt+preferred stock carrying value deferred taxes and investment tax credit+stock price at the end of quarter common shares outstanding) divided by total assets.

Maturity: Facility maturity in months.

Profitability: EBIDTA divided by total assets.

Purpose: Indicator variables for the following categories reported in DealScan: debt repayment, working capital, takeover or other.

Sales: Total Sales (net).

Secured: Dummy variable, 1 if facility is secured and 0 otherwise.

Total Assets: Total book assets in billions USD.

Tangibility: Net property, plant, and equipment divided by total assets.

Working Capital : Total Current Assets (excluding Cash) - Total Current Liabilities.

Z-Score = 3.3 Pretax operating income/total assets + sales/total assets + 1.4 retained earnings/total assets

Regression

DealScan contains information on loans (facility items) received by a borrower identified with its borrowing identification code. Loans are usually extended as a form of package (with Package ID) which contains the usual financial and business covenants. Moreover in this database, the amount of loan, the start of the loan (identified as facility date), the spread (known as all in drawn including fees), maturity, amount of loan and the lenders are documented. Therefore given the richness I can control for several different dimensions. In this work I have excluded the financial companies, the ones which their SIC identification codes are between 6000-6999. The database contains loans which are big, hence makes the results of this empirical study more credible. To take into account the borrower conditions, I have retrieved the data from COMPUSTAT and merged it with DealScan given their unique company ID.

Since in the database the lender identification code for each borrower is available, I can control for lender and borrower joint relationship. This approach is desirable since there could be arguments that spread is partially a product of the lender and borrower relationship. Since one end are bankers, the impact of legal fines on banking industry affects the spread through this channel. Therefore I run the following regression to see the impact of legal fines on the spread

$$R_{i,t} = \alpha + \beta^T X_{i,t} + \gamma \log(f_{t-1}) + \gamma' (\Delta f_{t-1}) + (Borrower_i \times Lender_j) + Quarter + Year + QE_j + \epsilon_{i,t}$$

where $R_{i,t}$ is the logarithm of all-in-drawn spread of loan i issued at time t by a syndicate of lenders j , $X_{i,t}$ contains controls for loan and firm specific characteristics, $(Borrower_i \times Lender_j)$ is the interactive term controlling for the lender and borrowing relationship, $Quarter$ and $Year$ capture the time trend. $(\log f_{t-1})$ is the log of legal fines paid by banking industry in the previous quarter of the loan's issuance. $\gamma' (\Delta f_{t-1})$ is The interactive terms deal with heterogeneity in firm characteristics in the following way. $(Borrower_i \times Lender_j)$ controls for fixed effects for firm-bank relationship. Firm-bank fixed effects capture not only time-invariant heterogeneity across borrowers or banks but also time-invariant heterogeneity across each bank-lender pairing and time fixed effects capture the time evolution²⁵. Controlling for loan and firm characteristics show that on average, legal fine's impact is negative on the spread.

²⁵This approach is common in empirical finance such as Rodano et al (forthcoming) and Cerqueiro et al (2014)

Table 10: Regression results

Dependent: All-in-drawn (log)	(1)		(2)		(3)	
Cumulative legal fine (log) f_{t-1}	-0.11***	(0.009)	-0.142	(0.008)	-0.12***	(0.0097)
Drag (log) ($f_{t-1} - f_{t-2}$)	-0.000036***		-0.00006***		-0.000037***	
Loan Characteristics	No		Yes		Yes	
Borrower Characteristics	Yes		No		Yes	
$(Lender_j \times Borrower_i)$	Yes		Yes		Yes	
Categories	(10,050)		(17,153)		(10,026)	
<i>Quarter</i> dummies	Yes		Yes		Yes	
<i>Year</i> dummies	Yes		Yes		Yes	
<i>QE</i> dummies	Yes		Yes		Yes	
Number of Observation.	15011		25325		15011	

The following regression is conducted for different specifications

$$R_{i,t} = \alpha + \beta^T X_{i,t} + \gamma (\log f_{t-1}) + \gamma' (\Delta f_{t-1}) + (Borrower_i \times Lender_j) + Quarter + Year + \epsilon_{i,t}$$

(1) only keeping the loan characteristics, (2) only firm characteristics, (3) the complete specification. For the sake of brevity only the coefficient of legal fines are reported. Loan characteristics include the deal amount (log), maturity (log) and a dummy whether or not the loan is secured (with collateral). The firm characteristics include the following variable market value of equity, total sales (net), assets net of liabilities, leverage, Ebitda (as a proxy for cash flow), Altman-Z (as a proxy for how close to bankruptcy the firm is), profitability and market- to-book ratio. The Macro variables include, the level of Treasury yields (which follows directly the Fed Fund Rate as a mean of longer investment), the total loan extended by commercial banks and the interbank loan. $(Borrower_i \times Lender_j)$ is the interactive term between the borrower and lender and the number includes the number of categories. The standard errors are all robust. The results should cautiously be interpreted as it shows a certain degree of correlation between the legal fine imposed in a quarter and the corporate spread having controlled for potential channels. ***, **, * designate statistical significance at 1%, 5% and 10%. I am cautious in terms of interpreting the results and I admit the above regression is capturing at best some form a correlation controlled for factors which potentially affect the spread

Appendix D: Derivations

Static model

There are simply two periods. Households deposit (d) and consume (c_1) out of their endowment (y) in the first period and in the second period, the consume (c_2) financed with earnings on their deposits ($R_d d$) and profit sent back by bankers to household (Π). A CAPM utility function is then assumed with risk aversion of σ . β is the discount factor of the second period.

$$\max u(c_1) + \beta u(c_2) \text{ where } u(c) = \frac{c^{1-\sigma}}{1-\sigma} \quad (34)$$

$$c_1 + d \leq y \text{ and } c_2 \leq R_d d + \Pi \quad (35)$$

The First Order Conditions (hereafter FOC) is then $c_2 = c_1 (\beta R_d)^{\frac{1}{\sigma}}$. Banks they finance firms (which simply produce a return on asset equal to R_k) with their net-worth N and deposit d . Hence the balance-sheet of the bank would be $s = N + d$ where s are securities purchased by the bank. Banks maximize their franchise value, or in this simple example, their end of second period profit, i.e. by choosing the level of demand of deposit

$$\Pi = R_k s - R_d d_b$$

The incentive constraint which bank maximize its profit, is a “running-away” constraint in a sense that bankers can raise deposit in the first period and in the second period they may well get tempted to abscond a fraction of it as unwarranted bonuses and they go default. Despite the fact that default never takes place in equilibrium, it is the fear of default that limits the willingness of depositors (or creditors in general) to extend their line of credit. Let's designate the fraction that can be absconded from assets (broadly captures such as liquid and illiquid assets purchased by banks) by θ . θ may also capture a parallel concept of moral hazard. The incentive constraint of the bank in the second period then becomes :

$$R_k (N + d_b) - R_d d_b \geq \theta (N + d_b) R_k \Rightarrow (1 - \theta) (N + d_b) R_k \geq d_b R_d$$

Banks should announce their desired level of deposit (i.e. d_b) and there is an implicit mechanism to compare the quantity that banks actually take with their announced level and in case of a difference, put sanctions on banks. Re-writing the constraint in the following form is more illustrative :

$$(1 - \theta) N R_k \geq (\theta R_k - (R_k - R_d)) d_b$$

On the other hand, depositor issue a level of d that would be equal to the announced level by banks (i.e. $d = d_b$). From the first and second period budget constraints we have $c_1 + \frac{c_2}{R_d} \leq y + \frac{\Pi}{R_d} \Rightarrow c_1 \leq \frac{y + \frac{\Pi}{R_d}}{\left(1 + \frac{(\beta R_d)^{\frac{1}{\sigma}}}{R_d}\right)}$. Therefore

$$d = y - c_1 = y - \frac{y + \frac{\Pi}{R_d}}{\left(1 + \frac{(\beta R_d)^{\frac{1}{\sigma}}}{R_d}\right)} = \frac{y \frac{(\beta R_d)^{\frac{1}{\sigma}}}{R_d}}{\left(1 + \frac{(\beta R_d)^{\frac{1}{\sigma}}}{R_d}\right)} - \frac{\frac{\Pi}{R_d}}{\left(1 + \frac{(\beta R_d)^{\frac{1}{\sigma}}}{R_d}\right)}$$

Substituting the profit in above equation :

$$d = y - c_1 = \frac{y \frac{(\beta R_d)^{\frac{1}{\sigma}}}{R_d}}{\left(1 + \frac{(\beta R_d)^{\frac{1}{\sigma}}}{R_d}\right)} - \frac{R_k (N + d) - R_d d_b}{R_d} \Rightarrow d = \frac{y \frac{(\beta R_d)^{\frac{1}{\sigma}}}{R_d} - \frac{N R_k}{R_d}}{\left(1 + \frac{(\beta R_d)^{\frac{1}{\sigma}}}{R_d} + \frac{R_k - R_d}{R_d}\right)}$$

$$d^* = \frac{y (\beta R_d)^{\frac{1}{\sigma}} - N R_k}{(\beta R_d)^{\frac{1}{\sigma}} + R_k}$$

The maximum level of moral hazard then corresponds to the situation where there will be no spread, i.e. $R_k = R_d$. This corresponds to $d_b \leq \left(\frac{1-\theta}{\theta}\right) N$. Therefore

$$d^* = \frac{y (\beta R_d)^{\frac{1}{\sigma}} - N R_k}{(\beta R_d)^{\frac{1}{\sigma}} + R_k} \leq \left(\frac{1 - \theta}{\theta}\right) N$$

$$\left(\frac{1}{\theta} - 1\right) = \frac{\frac{y}{N} (\beta R_k)^{\frac{1}{\sigma}} - R_k}{\underbrace{(\beta R_k)^{\frac{1}{\sigma}} + R_k}_B} \Rightarrow \theta^{max} = \frac{1}{1+B}$$

Corollary : (Christiano and Ikeda, 2011) A necessary and sufficient condition for the spread, $R_k - R_d > 0$ to exist in equilibrium is to have $\theta > \theta^{max}$.

Proof: The intuition is θ^{max} is the lower bound for which there will be no spread. A requirement to have spread is when the level of moral hazard would be higher than that of θ^{max} . To prove the corollary, one can use the proof by contradiction. We assume that the true statement is $\theta \leq \theta^{max}$ and this can be obtained by keeping the condition of the corollary valid. This is equivalent of showing that if $R_k = R_d$ then $\theta \leq \theta^{max}$. When there is no spread, the intermediary makes zero profit, and the quantity of deposit shall be determined by households. Substituting $d_b = d^*$ into $(1 - \theta)(N + d_b) R_k \geq d_b R_d$ gives

$$(1 - \theta) N \geq \theta d_b \Rightarrow \left(\frac{1}{\theta} - 1\right) \geq \frac{\frac{y}{N} (\beta R_d)^{\frac{1}{\sigma}} - N R_k}{(\beta R_d)^{\frac{1}{\sigma}} + R_k} \Rightarrow \theta \leq \frac{1}{1+B} = \theta^{max}$$

which is a contradiction. The necessary condition is if $R_k - R_d > 0$ then $(1 - \theta)(N + d_b) R_k \geq d_b R_d$ binds and therefore $(1 - \theta)(N + d_b) R_k - d_b R_d = 0$. Substituting $d_b = d^*$ we have

$$\theta = \frac{N}{N+y} \left(1 + \frac{y}{N} \left(1 - \frac{R_d}{R_k}\right) + R_d (\beta R_d)^{-\frac{1}{\sigma}}\right)$$

we know $\theta^{max} = \frac{1}{\frac{(\beta R_k)^{\frac{1}{\sigma}}}{(1 + \frac{y}{N})} + R_k} = \left(\frac{N}{N+y}\right) \frac{(\beta R_k)^{\frac{1}{\sigma}} + R_k}{(\beta R_k)^{\frac{1}{\sigma}}}$, which says $\theta > \theta^{max}$. The corollary shows the existence

of a positive premium is governed by the relative measure of absconded value by banks to the plausible measure of moral hazard, i.e. θ^{max} .

Legal Fine

Therefore the key idea is legal uncertainties will increase the efficiency of the equilibrium by increasing θ^{max} . We start by the possibility of paying some legal fines. The idea, as explained before is that there is an implicit government which costlessly retrieve the absconded amount. The fund retrieval takes place before the end of period two, i.e. within the timeline before banks pay dividends or sending back their profits to households. In this case since bankers know that retrieval is probabilistic, they might even get tempted to increase their level of moral hazard. The incentive constraint takes the following form :

$$R_k (d_b + N) - R_d d_b \geq \theta (d_b + N) R_k + \pi \cdot 0 + \underbrace{(1 - \pi) (-\theta (d_b + N) R_k)}_{\text{Legal fine}} \quad (36)$$

It is straight forward to see that $\theta_{\pi}^{max} = \frac{1}{1+B} \left(\frac{1}{\pi}\right)$ with $\frac{\partial \theta^{max}}{\partial \pi} < 0$ and since $0 < \pi < 1$ we have $\theta > \theta_{\pi}^{max} > \theta^{max}$. Since the outside option in both cases for the bank is indeed default, but one with a positive non zero probability has to even pay some legal fine for settlements. This would increase the lower bound for θ and according to the Corollary, makes the equilibrium more efficient.

Monitoring Technology

Suppose there is a lack of monitoring, i.e. the government cannot always watch over intermediaries. Without loss of generality, suppose that monitoring is done costlessly. However, the incentive constraint of banker changes in the following way :

$$R_k (d_b + N) - R_d d_b \geq \theta (d_b + N) R_k + \underbrace{(1 - \pi) (\kappa (1 - \theta) (d_b + N) R_k - R_d d_b)}_{\text{Franchise value after misappropriate conduct}} \quad (37)$$

where κ is appreciation parameter. I perceive $\kappa (1 - \theta) (d_b + N) R_k - R_d d_b$ as the book value or the franchise value of the intermediary in the form of profit which shall be sent back to the household. κ is a very novice way of capturing write-up and write-down in intermediaries' balance sheets. So the role of the implicit regulator (or government) is that its monitoring technology will detect the misappropriate conduct and shut down the firm.

Detection is done costlessly. One way of making this costly is to interpret it as a cost financed through taxes. We have then :

$$sR_k(1 - \kappa + \pi\kappa) - \pi R_d d_b \geq \theta sR_k(1 - \kappa + \pi\kappa)$$

assuming $\xi = (1 - \kappa + \pi\kappa)$

$$(d_b + N) R_k \xi - \pi R_d d_b \geq \theta (d_b + N) R_k \xi$$

d_b would be when $R_k = R_d$ hence

$$(d_b + N) \xi - \pi d_b \geq \theta (d_b + N) \xi$$

$$N\xi(1 - \theta) \geq d_b(\theta\xi - \xi + \pi) \Rightarrow d_b = \frac{N\xi(1 - \theta)}{(\theta\xi - \xi + \pi)}$$

when $d_b = d$ we have

$$\frac{\frac{y}{N} (\beta R_d)^{\frac{1}{\sigma}} - N R_k}{(\beta R_d)^{\frac{1}{\sigma}} + R_k} \leq \frac{\xi(1 - \theta)}{(\theta\xi - \xi + \pi)}$$

with some algebra it can be shown that $\frac{\partial \theta^{max}}{\partial \pi} < 0$ i.e. as the monitoring capacity decreases, the lower bound for which there would be no spread increases.

Government Unconventional Credit Policies

Without legal fines

With some minor modifications, we can have a framework, in which government inject credit directly into the balance sheet. The timeline looks like the following : in period (1), government taxes the household a lump sum amount of T and then injects it right away to the bank's balance sheet N_g . Government is now entitled to the profit and would also fight to protect its stake in the bank, if banks decides to default on its debt. Let's consider three cases as in (ibid.), (i) weak government where if bank defaults, it default both on private and public fund ($\delta = 0$), (ii) strong government where if bank decides to default it may do so only on private fund ($\delta = 1$) and (iii) punitive government which also requires a premium of R^k on its injected money. The share of government's entitlement to bank's profit is designated by ω_g . Therefore the bank's balance sheet will then become

$$\pi_b \geq \theta (\tilde{N} + d_b) R_k - \delta \pi_g$$

where $\tilde{N} = N + N_g$ (and $N_g = T$ i.e. lump sum tax). The derivation would be

$$d = y - T - c_1 = y - \frac{y - T + \frac{\tilde{\pi}}{R_d}}{\left(1 + \frac{(\beta R_d)^{\frac{1}{\sigma}}}{R_d}\right)} = \frac{(y - T) \frac{(\beta R_d)^{\frac{1}{\sigma}}}{R_d}}{\left(1 + \frac{(\beta R_d)^{\frac{1}{\sigma}}}{R_d}\right)} - \frac{\frac{\tilde{\pi}}{R_d}}{\left(1 + \frac{(\beta R_d)^{\frac{1}{\sigma}}}{R_d}\right)}$$

$$d^* = \frac{(y - N_g) (\beta R_d)^{\frac{1}{\sigma}} - (N + N_g) R_k}{(\beta R_d)^{\frac{1}{\sigma}} + R_k}$$

$$\pi_b \geq \theta (\tilde{N} + d_b) R_k - \delta \pi_g \Rightarrow (1 - \omega_g) \tilde{\pi} \geq \theta (\tilde{N} + d_b) R_k - \delta \omega_g \pi_g$$

$$(1 + (\delta - 1) \omega_g) \tilde{\pi} \geq \theta (\tilde{N} + d_b) R_k$$

$$(1 + (\delta - 1) \omega_g) (R_k (N + N_g + d_b) - R_d d_b) \geq \theta (N + N_g + d_b) R_k$$

$$(1 + (\delta - 1) \omega_g) (N + N_g) \geq \theta (N + N_g + d_b)$$

$$(1 + (\delta - 1) \omega_g) (N + N_g) - \theta (N + N_g) \geq \theta (d_b)$$

$$(1 + (\delta - 1) \omega_g) (N + N_g) (1 - \theta) \geq \theta d_b$$

$$\begin{aligned}
(1 + (\delta - 1)\omega_g)(N + N_g) \frac{(1 - \theta)}{\theta} &\geq d_b \\
(1 + (\delta - 1)\omega_g)(N + N_g) \frac{(1 - \theta)}{\theta} &\geq \frac{(y - N_g)(\beta R_d)^{\frac{1}{\sigma}-1} - (N + N_g)}{(\beta R_d)^{\frac{1}{\sigma}-1} + 1} \\
(1 + (\delta - 1)\omega_g)(N + N_g)(1 - \theta) &= \theta \frac{(y - N_g)(\beta R_d)^{\frac{1}{\sigma}-1} - (N + N_g)}{(\beta R_d)^{\frac{1}{\sigma}-1} + 1} \\
\frac{(1 - \theta)}{\theta} &= \frac{\frac{(y - N_g)(\beta R_d)^{\frac{1}{\sigma}-1} - (N + N_g)}{(\beta R_d)^{\frac{1}{\sigma}-1} + 1}}{(1 + (\delta - 1)\omega_g)(N + N_g)} \\
\frac{1}{\theta} &= \frac{\frac{(y - N_g)(\beta R_d)^{\frac{1}{\sigma}-1} - (N + N_g)}{(\beta R_d)^{\frac{1}{\sigma}-1} + 1}}{(1 + (\delta - 1)\omega_g)(N + N_g)} + 1 \\
\theta &= \frac{1}{\frac{(y - N_g)(\beta R_d)^{\frac{1}{\sigma}-1} - (N + N_g) + (1 + (\delta - 1)\omega_g)(N + N_g)((\beta R_d)^{\frac{1}{\sigma}-1} + 1)}{(\beta R_d)^{\frac{1}{\sigma}-1} + 1}} \\
&= \frac{1}{(1 + (\delta - 1)\omega_g)(N + N_g)}
\end{aligned}$$

After some algebra we get to

$$\theta_{\delta}^{max} = \frac{(N + N_g)(1 - (\delta - 1)\omega_g)}{N + y} \left(1 + R_k (\beta R_k)^{-\frac{1}{\sigma}}\right)$$

With legal fines

Suppose government finances the cost to retrieve any possible diversion through taxes. In this case, less will be directed as equity injection to the bank and a portion of it shall be used as a cost to retrieve whatever bankers might abscond. Suppose the government utility is defined in the following way, such that $U = u(T) - \frac{1}{2}\beta\pi^2$ where utility is received by taxing in the first period, which then minimizes the discounted cost of retrieving the fund. Suppose $u(T) = \frac{T^{1-\sigma}}{1-\sigma}$. The government budget constraint in periods (1) and (2) will be

$$N_g \leq \nu_g T$$

$$\pi \leq (1 - \nu_g) T$$

The cost will then be financed out of the profit that would be given to bank in case of no default and the remaining tax. The maximum level of θ is then given by

$$\theta_{\delta}^{max} = \frac{(N + N_g)}{N + y} \left(1 + R_k (\beta R_k)^{-\frac{1}{\sigma}}\right) \left(\frac{1}{\pi^*}\right)$$

and π^* would be the outcome of a minimizing the cost. Therefore, we have $\pi^* = \left(\frac{1}{T\sigma}\right) \left(\frac{1}{\beta}\right)$. $\frac{\partial \pi}{\partial T} < 0$ which as government gets more taxes, the cost retrieving absconded funds decrease.

Appendix E: A note on the dynamic set-up

In the dynamic set-up, the expected discounted value of the value function appears in the participation constraint. However, for the class of models in which the expected discounted value appears in the implementation or participation constraint, it is shown by [Kydlan and Prescott \(1977\)](#) that the usual Bellman equation properties are not satisfied. An insightful work of [Marcet and Marimon \(2011\)](#) argue that it is possible to obtain a recursive formulation for a general class of contracting problems involving incentive constraints. Their approach is to study a recursive Lagrangian. To observe the idea let's consider the following program as a simplified version of the model considered in the paper:

$$V(s_t, d_t) = \sup_{\{s_t, d_t\}} \mathbb{E}_0 \sum_{t=1}^{\infty} (1 - \sigma) \sigma^{t-1} \Lambda_{0,t} n_t$$

$$\mathbb{E}_t \sum_{i=1}^{\infty} (1 - \sigma) \sigma^{i-1} \Lambda_{i,t+i} n_{t+i} \geq \theta Q_t s_t$$

where s_t is the asset, d_t is the deposit, σ survival rate of bankers, $\Lambda_{0,t}$ is the banker's discount factor and n_t is the net-worth. The banker is maximizing the franchise value with respect to the following constraint. θ is the diversion rate, or what I have argued the plausible moral hazard set by the household (due to equality of demand and supply of credit functions). The constraint is dictating that if the banker stands at a given point of time t , its forward expected discounted value should be more than the default threshold $\theta Q_t s_t$ to continue its operation. The law of motion for the net-worth is given by $n_{t+1} = R_{k,t+1} Q_t s_t - R_{t+1} d_t$. Suppose the Lagrangian corresponding the incentive constraint is λ_t then collecting the maximization terms given at each point of time we have

$$[s_0] : [(1 + \lambda_0) \mathbb{E}_0 (1 - \sigma) \Lambda_{0,1} R_{k,1} Q_0 - \lambda_0 \theta Q_0]$$

$$[s_1] : [(1 + \lambda_0) \mathbb{E}_0 (1 - \sigma) \Lambda_{0,2} R_{k,2} Q_1 + (\lambda_1) \mathbb{E}_1 (1 - \sigma) \Lambda_{1,2} R_{k,2} Q_1 - \lambda_1 \theta Q_1]$$

$$[s_2] : \left[(1 + \lambda_0) \mathbb{E}_0 (1 - \sigma)^2 \Lambda_{0,3} R_{k,3} Q_2 + (\lambda_2) \mathbb{E}_2 (1 - \sigma) \Lambda_{1,3} R_{k,3} Q_2 - \lambda_2 \theta Q_2 \right]$$

$$\vdots$$

$$[s_t] : [(1 + \lambda_0) \mathbb{E}_0 (1 - \sigma) \sigma^t \Lambda_{0,t+1} R_{k,t+1} Q_t$$

$$+ (\lambda_1) \mathbb{E}_1 (1 - \sigma) \sigma^{t-1} \Lambda_{1,t+1} R_{k,t+1} Q_t + (\lambda_2) \mathbb{E}_2 (1 - \sigma) \sigma^{t-2} \Lambda_{2,t+1} R_{k,t+1} Q_t$$

$$+ \dots + (\lambda_t) \mathbb{E}_t (1 - \sigma) \Lambda_{t,t+1} R_{k,t+1} Q_t - \lambda_t \theta Q_t]$$

We then have

$$[s_t] : [(1 + \lambda_0) \mathbb{E}_0 (1 - \sigma) \sigma^t \Lambda_{0,t+1} R_{k,t+1} Q_t$$

$$+ \mathbb{E}_1 (1 - \sigma) \sigma^t \left(\frac{\lambda_1 \Lambda_{1,t+1}}{\sigma} \right) R_{k,t+1} Q_t + \mathbb{E}_2 (1 - \sigma) \sigma^t \left(\frac{\lambda_1 \Lambda_{1,t+1}}{\sigma} \right) R_{k,t+1} Q_t$$

$$+ \dots + \mathbb{E}_t (1 - \sigma) (\lambda_t \Lambda_{t,t+1}) R_{k,t+1} Q_t - \lambda_t \theta Q_t]$$

Given the recursive nature of expected discounted value, we can define $\tilde{\lambda}_n = \frac{\lambda_n}{[\sigma \Lambda_{0,n}]}$ to rewrite the above constraint :

$$[s_t] : [(1 + \lambda_0) \mathbb{E}_0 (1 - \sigma) \sigma^t \Lambda_{0,t+1} R_{k,t+1} Q_t$$

$$+ \mathbb{E}_1 (1 - \sigma) \sigma^t \Lambda_{0,t+1} \left(\frac{\lambda_1}{\sigma \Lambda_{0,1}} \right) R_{k,t+1} Q_t + \mathbb{E}_2 (1 - \sigma) \sigma^t \Lambda_{0,t+1} \left(\frac{\lambda_2}{\sigma \Lambda_{0,2}} \right) R_{k,t+1} Q_t$$

$$+ \dots + \mathbb{E}_t (1 - \sigma) \sigma^t \Lambda_{0,t+1} \left(\frac{\lambda_t}{\sigma \Lambda_{0,t}} \right) R_{k,t+1} Q_t - \lambda_t \theta Q_t]$$

Hence:

$$[s_t] : \left[(1 + \tilde{\lambda}_0) \mathbb{E}_0 (1 - \sigma) \sigma^t \Lambda_{0,t+1} R_{k,t+1} Q_t \right.$$

$$\left. + \mathbb{E}_1 (1 - \sigma) \sigma^t \tilde{\lambda}_1 \Lambda_{0,t+1} R_{k,t+1} Q_t + \mathbb{E}_2 (1 - \sigma) \sigma^t \tilde{\lambda}_2 \Lambda_{0,t+1} R_{k,t+1} Q_t \right]$$

$$+ \dots + \mathbb{E}_t (1 - \sigma) \sigma^t \tilde{\lambda}_t \Lambda_{0,t+1} R_{k,t+1} Q_t - \tilde{\lambda}_t [\sigma \Lambda_{0,t}] \theta Q_t \Big]$$

Finally taking advantage of the laws of iterated expectations we have

$$[s_t] : \left[\mathbb{E}_0 \sigma^t \Lambda_{0,t+1} \left((1 - \sigma) \left(1 + \tilde{\lambda}_1 + \tilde{\lambda}_2 + \dots + \tilde{\lambda}_t \right) R_{k,t+1} Q_t - \tilde{\lambda}_t \theta Q_t \right) \right]$$

$$[d_t] : \left[-\mathbb{E}_0 \sigma^t \Lambda_{0,t+1} \left((1 - \sigma) \left(1 + \tilde{\lambda}_1 + \tilde{\lambda}_2 + \dots + \tilde{\lambda}_t \right) R_{t+1} \right) \right]$$

$$\min_{\tilde{\lambda}_t} \max_{\{s_t, d_t\}} \left[\mathbb{E}_0 \sum_{t=1}^{\infty} (1 - \sigma) \sigma^t \Lambda_{0,t+1} \left(1 + \tilde{\lambda}_1 + \tilde{\lambda}_2 + \dots + \tilde{\lambda}_t \right) (R_{k,t+1} Q_t s_t - R_{t+1} d_t) - \lambda_t \theta Q_t s_t \right]$$

$$\text{s.t. } Q_t s_t = n_t + d_t$$

What Marcat and Marimon (2011) propose is that for problems where the expected discounted value appears in the constraint, the objective function can be re-written by introducing a co-state Lagrangian, in this case $\mu_{t+1} = \left(1 + \tilde{\lambda}_1 + \tilde{\lambda}_2 + \dots + \tilde{\lambda}_t \right)$ We can propose the following propositions.

Proposition 1: Spread increases as the incentive constraint binds (i.e. $\lambda_t > 0$).

Proof: to show this, by taking the derivative with respect to d_t and s_t by taking into account the balance sheet identity we have

$$[s_t] : \mathbb{E}_0 \sum_{t=1}^{\infty} (1 - \sigma) \sigma^t \Lambda_{0,t+1} \left(1 + \tilde{\lambda}_1 + \tilde{\lambda}_2 + \dots + \tilde{\lambda}_t \right) (R_{k,t+1}) - \lambda_t \theta = \eta_t$$

$$[d_t] : \mathbb{E}_0 \sum_{t=1}^{\infty} (1 - \sigma) \sigma^t \Lambda_{0,t+1} \left(1 + \tilde{\lambda}_1 + \tilde{\lambda}_2 + \dots + \tilde{\lambda}_t \right) (R_{t+1}) = \eta_t$$

$$\mathbb{E}_0 \sum_{t=1}^{\infty} (1 - \sigma) \sigma^t \Lambda_{0,t+1} \left(1 + \tilde{\lambda}_1 + \tilde{\lambda}_2 + \dots + \tilde{\lambda}_t \right) (R_{k,t+1} - R_{t+1}) = \lambda_t \theta$$

$$\mathbb{E}_t (R_{k,t+1} - R_{t+1}) = \frac{\lambda_t}{\left(1 + \tilde{\lambda}_1 + \tilde{\lambda}_2 + \dots + \tilde{\lambda}_t \right)} \theta$$

Proposition 2: Leverage increases as the incentive constraint binds (i.e. $\lambda_t > 0$).

Proof: by taking the derivative with respect to $\tilde{\lambda}_t$ we have the following

$$[\tilde{\lambda}_t] : \mathbb{E}_0 \sum_{t=1}^{\infty} (1 - \sigma) \sigma^t \Lambda_{0,t+1} \left(1 + \tilde{\lambda}_1 + \tilde{\lambda}_2 + \dots + \tilde{\lambda}_t \right) (R_{k,t+1} Q_t s_t - R_{t+1} (Q_t s_t - n_t)) - \tilde{\lambda}_t \Lambda_{0,t} \sigma \theta Q_t s_t$$

$$[\tilde{\lambda}_t] : \mathbb{E}_0 \sum_{t=1}^{\infty} (1 - \sigma) \sigma^t \Lambda_{0,t+1} \left((R_{k,t+1} - R_{t+1}) Q_t s_t + R_{t+1} n_t \right) = \Lambda_{0,t} \sigma \theta Q_t s_t$$

$$\frac{\lambda_t}{\left(1 + \tilde{\lambda}_1 + \tilde{\lambda}_2 + \dots + \tilde{\lambda}_t \right)} \theta Q_t s_t + \mathbb{E}_0 \sum_{t=1}^{\infty} (1 - \sigma) \sigma^t \Lambda_{0,t+1} R_{t+1} n_t = \Lambda_{0,t} \sigma \theta Q_t s_t$$

$$\frac{Q_t s_t}{n_t} = \frac{\mathbb{E}_t R_{t+1}}{\theta} \frac{1}{1 - \frac{\tilde{\lambda}_t \Lambda_{0,t} \sigma}{\left(1 + \tilde{\lambda}_1 + \tilde{\lambda}_2 + \dots + \tilde{\lambda}_t \right)}}$$

If $\tilde{\lambda}_t > 0$, $1 > \frac{\tilde{\lambda}_t \Lambda_{0,t} \sigma}{\left(1 + \tilde{\lambda}_1 + \tilde{\lambda}_2 + \dots + \tilde{\lambda}_t \right)}$ which increases the leverage.

Appendix F: A note on the welfare

Welfare is usually calculated as the expected discounted value of the utility, i.e.

$$W_t = U(C_t, L_t) + \beta \mathbb{E}_t(W_{t+1}) \quad \text{where } U(C_t, L_t) = \ln(C_t - \gamma C_{t-1}) - \frac{\chi}{1 + \varepsilon} L_t^{1 + \varepsilon}$$

The argument is whether different levels of (C, L) gets affected by the incentive constraint, i.e.

$$\mathbb{E}_t \sum_{i=1}^{\infty} (1 - \sigma) \sigma^{i-1} \Lambda_{i,t+i} n_{t+i} \geq \theta Q_t s_t$$

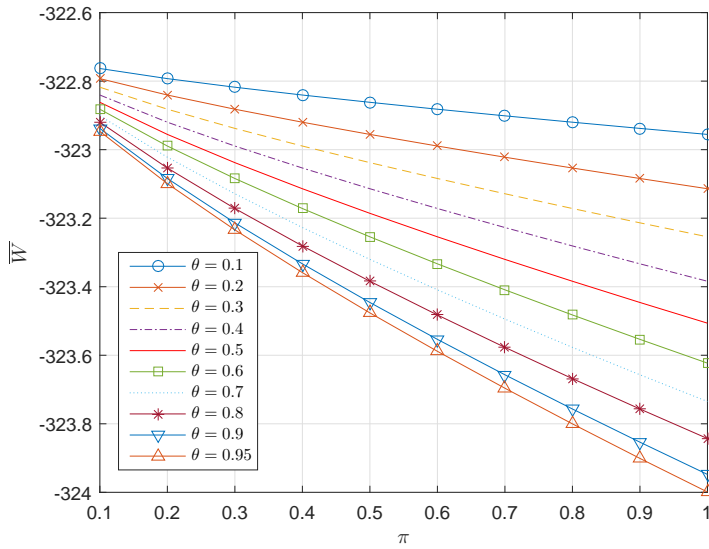
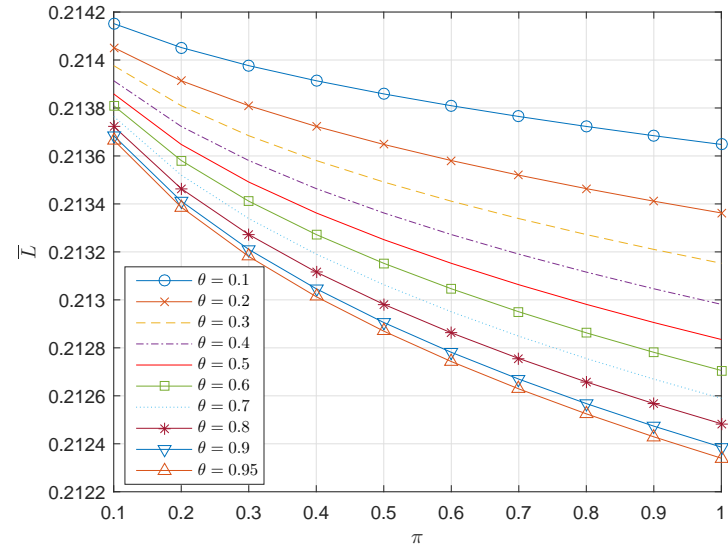
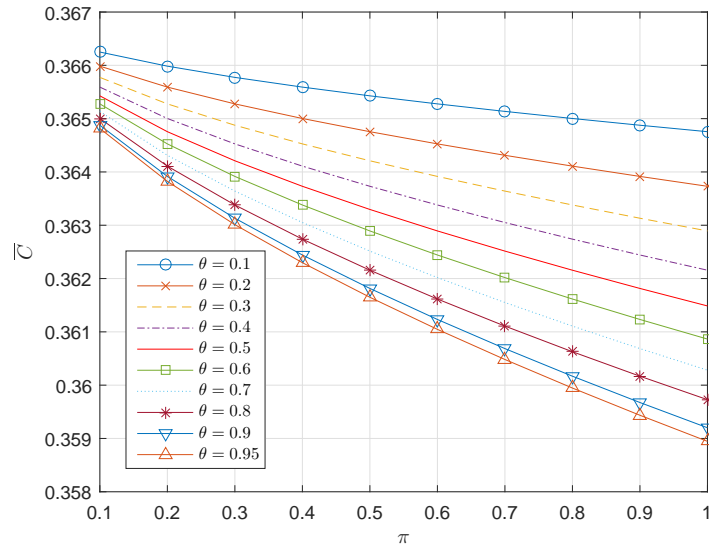
defined in the previous section. However, on equilibrium there is no diversion. The plausible level of θ is set as the joint intersection of credit supply and demand of bankers and households respectively. What the dynamic constraint is telling us, when it becomes binding, bankers will be indifferent between honest working and dishonest working. This means no diversion actually takes place. It is much more reasonable to think of θ as a degree of constraint relaxation (or the degree of pledgeability), which has been argued in the paper. Given this interpretation, different levels of θ does not affects the steady-state of C . However, suppose we interact θ with C and we literally interpret it as “diversion”, like a fraction of assets is that perished or completely destroyed. For a simpler version of the model, involving the following incentive constraint, I have calculated the steady-state welfare given changes in (θ, π)

$$V(s_t, d_t) = \max_{\{s_t, d_t\}} \mathbb{E}_0 \sum_{t=1}^{\infty} (1 - \sigma) \sigma^{t-1} \Lambda_{0,t} n_t$$

$$\mathbb{E}_t \sum_{i=1}^{\infty} (1 - \sigma) \sigma^{i-1} \Lambda_{i,t+i} n_{t+i} \geq \theta Q_t s_t + \pi \cdot 0 + (1 - \pi) (-\theta Q_t s_t)$$

The first interpretation of the result is, given the same level of θ as the probability of legal fine increases, meaning making the constraint more tight, welfare falls. Given the same probability, as θ increases, i.e. more assets get destroyed the steady-state welfare decreases. If one accepts this narrative that θ is the fraction of asset that gets destroyed, as θ increases, L falls. The reason is since in this class of models assets represent the available capital, as more assets get destroyed, less capital is available for production. As production falls, there will be less demand for labor, which is why L is falling. This narrative squares well with the degree of pledgeability if it was actually taking place on the equilibrium.

Figure 18: Welfare



The change of steady-state of consumption, labor and welfare given different values of (θ, π) .

Chapter 2 : Time-Varying Job Creation and Macroeconomic Shocks

(with Elisa Guglielminetti²⁶)

11 Chapter 2 : Introduction

Since the early contribution by [Diamond \(1984b\)](#) and [Mortensen and Pissarides \(1994\)](#) (DMP henceforth), search and matching models have become the workhorse in labor economics. The interaction between frictional labor markets and the macroeconomy has been explored by embedding the DMP setup in DSGE models²⁷. The success of this framework derives both from its simplicity and its ability to explain empirical regularities, such as the inverse relationship between vacancies and unemployment (the Beveridge curve) and the existence of voluntary unemployment.

Researchers have highlighted many areas in which the standard DMP setup performs less well. One prominent example is the so-called labor market volatility puzzle. Since the influential work of [Shimer \(2005\)](#), it has been widely recognized that the high volatility displayed by the labor market data cannot easily be replicated by conventional search and matching frameworks. He provided empirical evidence that in the United States the volatility of the vacancy-unemployment

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²⁷[Andolfatto \(1996\)](#) is the first to incorporate a frictional labor market in an otherwise standard RBC model. Among the subsequent numerous contributions, see [Walsh \(2005\)](#) and [Blanchard and Galí \(2010\)](#).

ratio is almost 20 times as large as the volatility of average labor productivity²⁸. Following his observation, this topic gained a lot of attention and numerous plausible solutions have been proposed to explain this empirical finding²⁹. In addressing the puzzle, however, other important labor market characteristics have largely been overlooked. First, there is a widespread tendency in considering technology shocks as the unique driving force of economic fluctuations. [Mortensen and Nagypál \(2007\)](#) and [Barnichon \(2010; 2012\)](#) have highlighted the possible contributions of shocks other than technology to labor market volatility but they do not address this question empirically³⁰. Second, many current studies focus on the magnitude of the conditional elasticity of vacancies to a given shock, while neglecting to verify whether its sign is consistent with the empirical observations³¹. Our paper investigate these dimensions often neglected in the existing studies by providing new evidence on the dynamics of job creation. Our findings also contribute to the debate on the labor market volatility puzzle and call into question some of the predictions of standard DMP models. In addition, we uncover non-linearities in the labor market dynamics in connection to the macroeconomy.

Our econometric setup allows us to tackle the potential time variation in the economic structural relationships and in the volatility of the shocks. It has been well documented that macroeconomic shocks have time-varying volatilities ([Primiceri, 2005](#); [Justiniano and Primiceri, 2008](#)). However, the impact of such time-varying volatilities on the labor market has not been investigated thoroughly³². To the best of our knowledge, only [Barnichon \(2010\)](#) and [Benati and Lubik \(2014\)](#)

²⁸This observation has been validated for other countries such as Japan by [Esteban-Pretel, Nakajima and Ryuichi \(2011\)](#) and the OECD countries by [Amaral and Tasci \(2013\)](#). The ubiquitous presence of this puzzle has led to a great amount of research on the topic, which is not possible to cover here.

²⁹Proposals revolve around three major conceptual points. The first one is based on real wage rigidity, which prevents full wage renegotiation ([Hall, 2005](#); [Gertler and Trigari, 2009](#)). Another concurrent explanation hinges on a different calibration strategy, which assigns a higher value to non-market activities ([Mortensen and Nagypál, 2007](#)). This implies a small size of accounting profits which become more elastic to changes in productivity. Finally, [Pissarides \(2009\)](#) showed that the introduction of a fixed component in hiring cost fosters firms' response to productivity shocks. For an excellent survey refer to [Cardullo \(2010\)](#).

³⁰[Ravn and Simonelli \(2007\)](#) provide some evidence on the importance of monetary policy shock in explaining the volatility of the labor market in the context of a large, constant SVAR.

³¹[Barnichon \(2010; 2012\)](#) and [Balleer \(2012\)](#) “insist” on the importance of studying the sign of the elasticity conditional on the type of shock. They find that technology shocks generally determine a rise in unemployment, contrary to what implied by standard DMP models.

³²However constant volatility models have been estimated in several papers. For example [Gertler et al \(2008\)](#) have estimated an otherwise simple NK mode augmented with a staggered wage setting process à la [Gertler and Trigari \(2009\)](#). [Christiano et al \(2010; forthcoming\)](#) have also introduced

perform a similar exercise, where the former studies the correlation between unemployment and labor productivity and the latter investigates the time-varying properties of the Beveridge curve. Our work brings further structural evidence on the topic.

We estimate a time-varying parameter VAR (hereafter TVP-VAR) using GDP growth, inflation, real interest rate and vacancy rate, to provide reduced-form evidence on the job creation's time-varying volatility. We then offer a structural interpretation by building a DSGE model enriched by a search-and-matching framework with price stickiness, real wage rigidity *à la* Hall (2005) and a large set of shocks. Our identification strategy combines long-run restrictions on technology shocks with the model-implied short-run sign restrictions. This allows us to disentangle the contribution of four identified shocks to the labor market volatility throughout business cycles. Our identification structure is robust to a wide range of parameterizations.

Our analysis documents a considerable amount of time variation both in the structural economic relationships and in the sources of volatility. As it is well known, during the '70s the economy experienced a high degree of volatility. That said, after normalizing by the size of the shock, results show that job creation respond more strongly to non-supply shocks towards the end of the sample period. Moreover, we uncover an interesting pattern in the response of the job creation to technology shocks. We find that vacancies fall after a positive technology shock at least until the beginning of the '90s. This result contributes to the debate on the recessionary effects of technology shocks initiated by Galí (1999), by showing that the “puzzle” also holds at the extensive margin of labor demand. However, our econometric setup reveals a sign switch over time. The response of vacancies to technology shocks turns from negative to insignificantly different from zero in the last twenty years. This evidence suggests two considerations. From a theoretical point of view, the simplest version of the widely adopted DMP model of the labor market must be utilized with caution, given that it implies that vacancies react positively to rising labor productivity. From a policy point of view, it is not clear whether positive technology shocks improve the labor market search and matching frameworks in NK models. In their latest work the model has replaced the traditional NK models with the wage bargaining introduced *à la* Hall and Milgrom (2008). These models despite their complex forms, assume a time-constant volatility. Models are usually estimated and except for the works Christiano et al (2010; forthcoming), the VAR implications are not reported. Moreover, identification is also an issue for these complex models (For an excellent discussion of this point refer to Komunjer and Ng (2011b)).

performance in the short run. We further investigate this point through the lens of the model. We show, first, that price stickiness coupled with wage flexibility can explain why firms cut vacancies after a rise in labor productivity. Second, changes in the conduct of monetary policy and in the wage setting mechanism can be responsible of the sign switch of the elasticity of job creation to technology shocks.

Finally, we perform the decomposition of the variance of the forecast errors: non-technology shocks always contribute by more than 60% to the variance of job creation, thus calling into question the tendency of addressing the labor market volatility puzzle by taking into account technology shocks only. Our estimation shows that the high volatility observed in the labor market and the whole economy during the '70s was mainly due to monetary policy shocks. In line with Galí and Gambetti (2009), the volatility fueled by non-technology shocks has sharply declined from the mid-'80s onward. This notwithstanding, demand and cost-push shocks still explain a great share of the volatility of job creation.

The rest of the paper is organized as follows. Section 12 describes the empirical methodology. Section 13 presents the results of the reduced-form estimation. Section 14 introduces the theoretical model which is the base of our identification strategy. The main results of the paper, which come from the structural interpretation of the TVP-VAR, are contained in Section 15. In Section 17 we offer some considerations about the theoretical implications of our findings and directions for future work. Section 19 concludes.

12 Methodology

We follow the methodology presented in Benati and Lubik (2012; 2014). We specify a TVP-VAR of order k . $Y_t = [\Delta y_t, \pi_t, r_t, v_t]$ is the vector which collects the time series of interest, where Δy_t is the real GDP growth computed as log difference of real GDP, π_t is inflation computed as the log difference of GDP deflator, r_t is the real interest rate computed as the difference between the 3 months Treasury bill rate and inflation and v_t is the vacancy rate, that is the composite Help-Wanted-Index (HWI) calculated by Barnichon (2010) and normalized by the size of the labor force³³. Our data cover from 1951Q1 to 2008Q3 and we utilize the first 10 years to initialize the

³³The 3 months Treasury bill rate is preferred to the federal funds rate because it is available for a longer period of time. Moreover, we transform it to quarterly frequency to make it consistent with our inflation measure. We prefer to include the real interest rate rather than the nominal one

prior. We stop the estimation before the interest rate reached the ZLB, to avoid issues in the identification of monetary policy shocks³⁴. The TVP-VAR(k) takes the following form:

$$Y_t = B_{0,t} + B_{1,t}Y_{t-1} + \dots + B_{k,t}Y_{t-k} + \epsilon_t \equiv X_t' \theta_t + \epsilon_t \quad (38)$$

$$X'(t) = I_n \otimes [1, Y_{t-1}', \dots, Y_{t-k}']$$

where \otimes is the Kronecker product and I_n is the identity matrix of dimension n .

As it is customary in the VAR literature we set the lag order $k = 2$ (Benati and Mumtaz, 2007; Primiceri, 2005). We then collect the VAR's time-varying coefficients at time t - that is, the elements of the matrices $B_{0,t}, B_{1,t}, \dots, B_{k,t}$ - in the vector θ_t and we postulate that they evolve according to:

$$p(\theta_t | \theta_{t-1}, Q) = I(\theta_t) f(\theta_t | \theta_{t-1}, Q) \quad (39)$$

with $I(\theta_t)$ being an indicator function that rejects the unstable draws, thus enforcing stationarity on the VAR³⁵. Following Primiceri (2005), $f(\theta_t | \theta_{t-1}, Q)$ is given by:

$$\theta_t = \theta_{t-1} + \eta_t \quad (40)$$

with η_t following a normal distribution of mean zero and variance-covariance matrix Q . The VAR's reduced-form innovations (ϵ_t) are assumed to be zero-mean and normally distributed. We factor the time-varying covariance matrix Ω_t as:

$$\text{Var}(\epsilon_t) \equiv \Omega_t = A_t^{-1} H_t (A_t^{-1})' \quad (41)$$

where the matrices H_t and A_t are defined as follows:

to ensure stationarity in the VAR.

³⁴In a similar econometric model, Baumeister and Benati (2013) and Kapetanios et al. (2012) study the macroeconomic effects of unconventional measures of monetary policy at the ZLB.

³⁵As highlighted by Koop and Potter (2011), in absence of such a restriction, even a small amount of posterior weight in explosive regions of the parameter space can lead to impulse responses and forecasts which have counterintuitively huge posterior means or standard deviations.

$$H_t = \begin{bmatrix} h_{1,t} & 0 & 0 & 0 \\ 0 & h_{2,t} & 0 & 0 \\ 0 & 0 & h_{3,t} & 0 \\ 0 & 0 & 0 & h_{4,t} \end{bmatrix} \quad A_t = \begin{bmatrix} 1 & 0 & 0 & 0 \\ \alpha_{21,t} & 1 & 0 & 0 \\ \alpha_{31,t} & \alpha_{32,t} & 1 & 0 \\ \alpha_{41,t} & \alpha_{42,t} & \alpha_{43,t} & 1 \end{bmatrix} \quad (42)$$

The $h_{i,t}$ are assumed to evolve as geometric random walks :

$$\ln(h_{i,t}) = \ln(h_{i,t-1}) + \nu_{i,t} \quad (43)$$

As in [ibid.](#) we can postulate that the non-zero and non-unity elements of the matrix A_t collected in the vector $\alpha_t = [\alpha_{21,t}, \alpha_{31,t}, \dots, \alpha_{41,t}]'$ evolve as driftless random walks

$$\alpha_t = \alpha_{t-1} + \tau_t \quad (44)$$

We assume the vector of innovations $[u'_t, \eta'_t, \tau'_t, \nu'_t]'$ to be distributed as :

$$\begin{bmatrix} u_t \\ \eta_t \\ \tau_t \\ \nu_t \end{bmatrix} \sim N(0, V), \text{ with } V = \begin{bmatrix} I_4 & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & S & 0 \\ 0 & 0 & 0 & Z \end{bmatrix} \text{ and } Z = \begin{bmatrix} \sigma_1^2 & 0 & 0 & 0 \\ 0 & \sigma_2^2 & 0 & 0 \\ 0 & 0 & \sigma_3^2 & 0 \\ 0 & 0 & 0 & \sigma_4^2 \end{bmatrix} \quad (45)$$

Since the model is heavily parameterized, we impose block-diagonal structure on V for parsimony. Moreover, allowing for a completely generic correlation structure among different sources of uncertainty would preclude any structural interpretation of the innovations. Finally, as an additional simplifying assumption, we adopt a block-diagonal structure for S :

$$S \equiv \text{Var}(\tau_t) = \text{Var}(\tau_t) = \begin{bmatrix} S_1 & 0_{1 \times 2} & 0_{1 \times 3} \\ 0_{2 \times 1} & S_2 & 0_{2 \times 3} \\ 0_{3 \times 1} & 0_{2 \times 2} & S_3 \end{bmatrix} \quad (46)$$

with $S_1 \equiv \text{Var}(\tau_{21,t})$, $S_2 \equiv \text{Var}([\tau_{31,t}, \tau_{32,t}]')$ and $S_3 \equiv \text{Var}([\tau_{41,t}, \tau_{42,t}, \tau_{43,t}]')$. This implies that the non-zero and non-unity elements of A_t which belongs to different rows evolve independently.

This assumption drastically simplifies inference, since it allows one to perform Gibbs sampling on the non-zero and non-unity elements of A_t equation by equation. The details of the algorithm are relegated to the Appendix.

13 Reduced-form Evidence

The reduced-form evidence is informative in itself. Figure 19 represents the original data together with the time-varying estimates of the states. The estimation tracks very well the pattern of the data. In what follows, the blue solid line represents the median of a given object among the 10,000 draws from the posterior distribution. Lower and upper red lines represent the 16th and 84th percentiles, respectively. The fourth panel shows the high volatility of job creation over the past four decades: this also affects the dispersion of the draws of the states, as highlighted by the wider red bands.

Figures 20 and 21 provide evidence of time variation in the VAR coefficients as well as in the volatility of the shocks. In figure 20 the coefficients which display substantial time variation are the ones corresponding to the vacancy equation. This can be interpreted as a first set of mild indications that the response of labor market to the macroeconomy has changed over time. Figure 21 plots $\log \det(\Omega_t)$, where Ω_t is the variance-covariance matrix of the reduced-form VAR residuals. Following Cogley and Sargent (2005) we interpret this as the total amount of uncertainty hitting the economy at each point in time. Our findings are remarkably similar to those provided by *ibid.* and Benati and Mumtaz (2007). The variance exhibits a substantial increase from 1965 to 1981; then, it decreases during the Great Moderation period and exhibits two small peaks around 2001 and at the onset of the recent crisis.

In Figure 22 we plot the amount of volatility which can be attributed to each equation separately. In general, volatility tends to be higher during the Great Inflation period and begins to increase again towards the end of the sample. Innovations related to the vacancy equation, however, represent a noticeable difference: starting from the beginning of the 2000s, they are even more volatile than in the '70s. Given that we have not provided a structural identification yet, the results must be interpreted with caution. However, this finding suggests that the volatility of the labor market is largely independent from the volatility of the economy as a whole.

Figure 23 is equivalent to Figure 22 but normalized by the volatility of the innovations in the GDP equation. Not surprisingly, the innovations to the vacancy equations display a much higher variation, up to 10 times GDP innovations.

Finally, Figure 24 plots the time-varying correlations between the reduced-form innovations: positive innovations to the vacancies equation tend to be associated with positive innovations to inflation and GDP.

14 Model

The benchmark model combines features of an otherwise standard RBC setting with labor market search frictions *à la* Mortensen-Pissarides. Time is discrete. The economy is populated by households, firms and policy authorities. Households consume, invest in the bond market and supply labor. We distinguish between wholesale and retail firms. Wholesale firms employ labor to produce a homogeneous good sold to retailers in a perfect competitive market. Workers are recruited on a frictional labor market. We consider both a flexible and a sticky wage setting. In the first case, wages are the outcome of a Nash-bargaining process. In the second case we introduce real wage stickiness *à la* Hall (2005). Retailers own a technology which allows them to differentiate the goods without any cost. The differentiated good is then sold to the households under monopolistic competition. As for policy, the monetary authority is in charge of setting the nominal interest rate, while the central government collects lump-sum taxes to finance public expenditure and unemployment benefits. The model is non-stationary for the presence of a unit root in the technological process. In addition, the model is enriched with a large set of transitory shocks.

In what follows we present the main equations in log-linearized form. Hatted variables are log-deviations from the steady state, whereas capital letters with an upper bar represent steady state values. A full description of the model as well as the calibration strategy can be found in Appendix A.

From the households' optimization problem we obtain the dynamic IS curve:

$$\hat{c}_t = E_t(\hat{c}_{t+1}) - [\ln \beta + r_t - E_t(\pi_{t+1}^p)] + \varepsilon_t^{IS}$$

where β is the discount factor, r_t is the nominal interest rate, π_t^p is inflation in the product market and ε_t^{IS} is the demand shock. Household members also take decisions over labor supply. The marginal rate of substitution between consumption and labor is: $m\hat{r}s_t = \hat{c}_t + \sigma_N \hat{n}_t + \varepsilon_t^\psi$, where ε_t^ψ is the preference shock.

New matches are created according to a standard Cobb-Douglas technology, increasing in vacancies (v_t) and searchers (u_t^0): $\hat{m}_t = \varepsilon_t^\xi + \eta \hat{v}_t + (1 - \eta) \hat{u}_t^0$. ε_t^ξ is a shock which positively affects matching efficiency. Employment is a state variable, which depends on the matches surviving from the previous period and the newly created ones:

$$\hat{n}_t = (1 - s)\hat{n}_{t-1} + s(\hat{m}_t - \varepsilon_t^s)$$

where s is the exogenous separation rate which may vary over time due to the presence of the shock ε_t^s .

The inputs of production are technology and labor. Technology consists of a transitory and a permanent component: $a_t = a_t^T + a_t^P$. The transitory component a_t^T and the growth rate of the permanent component ($a_t^P - a_{t-1}^P$) both follow an AR(1) process.

Wholesale firms create jobs until when the real cost of posting a vacancy equates the value of a productive match.

$$\hat{\mu}_t^p = m\hat{p}n_t - \left[(1 - \Phi)\hat{\omega}_t + \Phi\hat{d}_t \right]$$

where $\Phi = \frac{\bar{D}}{\bar{W}/\bar{P} + \bar{D}}$ is a constant which only depends on steady state values, ω_t is the real wage, μ_t^p is the mark-up in the product market and d_t represents the net hiring costs:

$$\hat{d}_t = \frac{1}{1 - \beta(1 - s)}(-\hat{p}_t^f) + \frac{\beta(1 - s)}{1 - \beta(1 - s)}E_t \left[\hat{p}_{t+1}^f + \hat{r}_t - E_t \pi_{t+1}^p - \varepsilon_t^{IS} \right]$$

In the previous equation p_t^f is the job filling rate. The real Nash-bargained wage increases with the disutility of labor, the amount unemployment benefit (b_t) and the firm's surplus, which partly accrues to workers. Indicating with γ the worker's bargaining power and with q_t^w the job finding

rate, we obtain

$$\hat{\omega}_t^N = \frac{M\bar{R}S}{\Omega^N} m\hat{r}s_t + \frac{\bar{b}}{\Omega^N} \hat{b}_t + \frac{\gamma\kappa^f}{\Omega^N(1-\gamma)\bar{p}^f} \left[(1-\beta(1-s)) \hat{d}_t - \beta(1-s)\bar{q}^w \mathbb{E} \left(\hat{r}_t - \pi_{t+1} - \hat{q}_{t+1}^w + \hat{p}_{t+1}^f \right) \right]$$

We allow for the possibility of real wage stickiness by postulating $\hat{\omega}_t = (1-\theta_w)\hat{\omega}_t^N$, where $\theta_w = 0$ corresponds to wage flexibility.

Monopolistic competition in the retail product market lead to the standard Philipps curve:

$$\pi_t^p = \beta E_t \pi_{t+1}^p - \lambda_p \hat{\mu}_t^p + \varepsilon_t^u$$

where $\lambda_p = \frac{(1-\theta_p)(1-\theta_p\beta)}{\theta_p}$ and ε_t^u is the cost-push shock.

The monetary authority fixes the nominal interest rate following a standard Taylor rule: $r_t = \rho_r r_{t-1} + (1-\rho_r) [-\ln \beta + \delta_y \hat{y}_t + \delta_\pi \pi_t] + \varepsilon_t^r$.

Finally, public expenditure and unemployment benefits follow a random process:

$$\hat{g}_t = \rho_g \hat{g}_{t-1} + \sigma_g \varepsilon_t^g$$

$$\hat{b}_t = \rho_b \hat{b}_{t-1} + \sigma_b \varepsilon_t^b$$

The model is closed by the aggregate resource constraint: $\hat{y}_t = \frac{\bar{C}}{\bar{Y}} \hat{c}_t + \frac{\kappa^f \bar{V}}{\bar{Y}} \hat{v}_t + \frac{\bar{G}}{\bar{Y}} \hat{g}_t$.

To recap, the economy is hit by one permanent technology shock and other eight transitory shocks: transitory technology (ε_t^{aT}), demand (ε_t^{IS}), preference (ε_t^ψ), matching efficiency (ε_t^ξ), separation rate (ε_t^s), cost-push (ε_t^u), public expenditure (ε_t^g) and unemployment benefit (ε_t^b).

15 Structural Evidence

15.1 Identification Strategy

We identify four structural shocks, labeled as: permanent supply, monetary policy, demand non-policy and cost-push shocks. As in [Galí and Gambetti \(2009\)](#), permanent supply shocks are identified by imposing that they are the only ones which affect the level of output in the long run. This is consistent with the model, which features non-stationarity in technology. To clarify ideas, a time-varying VAR can be written in the following form ³⁶.

³⁶The MA representation permits us to write a VAR in the following form $Y_t = \mu_{0,t} + \sum \Psi_k \varepsilon_{t-k}$,

$$Y_t = \mu_{0,t} + C_{t,\infty}u_t$$

where $C_{t,\infty} = C_0\tilde{A}_{0,t}$ is the matrix of the cumulative IRFs and takes the following form:

$$C_{\infty,t} = \begin{bmatrix} C_{\infty,11} & 0 & 0 & 0 \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ C_{\infty,41} & \dots & \dots & C_{\infty,44} \end{bmatrix} \quad (47)$$

$C_{\infty,11}$ is the cumulative long-run impact of the first shock on the first variable, in our case the supply shock on GDP growth. We impose zeros on all the elements of the first row except the first one. This implies that the supply shock is the only one which potentially has a permanent effect on output. No long-run restrictions are imposed on the other variables.

The other three structural shocks are identified by sign-restrictions on the impact matrix. These are fully derived from the model described above. For example, following an unexpected monetary policy shock, inflation falls. Therefore in the impact matrix, the reaction of inflation to an unexpected monetary policy shock is set negative. The full set of sign restrictions is reported in Table 11³⁷.

The combination of zero and sign restrictions is performed through the same algorithm described in Baumeister and Benati (2013). This combines the procedure proposed by Rubio-Ramirez, Waggoner and Zha (2010) for imposing sign restrictions, with a deterministic Householder transformation of the long-run impact matrix such that it takes the same structure as in (47). This algorithm uses the QR decomposition of randomly drawn standard normal matrices to obtain many orthogonal rotations of the candidate impact matrix. In other words, we do not select a unique convenient matrix as in the penalty function approach (PFA) proposed by Mountford and Uhlig (2009). Then, the critique advanced by Arias, Rubio-Ramirez and Waggoner (2014) does not apply to our case by using $\epsilon_t = A_{0,t}u_t$ the VAR can then be expressed in terms of the structural shocks.

³⁷Given the limited dimension of our VAR we are able to identify only four shocks. However, the model presented in Section 14 incorporates one permanent and eight transitory shocks. Our strategy uniquely identifies permanent technology and monetary policy shocks. The restrictions we place to identify cost-push shocks equally apply to preference shocks and changes in unemployment benefits. Likewise, what we have labeled as demand shocks in Table 11 have the same effect of shocks to the public expenditure, the separation rate and the matching efficiency (negative). We will come back on this issue when presenting the results.

Table 11: The matrix of short-run restrictions

Variable	Shocks		
	Cost-push	Monetary policy	Demand
Inflation	+	-	+
Nominal Interest Rate	?	+	+
Vacancy/Labor Force	-	-	+

and our procedure is similar to the their Algorithm 4.

Since the structural identification is based on signs obtained from a model, it is necessary to make sure that our choice of time series is good enough to identify the underlying process (i.e. persistence and volatility) of those shocks. For example, suppose that the time series we include in the TVP-VAR fail to identify cost-push shocks. Then, the signs derived from the response of the model to the cost-push shock are flawed, since the shock itself is not identified in the first place. To make sure that shocks are identified using the time series of our interest we follow [Iskrev \(2010\)](#) and [Komunjer and Ng \(2011a\)](#). The method of [Iskrev \(2010\)](#) is based on calculating the unconditional moments of model and the method of [Komunjer and Ng \(2011a\)](#) is based on the concept of minimality of systems borrowed from adaptive control theory. Results show strong degree of identification of shocks given the choice of our time series. Hence we can make sure the shocks are identified and the implied signs are not flawed. Details of the procedure are relegated to the Appendix.

16 Results

The TVP-SVAR analysis permits us to compute the time-varying IRFs for job creation ³⁸. The response of job creation at impact together with the 16th and 84th confidence bands are reported in the Fig. ²⁵³⁹. Results reveal that the job creation responded stronger to cost-push shocks during the seventies despite the larger posterior uncertainty. It is however difficult to distinguish whether this movement is due to shocks of a sizable magnitude or amplifications because of the search friction. We hence adopt a convenient normalization to disentangle the two sources of variation. . . : Specifically we normalize responses to monetary policy shocks by the median short-run impact

³⁸For the sake of brevity only the results for vacancy are reported. Results for other variables are available upon request.

³⁹The responses 2 quarters ahead and one year ahead display similar dynamics.

on the nominal interest rate in the same period. Permanent supply shocks are normalized by the long-run response of GDP, whereas cost-push and demand shocks are assumed to raise inflation by 1% on impact⁴⁰. The normalized responses are plotted in Figure 26.

The exercise permits us to compare the original impulse responses to the normalized ones to gauge the magnitude of the shocks. . The lower left panel shows that larger monetary policy shocks during the '70s are mainly responsible for the stronger reaction of vacancies depicted in Figure 25. We also find that the job creation reacts more strongly to cost-push and demand shocks in the recent periods.

Interestingly, the impact of permanent supply shocks on vacancies evolves over time: while job creation reacted negatively to positive technology shocks until the end of the 80s, the response is indistinguishable from zero later on. These findings are in line with [Barnichon \(2010\)](#) and [Balleer \(2012\)](#). The former shows that technology shocks generate a negative co-movement between unemployment and labor productivity and the latter documents a fall in the job finding rate following a rise in the productivity. These papers are however based on a constant parameter VAR, which is not able to uncover the structural economics changes. Our result is reminiscent of the well-known “hours puzzle” formulated by ([Galí, 1999](#)): we show that the adverse effect of technology shocks on the labor market is also at work on the extensive margin, but less so in the latest part of the sample period. As already highlighted by [Barnichon \(2012\)](#), this represents an important challenge for DMP models, whose simplest and standard version implies a positive elasticity of vacancies to labor productivity. In the next Section we provide model-based intuitions on our findings about the impact of technology shocks and its time pattern.

Results for GDP growth are presented in Figure 27. The figure is useful in showing the soundness of our long-run identification strategy. Output growth increases with technology and is negatively impacted by cost-push and monetary policy shocks. The fourth panel shows the time-varying response of GDP growth to the “demand shock”. The restriction we impose on this shock however

⁴⁰As for monetary policy shocks, this normalization strategy is well-suited and it has been applied, among others, by [Silvestrini and Zaghini \(2015\)](#) and [Canova and Forero \(2015\)](#). For the other shocks, the normalization implicitly assumes that the way supply shocks translate into output growth as well as the transmission of cost-push and demand shocks to inflation have not changed over time. [Gambetti, Pappa and Canova \(2008\)](#) question this hypothesis because of changes in the inventory technology and in the slope of the Philipps curve that have been documented by other authors.

may equally identify shocks to the labor market, namely shocks to the separation rate and negative shocks to the matching efficiency. Nonetheless the theory tells us that the latter should have a negative impact on output, contrary to what is conventionally expected for demand shocks. The last panel indicates that the shocks we identify can mainly be classified as demand shocks, given that the response of GDP growth is mostly positive throughout the sample⁴¹.

We also plot the response of vacancies in four dates, namely 1975Q1, 1987Q1, 1999Q1 and 2003Q1 in Fig 28. Responses are normalized to ensure comparability over time. Moreover, we take into account the uncertainty about the future evolution of the economy by computing Generalized Impulse Response Functions instead of standard ones⁴². Results confirms what we already obtained in the previous figures. Each of the selected quarters is representative of a salient economic feature of the time back then. 1975Q1 represents the pre-Volcker era with high inflation, 1987Q1 captures the start of the financial deregulation, 1999Q1 the build up towards the dot-com crash and 2005Q1 designates the most recent period of the Great Moderation. The choice of the specific quarter only slightly affects the quantitative results in terms of amplification and persistence and does not undermine the take-away message of the Figure. This highlights the fact that the tendency of replicating the observed volatility in labor market by computing an average over the whole sample period and considering only technology shock might not be a well-advised exercise. In addition to the time-varying impact of technology shocks, Figure 28 shows that job creation is more responsive to non-supply shocks in the last two decades.

We can also compute the unconditional and conditional correlations from the impulse responses. Results of this exercise are plotted in Figure 29. The first panel depicts the correlation between vacancies and GDP growth. The figure is remarkably similar to the figure 4a Galí and Gambetti (2009) despite major differences in the two approaches, most notably that we consider the extensive margin of the labor market and we use GDP growth as a measure of productivity. The strong positive cyclical correlation between job creation and GDP is mainly driven by the non-technology shocks. The correlation conditional on technology shock displays medium-run fluctuations, oscillating around zero.

⁴¹ The modest contribution of mismatch shocks to fluctuations in unemployment has also been documented by Zhang (2013) and Furlanetto and Groshenny (2014).

⁴²The algorithm used to compute Generalized Impulse Response Functions is described in Appendix C.

lating from positive to negative territory. The other two panels show that vacancies are negatively correlated to the nominal interest rate, no matter the shock, while the correlation with inflation depends on the shock, instead. Conditional on cost-push shocks it is negative and fairly constant throughout the sample period, while it is predominantly positive conditional on demand and monetary policy shocks, and more so in the recent period. This picture is broadly in line with what theory predicts.

We now turn to the analysis of the variance, which has received a lot of attention in the literature. To compute the "median" FEVD, we apply twice the Median Target (hereafter MT) criterion introduced by [Fry and Pagan \(2005\)](#) in each period. We make a methodological point here, which we think is sometimes overlooked in practice. As stressed by [ibid.](#), one should be careful in selecting median estimates for different objects of interest which may come from different models. We first consider each shock separately and find a measure of distance of each parameterization (i.e. a draw of states from the posterior distribution and impact matrix rotation) to the one that would produce the median fraction of the variance explained by the shock. This is done by considering all forecast horizons jointly. Secondly, we apply again the MT criterion on the previous measures to take into account all shocks at the same time. The output of this procedure is a "median" set of VAR parameters which corresponds to a unique draw from the posterior distribution of the states and to a unique impact matrix rotation. This is a sufficient condition to ensure orthogonality of the shocks. As a consequence, the variance of the data is fully accounted for and we can safely perform the decomposition.

[Figure 30](#) plots the unconditional variance of the variables included in our model, as well as the contribution of supply and non-supply shocks (in this category we group cost-push, demand and monetary policy shock). We have plotted the two years ahead variance of the forecast error, which corresponds to a business cycle horizon. The unconditional variance spikes between the mid-70s and the beginning of the '80s for all the variables in line with the evidence and the narratives on the Great Moderation, . It then decreases to lower levels after the Great Moderation. The fourth panel shows a remarkable importance of non-technology shocks for the variance of job creation. The declining contribution of non-technology shocks from the mid-'80s is documented also by [Galí and Gambetti \(2009\)](#) and [Barnichon \(2010\)](#). The latter suggests that this could partly be

responsible for the switching sign of the unconditional correlation between unemployment and labor productivity (from predominantly negative before 1984 to positive afterwards). In our case, the first panel of Figure 29 shows that the unconditional correlation between vacancies and GDP growth is always positive, despite lowering from the beginning of the '90s onwards.

The median Forecast Error Variance Decomposition (FEVD) is reported in Figure 31. The contributions of each shock to the variance of vacancies display considerable time variation. Technology shocks do not always represent the lion share of the variance of vacancies. The share of variance due to technology shocks is estimated below 40%. During the Great Inflation, the increased volatility is mainly explained by the rising importance of monetary policy shocks. Another 40% of variance is generated by cost-push and demand shocks. The importance of non-technology shocks and especially non-monetary demand shocks in driving labor market fluctuations has also been highlighted by Braun, De Bock and Di Cecio (2009).

17 Theoretical implications and future work

17.1 The impact of technology shocks

The results of this work put forward two research questions. Why do vacancies react negatively to expansionary technology shocks for large part of the sample period? Why this response is attenuated (if not reversed) from the early '90s onwards?

In this section we aim at offering some theoretical considerations on the possible mechanisms driving the results. We do that through the lens of the model presented earlier. The blue line in Figure 32 represents the model based IRFs to a technology shock of 1 standard deviation. This is obtained for a Taylor rule calibrated with standard values, with sticky prices and perfectly flexible wages. The lower right panel shows that job creation is negatively affected, in accordance to our estimates for the earliest part of the sample. The predictions of the model contrast the ones produced by standard DMP settings, where shocks increasing labor productivity foster job creation. In a NK framework, price stickiness prevents demand from increasing as much as productivity, thus inducing firms to cut labor. This is the standard mechanism proposed to explain the negative reaction of hours worked to technology shocks found by Galí (1999).

In this fairly standard NK economy, a number of factors could influence how firms react to technology shocks. If one or more of these factors have changed over time, this could explain why

our empirical estimates indicate a milder response of vacancies in more recent years.

First, the monetary policy stance plays an important role in the transmission of supply shocks to the labor market as highlighted by [Barnichon \(2012\)](#). The more the monetary authority accommodates demand, the more firms need to increase their production capacity and expand employment. We graphically represent this mechanism in [Figure 32](#). The red dashed line is obtained when the nominal interest rate is more responsive to current inflation ($\delta_\pi = 3$). The response of job creation changes dramatically, turning from negative to positive. Hence, the time variation in the response of job creation to permanent supply shocks detected by our econometric model can be due to a more active monetary policy stance during the Volker and Greenspan era. Indeed, the conventional wisdom on the Great Moderation has stressed the importance of a firmer reaction by the central bank in curbing inflation⁴³.

Second, we neglect adjustments at the intensive margin, that is per capita hours worked and effort. [Barnichon \(2010; 2012\)](#) builds a NK model with variable labor effort and short-run increasing returns to hours in production. There exists a trade-off between the two margins. On the one hand, more hours generate increasing returns in productivity; on the other hand any additional worker allows the firm to lower the wage for any employee. At the same time, [Barnichon \(2010\)](#) observes that labor productivity is less pro-cyclical after 1984. He then argues that some changes in the economic and institutional environment, like lower hiring frictions, may have induced firms to rely more on adjustments at the extensive margin. This is of interest for our discussion, since less frictional hiring markets could also explain why nowadays firms are less scared to engage in vacancy posting .

Third, wage stickiness affects how any change in the match surplus accrues to the firm. [Figure 33](#) shows the theoretical IRFs to technology shocks for different degrees of wage rigidity (where $\theta_w = 0$ stands for wage flexibility). With flexible wages (blue solid line), vacancies respond negatively. Firms are less prone to cut labor as wages become more rigid. Therefore job creation reacts positively when wages are almost fixed. This shows that firms are more willing to post jobs when they can appropriate a greater share of the increased match productivity. If any change in the

⁴³Beginning with [Cogley and Sargent \(2001\)](#), TVP-VARs models have been largely used to explore the causes of the Great Inflation and the subsequent Great Moderation periods. Evidence points towards the importance played by large shocks hitting the economy during the '70s, together with minor differences in the conduct of monetary policy.

wage setting mechanism has occurred over time, our empirical findings indicate that it should have made wages less responsive to productivity gains.

Finally, if there is any difference in the way distinct sectors respond to technological progress, any sectoral change would also affect the aggregate response. Regarding this point, we should find a rising importance of sectors for which supply shocks have a smaller impact on job creation. Data on job openings by sectors are available from 2001 onwards⁴⁴. We have estimated constant VAR models on this short period of time to check whether different sectors react differently to the same permanent supply shock. We find that after a positive technology shock job creation increases in all sectors but education. Moreover, the share of employment in education has steadily increased from WWII⁴⁵. We can thus exclude that a composition effect due to structural changes can explain why the impact of supply shocks on vacancies has varied over time.

The computational burden already imposed by our TVP-VAR model does not allow us to include additional variables to test the other competing and complementary explanations. We discussed them as a guidance for future empirical research on this topic.

18 Open issues

Beyond the discussion on the impact of supply shock, our empirical findings have other important theoretical implications. First of all, this work calls for more attention on the effects of non-technology shocks on the job creation. Only few works deal with this issue. [Braun, De Bock and Di Ceglie \(2009\)](#) address the question empirically in a time-invariant environment, finding that demand shocks are at least as important as supply shocks. [Balleer \(2012\)](#) considers the inclusion of preference shocks, but she finds they are not able to replicate the negative correlation between non-technology shocks and unemployment found in the data. [Barnichon \(2010; 2012\)](#) is mainly concerned about the conditional elasticity of technology and demand shocks, respectively; this is another important topic to which we are able to offer our contribution by showing the time-varying conditional responses of vacancies. [Justiniano and Michelacci \(2012\)](#) estimate an RBC model with search and matching frictions driven by several shocks; they find considerable

⁴⁴These data are taken from the Job Openings and Labor Turnover Survey (JOLTS), administered by the BLS.

⁴⁵Results of this exercise are available upon request.

cross-country variation in the contribution of technology shocks to the cyclical fluctuations of the labor market. Contrary to our results, they argue that technology shocks alone replicate well the volatility of vacancies in the US. This discrepancy may be due to the different methodologies we adopt: their estimates are constrained by their model specification, in which nominal rigidities and monetary policy do not play any role by construction.

Another important message stressed by this paper regards the role of monetary policy. Our variance analysis shows that monetary policy shocks strongly affected the volatility of job creation during the Great Inflation period but their relevance has shrunk in recent years. The triangular relationship of the monetary policy, nominal rigidities and hiring decision is likely to shape labor market fluctuations more than by only taking into account monetary policy alone. Indeed, [Barnichon \(2012\)](#) shows that in presence of price stickiness the effects of technology shocks depend on the central bank's response. Furthermore, existing models (including ours) neglect the role played by financial markets. If firms are credit constrained, financial conditions may affect the loan availability and the possibility of posting vacancies. In this context, central bank's decisions are likely to impact labor market conditions even stronger. These points certainly deserve more research.

We have only marginally addressed the question about the influence of mismatch and separation shocks, which has been debated in some recent contributions. Our conclusions point into the direction of a modest importance of these shocks on US labor market dynamics; however, a more thorough analysis is needed ⁴⁶.

The other point which merits further scrutiny regards the time-varying properties of labor force participation. We have abstracted from this issue by considering a normalization of vacancies with respect to the labor force. The series we obtain displays cyclical properties remarkably similar to the labor market tightness, another variable largely studied in the literature. Labor force participation is only mildly pro-cyclical and not very volatile. However, [Erceg and Levin \(2014\)](#) show that average estimates may hide important drops of the labor force participation rate in the wake of prolonged recessions. Our empirical methodology is well suited to investigate time

⁴⁶For example the following works have looked into the matching efficiency shock's dynamics. [Zhang \(2013\)](#) claims matching efficiency has had less of an impact on labor market dynamics whereas [Furlanetto and Goshenny \(2012\)](#) have claimed a large decline in matching has taken place during the great recession.

variation in the response of labor supply and its contribution to employment dynamics.

19 Conclusions

In this work we have tried shedding more light on the dynamics of job creation in connection to the macroeconomy. Since [Shimer \(2005\)](#)'s influential contribution, many studies have focused on the magnitude of the volatility of job creation by proposing different mechanisms to explain the “puzzle”. However, other characteristics of the job creation have not been thoroughly explored . The majority of these models do not consider the contribution of non-technology shocks to the observed volatility of job creation. Additionally, they only pay attention to the magnitude of the conditional elasticity of vacancies to a given shock rather than to its sign. Lastly, they usually do not take into account the evolution of the economic structure and the volatility of the shocks over time.

We have tried reducing the gap by performing a TVP-VAR analysis identified by long- and short-run sign restrictions. The signs are derived from a NK DSGE model enriched with search and matching in the labor market. We are able to identify one permanent supply shock and three temporary non-supply shocks, namely demand, cost-push and monetary policy shocks. The main findings regarding job creation are the followings. First, its response and variance to different shocks display considerable time variation. The Great Inflation period is characterized by a very volatile economy. However, after normalizing by the size of the shock, job creation appears to respond more strongly to all non-supply shocks in the last two decades.. Second, the main contributors to the high volatility displayed by job creation are non-technology shocks, which have accounted for more than 60% throughout time. Finally, our analysis also helps in understanding the impact of technology shocks on vacancies, a point which is still debated in the literature. We show that supply shocks had a negative impact on job creation until the beginning of the '90s but a mildly positive one later on. From a theoretical point of view, we show that different institutional changes may be compatible with such a time pattern. Overall, results show the importance of taking into account the contribution of other shocks in understanding the observed volatility exhibited by the labor market and challenge some of the predictions of the standard DMP model.

Appendix

A) The full model

Here we describe in more detail the model just sketched in log-linear form in Section 14.

Households

The economy is populated by a continuum of identical households of mass 1. They consume a composite good C_t which incorporates all goods produced by the retailers. They hold bonds and supply labor. Since in any period workers are either employed or unemployed (i.e. matched or unmatched), an income distributional problem may arise. As in Merz (1995), we assume that households pool consumption and they behave like a big family which fully insures each member against unemployment⁴⁷:

$$\begin{aligned} \max \mathbb{E}_0 \sum_{t=0}^{\infty} \exp(\varepsilon_t^\beta) \beta^t \left(\ln C_t - \psi \exp(\varepsilon_t^\psi) \frac{N_t^{1+\sigma_n}}{1+\sigma_n} \right) \\ \text{subject to } C_t + \frac{B_t}{R_t P_t} = \frac{B_{t-1}}{P_t} + \frac{w_t}{P_t} N_t + \frac{b_t}{P_t} U_t + \Pi_t - T_t \end{aligned}$$

where σ_n is the inverse of Frisch elasticity⁴⁸. ε_t^β is a shock to the discount rate which we interpret as a non-policy-demand shock⁴⁹. ε_t^ψ accounts for a potential shift in the desutility of labor: we call it a preference shock.

Households can allocate their income between consumption and nominal bonds, which pay the nominal (gross) interest rate R_t . In addition, households supply labor: the labor income is represented by the real wage paid to the household's members who are employed during the period (N_t). Unemployed workers receive benefits b_t from the government. Public expenditure and unemployment benefits are financed by lump-sum taxes T_t . Finally, households own firms, whose profits are denoted as Π_t . C_t is the Dixit-Stiglitz aggregator

$$C_t = \left(\int_0^1 C_{it}^{\frac{\epsilon-1}{\epsilon}} di \right)^{\frac{\epsilon}{1-\epsilon}}$$

where ϵ is the elasticity of demand.

The first order conditions are the following:

$$\frac{1}{C_t} = \lambda_t \tag{48}$$

$$\mathbb{E}_t \left[Q_{t,t+1} \frac{P_t}{P_{t+1}} R_t \right] = 1 \tag{49}$$

where $Q_{t,t+k} = \beta^k \frac{\exp(\varepsilon_{t+k}^\beta) \lambda_{t+k}}{\exp(\varepsilon_t^\beta) \lambda_t}$ is the stochastic discount factor and λ_t is the marginal value of wealth. Moreover, the demand for variety i is

$$C_{it} = \left(\frac{P_{it}}{P_t} \right)^{-\epsilon} C_t$$

where $P_t = \left(\int_0^1 P_{it}^{\epsilon-1} di \right)^{\frac{1}{1-\epsilon}}$ is the aggregate retail price index.

⁴⁷All household's members, i.e. employed or unemployed, consume the same amount of good. The representative household finance consumption with benefits received by its unemployed members and wages earned by the employed workers. This assumption greatly simplifies the model since we do not need to track the income distribution of each household's member. However, the implicit consequence of this widely exercised assumption is to make unemployed workers to have a higher utility than the employed ones, since they enjoy the same consumption but exert no effort. There is much evidence that unemployment generates desutility. For a discussion on this point refer to Christiano (2011).

⁴⁸ Notice that the log specification makes these preferences consistent with balanced growth.

⁴⁹Referring to the log-linear specification of Section 14, we have $\varepsilon_t^{IS} = -\varepsilon_t^\beta$.

Labor supply decisions must take into account the frictions characterizing the labor market, which are relegated in the subsequent sections. Notice that, with perfectly competitive labor markets, the following condition would hold:

$$\frac{w_t}{P_t} = \psi \exp(\varepsilon_t^\psi) C_t N_t^{\sigma_N} = MRS_t \quad (50)$$

Absent any friction, households supply labor by equating the wage to the intratemporal marginal rate of substitution. In this case only voluntary unemployment exist.

Labor Market

Labor market clearing is prevented by search and matching frictions *à la* Mortensen and Pissarides (1994). Demand and supply conditions (number of vacancies posted and job-seekers, respectively) and labor market characteristics (matching efficiency) jointly determine the employment level.

Firms must post vacancies on the labor market in order to hire workers, incurring the real cost k_t^f ⁵⁰. The realized number of matches is the outcome of a Cobb-Douglas technology, which depends on the number of vacancies V_t and searchers U_t^0 : $M_t(V_t, U_t^0) = \exp(\varepsilon_t^\xi) \xi V_t^\eta (U_t^0)^{1-\eta}$, where ε_t^ξ is a shock to the efficiency of the matching function. The probability that a firm matches with a worker is $p_t^f = \frac{M_t(V_t, U_t^0)}{V_t}$. The probability of being hired is then given by $q_t^w = \frac{M_t(V_t, U_t^0)}{U_t^0}$. The labor market tightness is defined as $\theta_t = \frac{V_t}{U_t^0}$. It is easy to show that p_t^f is a decreasing function of θ_t while q_t^w is an increasing function of it ($q_t^w = \theta_t p_t^f(\theta_t)$).

In each period, the timing is the following: i) a fraction of productive matches from the previous period get severed exogenously and separated workers enter the unemployment pool; ii) unemployed workers and firms search on the labor market and matches are formed; iii) shocks realize; iv) production occurs. The employment dynamic is thus given by:

$$N_t = (1 - s \exp(\varepsilon_t^s)) N_{t-1} + M_t \quad (51)$$

where s is the exogenous separation rate which is rendered time-varying by the shock ε_t^s ⁵¹. The first term on the right hand side of the above equation represents workers matched in the previous period who do not separate (surviving matches); the second term represents new matches realized at the beginning of the period before production occurs. The number of searchers is

$$U_t^0 = \frac{U_t}{1 - q_t^w} \quad (52)$$

where $U_t = 1 - N_t$ is current unemployment, which is defined after the matching process has taken place. Under this timing assumption, the matches become immediately productive.

Wholesale Firms

Wholesale firms employ labor to produce an homogenous good to be sold to retailers at price P_t^w . Because of the frictions in the labor market, these decisions potentially differ among firms, which we index by j .

In order to hire workers, firms must post vacancies on the labor market, by paying the fixed real cost k_t^f . The value of a vacancy for firm j is

$$J_t^V(j) = -k_t^f + p_t^f J_t^F(j) + (1 - p_t^f) \mathbb{E}_t(Q_{t,t+1} J_{t+1}^V(j))$$

With probability p_t^f the firm fills the vacancy and gets the value of the match J_t^F . With a complementary probability $1 - p_t^f$ the vacancy remains unfilled. Free entry implies:

⁵⁰Because of the unit root in technology the vacancy cost is assumed to grow at the same rate of output.

⁵¹Separations are anti-cyclical. The model can incorporate this feature by allowing separation shocks to be negatively correlated with technology shocks. However, we are not interested in replicating the business cycle facts through model simulations, but only to study the response of the other macroeconomic aggregates to orthogonal shocks. Empirically, the correlation between layoffs and GDP is captured by the estimation of the variance-covariance matrix of the shocks, which provides us $n(n-1)/2$ identifying restrictions, where n is the number of time series considered in the econometric model (38).

$$J_t^F(j) = \frac{k_t^f}{p_t^f} \quad \forall j \quad (53)$$

The value of a productive match is represented by the following equation:

$$\frac{k_t^f}{p_t^f} = \frac{1}{\mathcal{M}_t^P} MPN_t - \frac{w_t(j)}{P_t} + \mathbb{E}_t \left(Q_{t,t+1} (1 - s \exp(\varepsilon_{t+1}^s)) \frac{k_{t+1}^f}{p_{t+1}^f} \right) \quad (54)$$

where $\mathcal{M}_t^P = \frac{P_t}{P_t^w}$ is the markup on the price of the wholesale good and $MPN_t = (1 - \alpha)A_t N_t^{-\alpha}$ is the marginal productivity of labor.

Equation 54 states that firms keep posting vacancies until the real cost they bear (which depends on the fixed cost and the search spell) equates the current productivity gains and the savings on future vacancy costs. Search frictions distort firm's optimization condition on hiring. For future reference we can define the real cost of posting vacancies net of the expected discounted saved cost:

$$D_t = \frac{k_t^f}{p_t^f} - \mathbb{E}_t \left[Q_{t,t+1} (1 - s \exp(\varepsilon_{t+1}^s)) \frac{k_{t+1}^f}{p_{t+1}^f} \right] \quad (55)$$

As for technology, we assume $A_t = A_t^T A_t^P$, where A_t^T denotes the transitory component and A_t^P is the permanent component.

$$\begin{aligned} \ln A_t^T &= \rho_a \ln A_{t-1}^T + \sigma_{aT} \varepsilon_t^{aT} \\ \frac{A_t^P}{A_{t-1}^P} &= \gamma_t^a \\ \ln \gamma_t^a &= \ln \bar{\gamma}^a + \sigma_{aP} \varepsilon_t^{aP} \end{aligned}$$

where ε_t^{aT} and ε_t^{aP} are standard normals.

Workers

Workers can be either employed or unemployed. We now characterize their value functions in both cases. The value function of a worker employed at firm j is:

$$J_t^w(j) = \frac{w_t(j)}{P_t} - MRS_t + \mathbb{E}_t \left\{ Q_{t,t+1} \left[(1 - s \exp(\varepsilon_{t+1}^s)) J_{t+1}^w(j) + s \exp(\varepsilon_{t+1}^s) (q_{t+1}^w J_{t+1}^w + (1 - q_{t+1}^w) J_{t+1}^u) \right] \right\}$$

where the second term is the marginal rate of intratemporal substitution, which expresses labor desutility in terms of consumption goods. The term in brackets is the continuation value. The worker stays with the firm with probability $1 - s \exp(\varepsilon_{t+1}^s)$. Alternatively, she gets back to the unemployment pool, where she can immediately find a new job with probability q_{t+1}^w . J_t^u is the value of being unemployed, which is given by the following:

$$J_t^u = b_t + \mathbb{E}_t \left\{ Q_{t,t+1} [q_{t+1}^w J_{t+1}^w + (1 - q_{t+1}^w) J_{t+1}^u] \right\}$$

where $J_t^w = \int_0^1 \frac{M_t(j)}{M_t} J_t^w(j) dj$.

Remember that unemployment is defined after the matches of the current period have taken place. Unemployed agents can find a job in the following period with probability q_{t+1}^w or stay unemployed.

The surplus which accrues to a worker employed at firm j is thus given by:

$$S_t^w(j) = J_t^w(j) - J_t^u = \frac{w_t(j)}{P_t} - (MRS_t + b_t) + \mathbb{E}_t \left\{ Q_{t,t+1} (1 - s \exp(\varepsilon_{t+1}^s)) (S_{t+1}^w(j) - q_{t+1}^w S_{t+1}^w) \right\}$$

where $S_t^w = \int_0^1 \frac{M_t(j)}{M_t} S_t^w(j) dj$ is the average surplus.

Wage setting

When wages can adjust in every period, they are set through Nash bargaining, thus implying the following relationship:

$$S_t^w(j) = \frac{\gamma}{1-\gamma} S_t^F(j)$$

where $S_t^w(j)$ is defined in above equation, γ is the worker's bargaining power and $S_t^F(j) = J_t^F(j)$ is the firm j 's surplus. Eq. (53) implies that all firms offer the same wage in equilibrium. The index j will be thus omitted in what follows. After some mathematical manipulations we can express the real wage as:

$$\omega_t^N = MRS_t + b_t + \frac{\gamma}{1-\gamma} \left[\frac{k^f}{p_t^f} - \mathbb{E}_t \left(Q_{t,t+1} (1 - s \exp(\varepsilon_{t+1}^s)) (1 - q_{t+1}^w) \frac{k^f}{p_{t+1}^f} \right) \right] \quad (56)$$

Where ω_t^N is the Nash-bargained real wage. The equation above shows that workers must be compensated for the desutility of working and for the foregone benefit (as in the competitive framework) but, as long as they have a positive bargaining power, they can also extract part of the firm's surplus (the term inside the brackets) ⁵².

Following [Blanchard and Galí \(2010\)](#) we introduce wage stickiness by imposing that the real wage in the economy is a geometric average of the Nash-bargained wage and the wage prevailing in normal times (\bar{w}):

$$\omega_t = \bar{\omega}^{\theta_w} (\omega_t^N)^{1-\theta_w}$$

In what follows we assume that $\bar{\omega}$ is the Nash bargained wage in steady state. This can be interpreted as a wage norm, in the sense of [Hall \(2005\)](#).

Retailers

The homogeneous wholesale good is sold to retail firms, which differentiate it at no cost and sell it to households. We introduce price stickiness in the form of Calvo prices. Let θ_p be the probability of not reoptimizing prices in a given period. Retailers maximize their profits subject to the demand schedule for each individual good i :

$$\begin{aligned} \max \mathbb{E}_t \sum_{k=0}^{\infty} \theta_p^k Q_{t,t+k} \left(\frac{P_{it}^* - P_{t+k}^w}{P_{t+k}} \right) Y_{i,t+k|t} \\ \text{subject to } Y_{i,t+k|t} = \left(\frac{P_{it}^*}{P_{t+k}} \right)^{-\epsilon} Y_{t+k} \end{aligned}$$

The price schedule turns out to be

$$\mathbb{E}_t \sum_{k=0}^{\infty} \theta_p^k Q_{t,t+k} \left(\frac{P_t^*}{P_{t+k}} \right)^{-\epsilon} Y_{t+k} \left[\frac{P_t^*}{P_{t+k}} - \frac{\epsilon_t}{\epsilon_t - 1} \frac{P_{t-k}^w}{P_{t+k}} \right] = 0$$

where we have omitted the index i because in equilibrium all firms charge the same price. $\mathcal{M}_t^p = \frac{\epsilon_t}{\epsilon_t - 1}$ is the mark-up charged by retailers on the marginal cost when prices are perfectly flexible. The desired mark-up changes over time following an AR(1) process, leading to the presence of a cost-push shock in the linearized Philipps curve.

The aggregate price index follows the dynamic given by

$$P_t = [\theta_p P + (1 - \theta_p)(P_t^*)^{1-\epsilon}]^{\frac{1}{1-\epsilon}} \quad (57)$$

⁵²Notice that we do not consider entries and exits into the labor force. Including the extensive margin of labor supply may strongly affect the sign and the magnitude of the IRFs to different types of shocks. Given the lack of consensus in the literature, we prefer to leave this issue for future research. However, we check that the prevailing wage is i) always above the worker's reservation wage (i.e. the wage that makes the worker indifferent between employment and unemployment) ii) always above the "full participation wage" (i.e. the wage that makes the worker indifferent between unemployment and inactivity once imposing full participation) iii) sufficiently low to guarantee a positive surplus to the firm.

Monetary Authority

The monetary authority sets the nominal interest rate following a standard Taylor rule:

$$R_t = R_{t-1}^{\rho_r} \left(\frac{1}{\beta} \left(\frac{Y_t}{\bar{Y}} \right)^{\delta_y} \left(\frac{P_t}{P_{t-1}} \right)^{\delta_\pi} \right)^{1-\rho_r} \exp(\varepsilon_t^r) \quad (58)$$

where $\frac{1}{\beta}$ is the steady state value of the interest rate, ρ_r is the degree of the monetary policy inertia, δ_y and δ_π express the monetary policy reactions to output gap and inflation, respectively. ε_t^r is a contractionary monetary policy shock.

Fiscal Authority

The government raises lump-sum taxes T_t to finance public expenditure G_t and unemployment benefits.

$$G_t + b_t U_t = T_t$$

Both public expenditure and the unemployment benefits follow a random process:

$$\ln \tilde{G}_t = (1 - \rho_g) \ln \bar{\tilde{G}} + \rho_g \ln \tilde{G}_{t-1} + \sigma_g \varepsilon_t^g$$

$$\ln \tilde{b}_t = (1 - \rho_b) \ln \bar{\tilde{b}} + \rho_b \ln \tilde{b}_{t-1} + \sigma_b \varepsilon_t^b$$

where ε_t^g and ε_t^b are standard normals. The tilde denotes stationarized variables (i.e. the original variable divided by the permanent component of technology).

Closing the Model

The resource constraint implies

$$Y_t = C_t + G_t + k_t^f V_t \quad (59)$$

To summarize, the model is driven by one permanent shock to technology and other eight transitory shocks which all follow an AR(1) process with their corresponding persistences and volatilities. The transitory shocks can be classified as follows: temporary supply, demand-non-policy (shock to the households' discount factor), monetary policy, cost-push (shock to the elasticity of demand), public expenditure, unemployment benefits, matching efficiency and separation rate.

Because of the presence of unit root in technology, we detrend the non-stationary variables and we then linearize the model around the balanced growth path.

Calibration

We calibrate the model on the U.S. quarterly data and we mainly rely on estimates taken from the literature. β is 0.99, so that the annual steady state interest rate is around 4%. σ_n is taken as half. We assume a steady state unemployment of 5 percent, which corresponds to the average unemployment rate in our sample. We set both the job filling rate (p^f) and the job finding rate to 0.7. This implies an exogenous separation rate of 12%.

We impose that the Hosios efficiency condition holds: the elasticity of the matching function (η) equals the firms' bargaining power ($1 - \gamma$) at the value of 0.5. The total vacancy expenditure on GDP ($\mathcal{M}^p \frac{k^f V}{Y}$) is 0.2 percent, which implies that the unit hiring cost is almost 2% of the nominal wage in steady state. We calibrate α in order to obtain a labor share of 2/3. The price mark up is calibrated at 1.2. The baseline values for price and wage stickiness are both sets at 0.75, so that resets occur once a year on average.

We adopt a standard specification of the monetary policy rule, with quite high inertia ($\rho_r = 0.8$), and monetary policy reactions which respect the Taylor principle ($\delta_y = 0.5$ and $\delta_\pi = 1.5$). The variance of the monetary policy shock is calibrated at 0.0025, so that 1 standard deviation contractionary monetary policy shock raises the nominal interest rate by 25 bp. Since we are not interested in the quantitative performance of the model and evidence is scarce, we do not try to find a proper calibration for each shock process. We set all the persistences to 0.9 and standard deviations to 0.01 instead.

B) Details of Markov-Chain Monte Carlo (MCMC) Procedure

This section describes our choices for the priors and the MCMC algorithm we use to simulate the posterior distribution of the hyperparameters and the states conditional on the data. The choice of the priors largely builds on [Benati and Lubik \(2012\)](#).

Priors

For the sake of simplicity, the prior distribution for the initial values of the states - θ_0 and h_0 - which we postulate to be all normal, are assumed to be independent both from each other and from the distribution of the hyperparameters. In order to calibrate the prior distributions for θ_0 and h_0 we estimate a time-invariant version of Equation 38 based on the first 10 years of data :

$$\theta_0 \sim N\left(\hat{\theta}_{OLS}, 4\hat{V}\left(\hat{\theta}_{OLS}\right)\right)$$

where $\hat{V}\left(\hat{\theta}_{OLS}\right)$ is the estimated asymptotic variance of $\hat{\theta}_{OLS}$. As for h_0 we proceed as follows. Let Σ_{OLS} be the estimated covariance matrix of ϵ_t from the time-invariant VAR and let C be its lower-triangular Cholesky factor, i.e. $CC' = \hat{\Sigma}_{OLS}$. We set

$$\ln h_0 \sim N(\ln \mu_0, 10 \times I_N)$$

where μ_0 is a vector collecting the logarithms of the squared elements on the diagonal of C . As stressed by [Cogley and Sargent \(2005\)](#) "a variance of 10 is huge on a natural log scale, making this weakly informative" for h_0 . Turning to the hyperparameters, we make the following, standard assumptions. The matrix Q is postulated to follow an inverted Wishart distribution

$$Q \sim IW\left(\bar{Q}^{-1}, T_0\right)$$

with prior degrees of freedom T_0 and scale matrix $T_0\bar{Q}$. In order to minimize the impact of the prior, thus maximizing the influence of sample information, we set T_0 equal to the minimum value allowed, the length of θ_t plus one. As for \bar{Q} we calibrate it as $\bar{Q} = \gamma\Sigma_{OLS}$ setting $\gamma = 3.5 \times 10^{-4}$ like in [ibid.](#). We assume independent inverse-Wishart distributions also for the blocks of S :

$$\begin{aligned} S_1 &\sim IW\left(\bar{S}_1^{-1}, 2\right), & \bar{S}_1 &= 0.001 * |\hat{\alpha}_{2,1}| \\ S_2 &\sim IW\left(\bar{S}_2^{-1}, 3\right), & \bar{S}_2 &= 0.001 * \text{diag}[|\hat{\alpha}_{3,1}|, |\hat{\alpha}_{3,2}|] \\ S_3 &\sim IW\left(\bar{S}_3^{-1}, 4\right), & \bar{S}_3 &= 0.001 * \text{diag}[|\hat{\alpha}_{4,1}|, |\hat{\alpha}_{4,2}|, |\hat{\alpha}_{4,3}|] \end{aligned}$$

where $\text{diag}(x_1, \dots, x_n)$ is a diagonal matrix of order n with elements x_i 's on the main diagonal and $|\hat{\alpha}_{i,i}|$ is the i, i element of the correlation matrix of the VAR shocks derived from $\hat{\Sigma}_{OLS}$. As for α we assume: $f(\alpha) = N(\hat{\alpha}, 10 * |\hat{\alpha}|)$.

Finally, as for the variance of the stochastic volatility innovations, we follow [ibid.](#) and we postulate an inverse-Gamma distributions for $\sigma_i^2 \equiv \text{Var}(\nu_{i,t})$:

$$\sigma_i^2 \sim IG\left(\frac{10^{-4}}{2}, \frac{1}{2}\right)$$

Simulating the Posterior Distribution

We simulate the posterior distribution of the hyperparameters and the states conditional on the data via the following MCMC algorithm, which combines procedures found in [ibid.](#) and [Primiceri \(2005\)](#). In what follows x^t denotes the entire history of the vector x up to time t i.e. $x^t = [x'_1, x'_2, \dots, x'_t]'$, while T is the sample length.

- *Drawing the elements of θ_t* : Conditional on Y^T, α and H^T the observation equation (38) is linear, with Gaussian innovations and a known covariance matrix. Following [Carter and Kohn \(2004\)](#) the density $p_U(\theta^T | Y^T, \alpha, H^T)$ can be factored as

$$p_U(\theta^T | Y^T, \alpha, H^T) = p(\theta_T | Y^T, \alpha, H^T) \prod_{t=1}^{T-1} p(\theta_t | \theta_{t+1}, Y^T, \alpha, H^T)$$

where the u subscript stands for unrestricted, since we do not have imposed stationarity yet. Conditional on α and H^T , the standard Kalman filter recursions nail down the first element on the right hand side: $p(\theta_T | Y^T, \alpha, H^T) = N(\theta_T, P_T)$, with P_T being the precision matrix of θ_T produced by the Kalman filter. The remaining elements in the factorization can then be computed via the backward recursion algorithm found, e.g. in [Cogley and Sargent \(2005\)](#). Given the conditional normality of θ_t we have:

$$\theta_{t|t+1} = \theta_{t|t} + P_{t|t} P_{t+1|t}^{-1} (\theta_{t+1} - \theta_t)$$

Draw

$$P_{t|t+1} = P_{t|t} + P_{t|t} P_{t+1|t}^{-1} P_{t|t}$$

which provides for each t from $T - 1$ to 1 the remaining elements in equation (38), $p(\theta_{t|t+1} | Y^T, \alpha, H^T) = N(\theta_{t|t+1}, P_{t|t+1})$. Specifically, the backward recursion starts with a draw from $N(\theta_T, P_T)$, call it $\tilde{\theta}_T$. Conditional on $\tilde{\theta}_T$, the Kalman formulation above gives us $\theta_{T-1|T}$ and $P_{T-1|T}$ thus allowing us to draw $\tilde{\theta}_{T-1}$ from $N(\theta_{T-1|T}, P_{T-1|T})$ and so on till $t = 1$.

Then, eq. (39) restricts the admissible value of θ by imposing stationarity through the function $I(\theta)$. [ibid.](#) show that the restricted density $p_R(\theta^T | Y^T, \alpha, H^T)$ is proportional to the truncation of the posterior of the unrestricted model $I(\theta)p_U(\theta^T | Y^T, \alpha, H^T)$. We follow their approach and we approximate the factor of proportionality to be constant. This implies that we reject any draws of θ^T where any of its elements violates the stationarity constraint⁵³.

- *Drawing the innovation variance for VAR parameters (Q)*: Conditional on a realization for θ^T , the VAR parameter innovations (η_t 's) are observable. Under the linear transition law, η_t is i.i.d. normal. Given an inverse-Wishart prior and a normal likelihood, the posterior is inverse-Wishart.
- *Drawing the innovation variances for α_t (S_1, S_2, S_3)*: Conditional on the vector of covariance parameters α , the innovations τ_t 's are observables and follow a normal distribution. Given the inverse Wishart prior on the innovation variance-covariance matrices S_1, S_2, S_3 the posterior follows an inverse Wishart distribution as well.
- *Drawing the covariance parameters (α_t)*: Conditional on Y^T and θ^T , the VAR residuals $\epsilon_t = Y_t - X_t' \theta_t$ are observable, satisfying $A \epsilon_t = u_t$, with u_t being a vector of orthogonalized residuals with known time-varying variance H_t . Following [Primiceri \(2005\)](#), we interpret $A \epsilon_t = u_t$ as the observation equation and Equation

⁵³[Koop and Potter \(2011\)](#) develop a multi-move algorithm which does not involve the use of any approximation. However, their method imposes a significantly higher computation burden, since it requires the calculation of the proportionality factor for each draw and each period. Moreover, they show that the results are only slightly affected by the use of their exact algorithm. Additionally, they also provide a single-move algorithm which has the advantage of having a much lower rejection probability of the draws: this may prove useful when the multi-move algorithms fail to accept the majority of the draws. However, this does not happen in our case.

44 as the unobserved state equation. Then we apply the [Carter and Kohn \(2004\)](#)'s algorithm as in point a) to obtain a draw of α . Given the block-diagonal structure of S , the algorithm can be applied equation by equation.

- *Drawing the standard deviation of volatility innovations* (σ_i 's): Conditional on a specific time path of $\log(h_t)$, the innovations to the logs of the stochastic volatilities (v_{it} 's) are directly observable. The v_{it} 's are i.i.d. normal with mean zero and variance σ_i^2 . Assuming an inverse-gamma prior for σ_i , $i = 1, \dots, 4$, the posterior is also inverse gamma.
- *Drawing the stochastic volatilities* (h_{it} 's): Since we assume that the stochastic volatilities evolve independently, we can sample them on a univariate basis by applying the algorithm of [Jacquier, Polson and Rossi \(1994\)](#) element by element.

Summing up, the MCMC algorithm simulates the posterior distribution of the states and the hyperparameters, conditional on the data. We use a burn-in period of 50,000 iterations to ensure convergence to the ergodic distribution. We then perform other 100,000 iterations sampling every 10th draw in order to reduce the autocorrelation across draws. What we are after are 10,000 draws from the ergodic distributions over which we calculate the statistics reported in the main text.

C) Generalized Impulse Response Functions

In the context of TVP-VAR models, standard impulse response functions may lead to inaccurate results, since they neglect the uncertainty on future changes of the structural parameters. In the spirit of [Koop, Pesaran and Potter \(1996\)](#), we thus compute Generalized Impulse Response Functions. These are defined as the difference between the expectation of the future path of the endogenous variables conditional on history ω_t and an arbitrary current shock ϵ_t and the same expectation without the exogenous shock.

$$GIRF_{i,t+k} = E[Y_{t+k}|\omega_t, \epsilon_t] - E[Y_{t+k}|\omega_t]$$

Our algorithm is similar to [Baumeister and Benati \(2013\)](#). For any period t we proceed as it follows:

1. For any draw from the Gibbs sampler, we take the sequence of the states from $t - 2$ to $t + k$, where $k = 20$ is the maximum horizon for which we compute the GIRF⁵⁴. In this way, we account for the changes in the structural economic relationships that may occur in the future.
2. Draw four sequences of length k of structural shocks - $\epsilon_{i,t}, \dots, \epsilon_{i,t+k}$, $i = 1, \dots, 4$ - from univariate standard normal distributions. Notice that draws are independent because we consider structural disturbances.
3. For any draw from the Gibbs sampler, our identification procedure described in Section 15.1 selects an impact matrix A_0 . Given A_0 , the history, the current state and the future path of VAR coefficients, we can compute the impulse response functions to the i -th shock as the difference between two distinct simulations. In the benchmark the shocks impacting the economy are the ones obtained in step 2. Call this benchmark simulated path $\hat{X}_{t,t+k}$. The second simulation is performed by considering an additional exogenous shock

⁵⁴Alternatively, future states can be stochastically simulated based on the law of motions and the draw of the posterior of the hyperparameters. Our procedure has the advantage of avoiding additional simulations. However, we can compute GIRFs only up to period $T - k$, where T is the length of the sample, since future paths of the structural coefficients are not available later in time. However, we do not have a special interest in the very latest years of the sample.

i at time t , namely $\epsilon_{i,t} + 1$, whereas $\epsilon_{-i,t}$ and $\epsilon_{i,t+1}, \dots, \epsilon_{i,t+k}, \forall i$ are left as in the benchmark. Call this second simulated path $\tilde{X}_{t,t+k}^i$, where i indexes the shock that has been augmented in the first period. Then, we obtain the GIRF to the i -th shock as the difference between the second simulation and the benchmark: $girf_{t,t+k}^i \equiv \tilde{X}_{t,t+k}^i - \hat{X}_{t,t+k}$.

4. Repeat steps 1-3 for all draws of the Gibbs sampler. The representative GIRF for each variable at period t is the median of this distribution.

D) Identification à la Iskrev (2010)

Iskrev (2010) proposes the following strategy for local identification. A DSGE model can be represented by the following g linear equations, where θ is the vector of deep parameters of the model and z_t is the vector of variables:

$$\mathbb{E}_t (g(z_t, z_{t-1}, z_{t+1}, u_t) | \theta) = 0$$

$$\Gamma_0(\theta) z_t = \Gamma_1(\theta) \mathbb{E}_t z_{t+1} + \Gamma_2(\theta) \mathbb{E}_t z_{t-1} + \Gamma_3(\theta) u_t \quad (60)$$

Assuming a unique solution to (60) exists, it takes the following form

$$z_t = A(\theta) z_{t-1} + B(\theta) u_t$$

Since some of the variables are not observed, the above system is augmented by the measurement equation:

$$x_t = C z_t + D u_t + \nu_t$$

Then, the unconditional first and second moments of the model are

$$\mathbb{E}_t x_t = \mu_x$$

$$\mathbb{E}_t x_{t+i} x_t = \Sigma_x(i)$$

$$\text{where } \Sigma_x(i) = \begin{cases} C \Sigma_x(0) C' & i = 0 \\ C A^i \Sigma_x(0) C' & i > 0 \end{cases} \text{ and } \Sigma_x(0) \text{ solves the matrix equation}$$

$$\Sigma_x(0) = A \Sigma_x(0) A' + \Omega$$

where $\Omega = B(\theta) B'(\theta)$. Define the unconditional second moment for T observations as

$$\mathbb{E}_t X_T X_T' = \Sigma_T$$

Then the identification strategy consists in checking that the following matrix is the mapping from the population moments of the data - the vector $\sigma_T = \left[\text{vec}(\Sigma_x(0))' \quad \text{vec}(\Sigma_x(1))' \quad \dots \quad \text{vec}(\Sigma_x(T-1))' \right]'$ - to the vector of structural parameters θ is unique:

$$\sigma_T(\theta) = \sigma_T(\theta_0) \iff \theta = \theta_0$$

The above global identification may never be achieved; hence it is well advised to find the conditions resulting

into local identification. A necessary condition for identification is that the number of deep parameters does not exceed the number of unique parameters in the utilized moment. A stronger necessary condition states that if $\sigma_T(\theta)$ is continuously differentiable and θ_0 is a regular point of the Jacobian matrix $J(T) = \frac{\partial \sigma_T}{\partial \theta'}$ then θ_0 is locally identifiable if the Jacobian has full column rank at the regular point.

This result is due to a classical work by [Rothenberg \(1971\)](#). A regular point is a point at which there exists an open neighborhood where the rank of the matrix remains constant. If θ_j cannot be identified, then the corresponding column of the Jacobian is zero for any T . A corollary to the theorem invites to look at the rank condition of $J_2(T) = \frac{\partial \tau}{\partial \theta'}$ where $\tau = [\text{vec}(A)' \text{vec}(C)' \text{vech}(\Omega)']$ is the solution to the DSGE model. The identification strength can be calculated using the Fisher information matrix in the following form. The log-likelihood function of the data $X = [x_1, \dots, x_T]$ can be derived using the prediction error method. The one step forecast error

$$e_{t|t-1} = x_t - C\hat{z}_{t|t-1} - Du_t$$

The one step forecast errors of the state variables are constructed by applying the Kalman Filter. The covariance matrix $S_{t|t-1} = CP_{t|t-1}C'$ where $P_{t|t-1} = \mathbb{E}_t(z_t - \hat{z}_{t|t-1})(z_t - \hat{z}_{t|t-1})'$ is the conditional covariance matrix of the one-step forecast error. This implies the log-likelihood of the sample takes the following form

$$\mathcal{L}_T(\theta) = \text{constant} - \frac{1}{2} \sum_{t=1}^T \log \det(S_{t|t-1}) - \frac{1}{2} \sum_{t=1}^T e'_{t|t-1} S_{t|t-1}^{-1} e_{t|t-1}$$

The precision of $\hat{\theta}_T$ is determined by the inverse Fisher information matrix as

$$I_T(\theta) = \mathbb{E}_t \left[\left\{ \frac{\partial \mathcal{L}_T(\theta)}{\partial \theta'} \right\}' \left\{ \frac{\partial \mathcal{L}_T(\theta)}{\partial \theta'} \right\} \right]$$

The strength of identification for parameter i is then defined as $s_i(\theta) = (\Delta_i(1 - \varrho_i))^{1/2}$, where Δ_i is a diagonal matrix containing the variances of the elements of the score vector and ϱ_i is the correlation of marginal log-likelihood of a parameter with respect to another. Likewise $\text{std}(\hat{\theta}_i) \geq s_i(\theta)^{-1}$, which states that “the covariance matrix of any unbiased estimator of θ is bounded from below by the inverse of the Fisher information matrix. It shows that the identification strength of a parameter can be expressed in terms of bounds on a one-standard-deviation intervals for unbiased estimators of the parameter. In that case identification will be weak if Δ_i is nearly zero or the correlation is very high ϱ_i . We have conducted the exercise using our time series (in our case, GDP growth, normalized vacancy by labor force, real interest rate and inflation) and three variables (interest rate, inflation and vacancy). Results show strong degree of identification. Hence we can make sure the shocks are identified and the implied signs are not flawed. In Fig - 13 the results of the identification exercise are reported. In the first panel, the results show that all parameters of interest are identified, i.e. we are not facing any situation where Δ_i is nearly zero or the correlation is very high ($\varrho_i = 1$). The second panel shows quite important sensitivity of the model behavior to the parameters, which is expected given that the model is driven by external shocks. The third panel shows the collinearity pattern of the parameters: it is the result of the search to find the critical combination of parameters explaining at best $J(T)$.

Figure 19: Original data and median estimates of the states

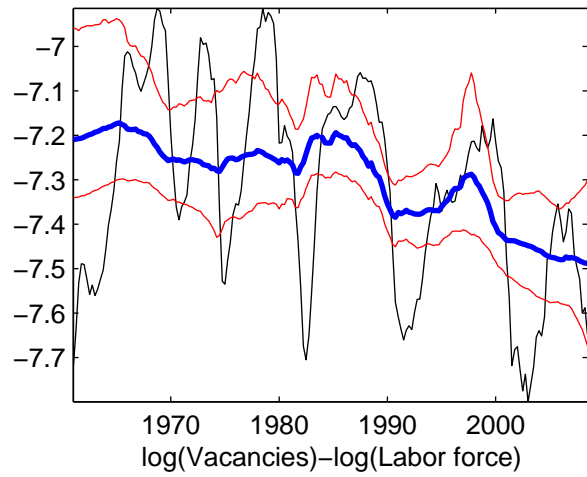
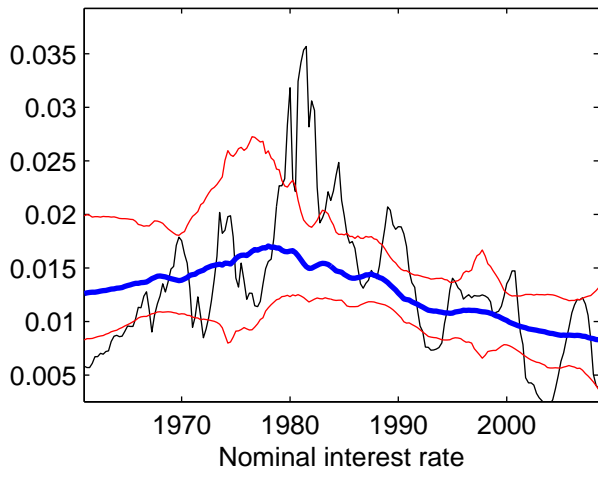
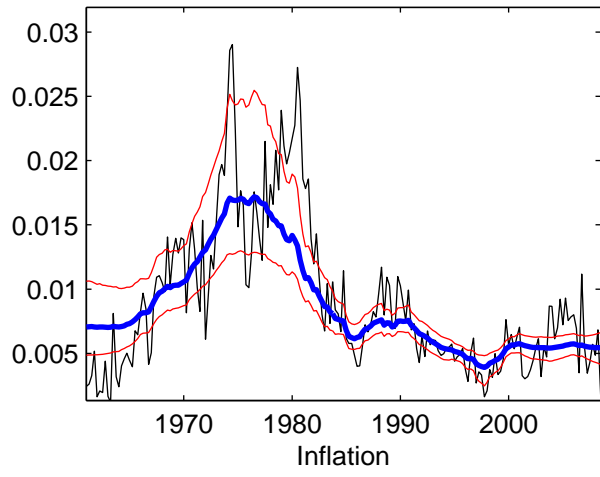
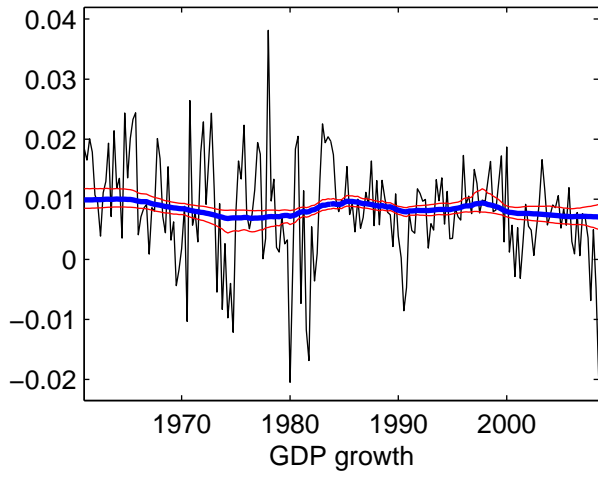


Figure 20: Median time-varying coefficients of the reduced-form VAR

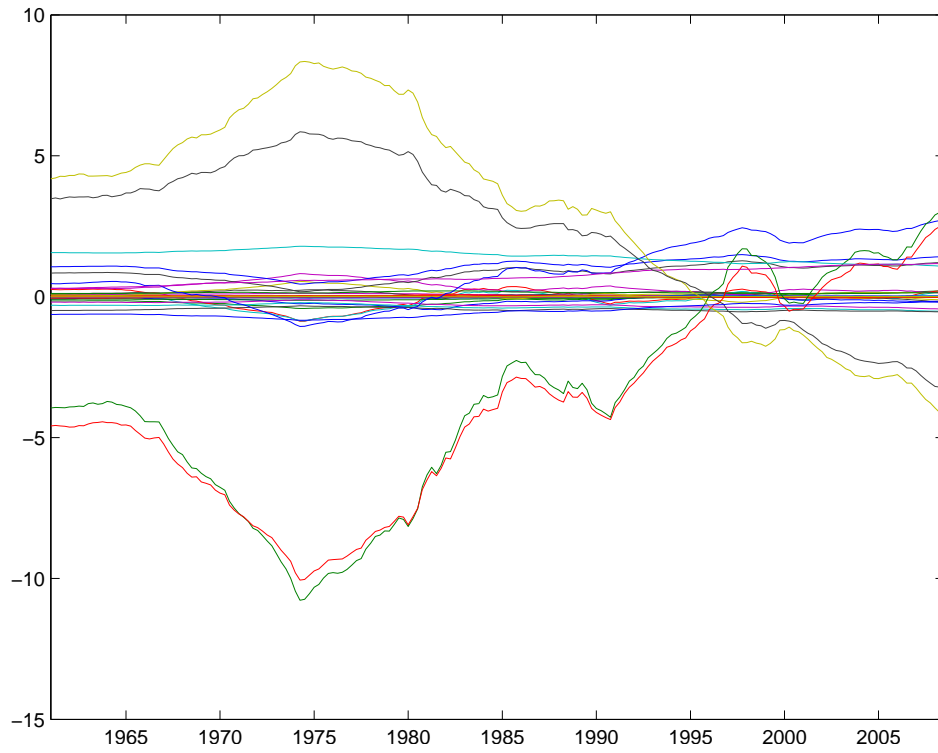


Figure 21: Time-varying total prediction variance (Bps)

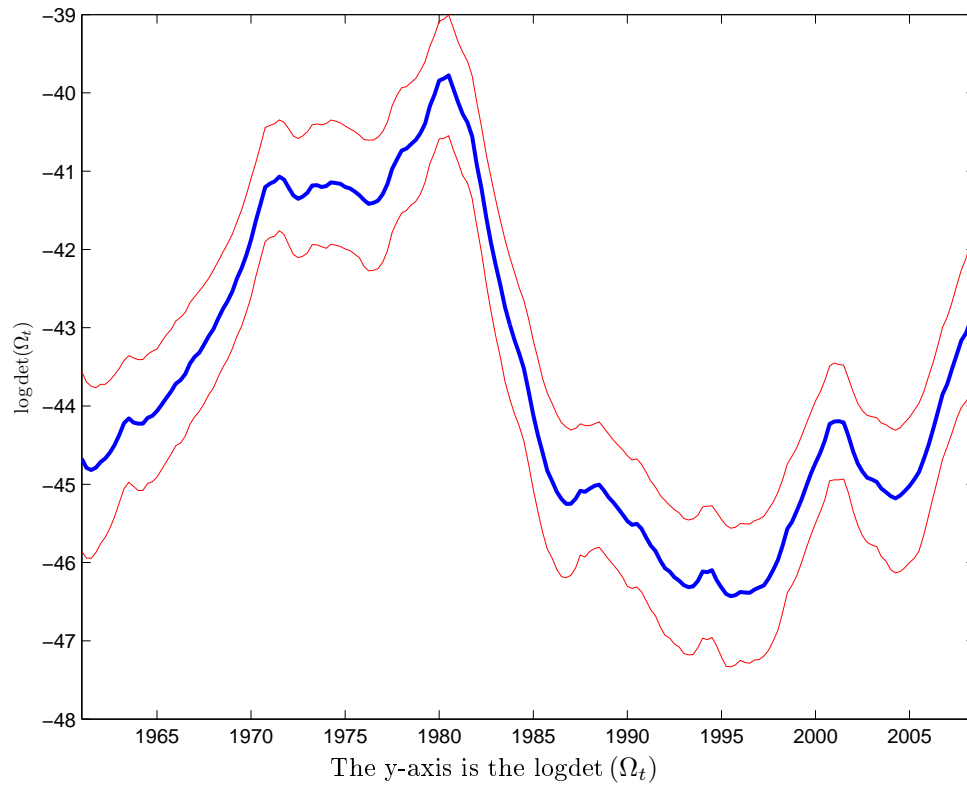


Figure 22: Time-varying volatility of reduced-form shocks (Bps)

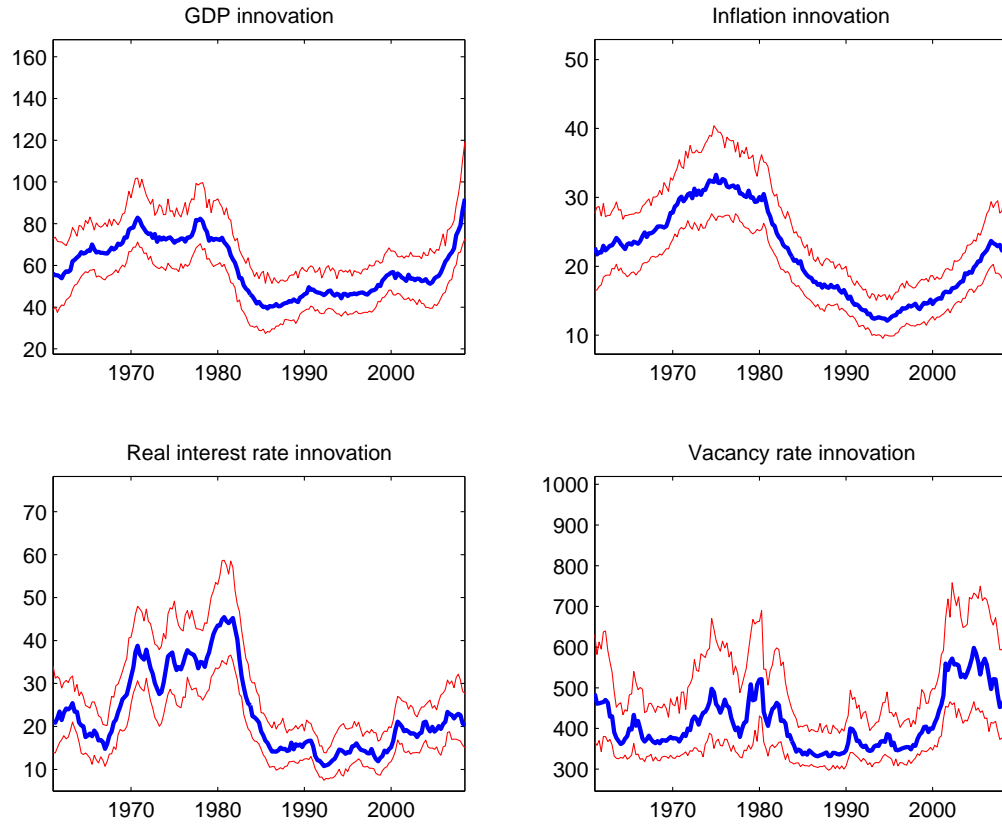


Figure 23: Time-varying volatility of the reduced-form shocks relative to that of GDP growth

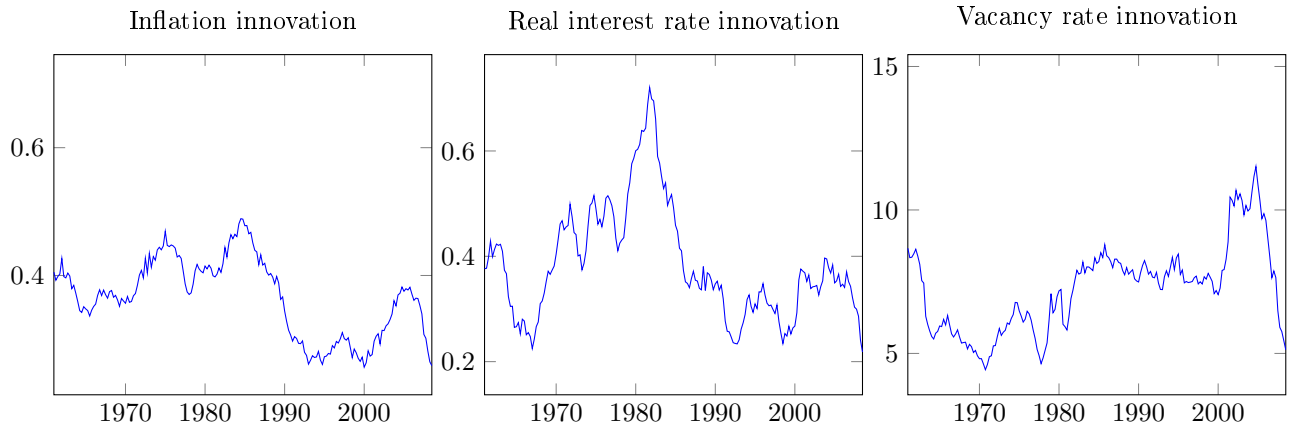


Figure 24: Time-varying correlations of the reduced-form shocks (Bps)

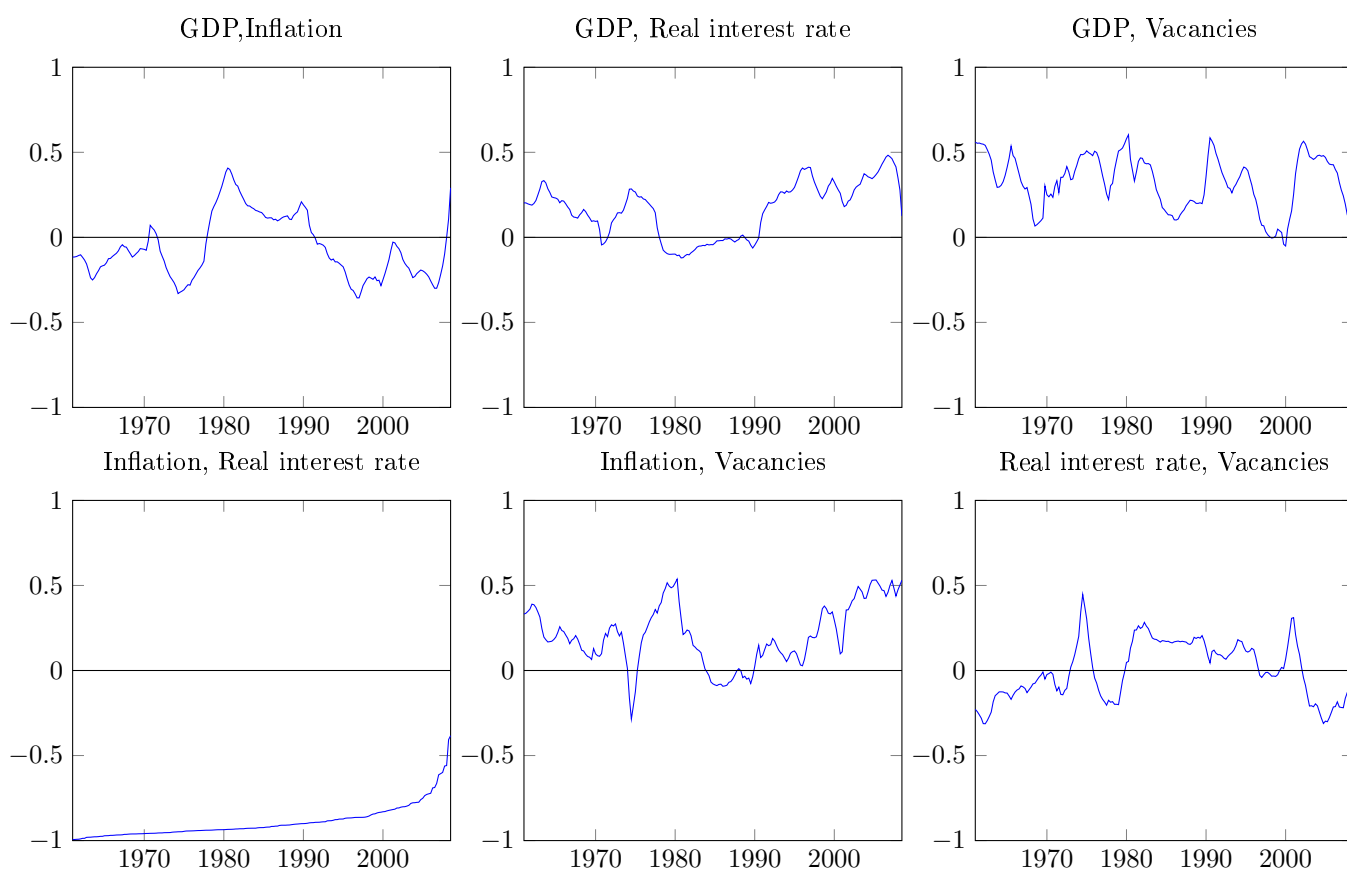


Figure 25: Vacancies: time-varying response on impact

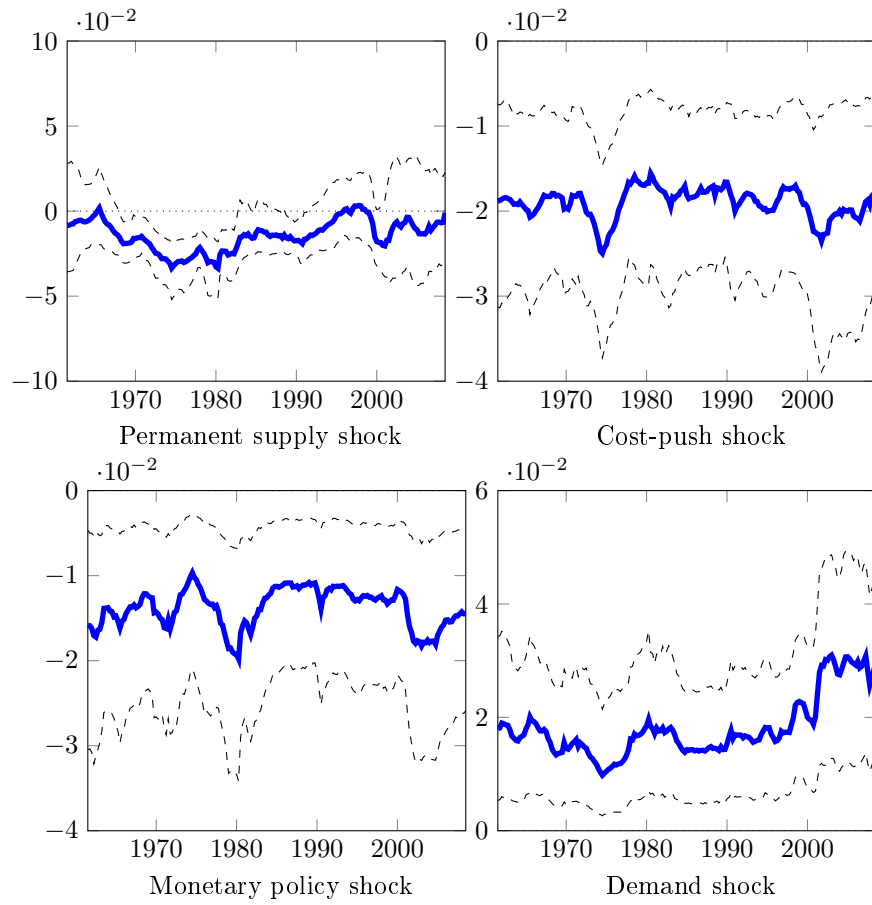


Figure 26: Vacancies: normalized time-varying response on impact

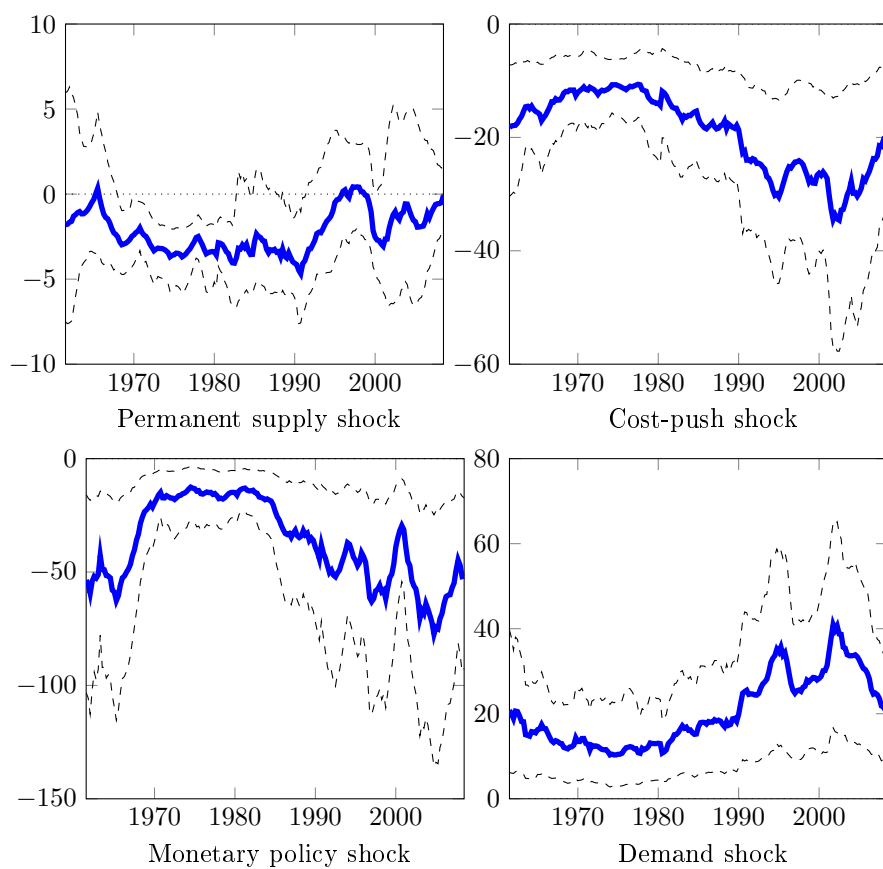


Figure 27: GDP growth: normalized time-varying response on impact

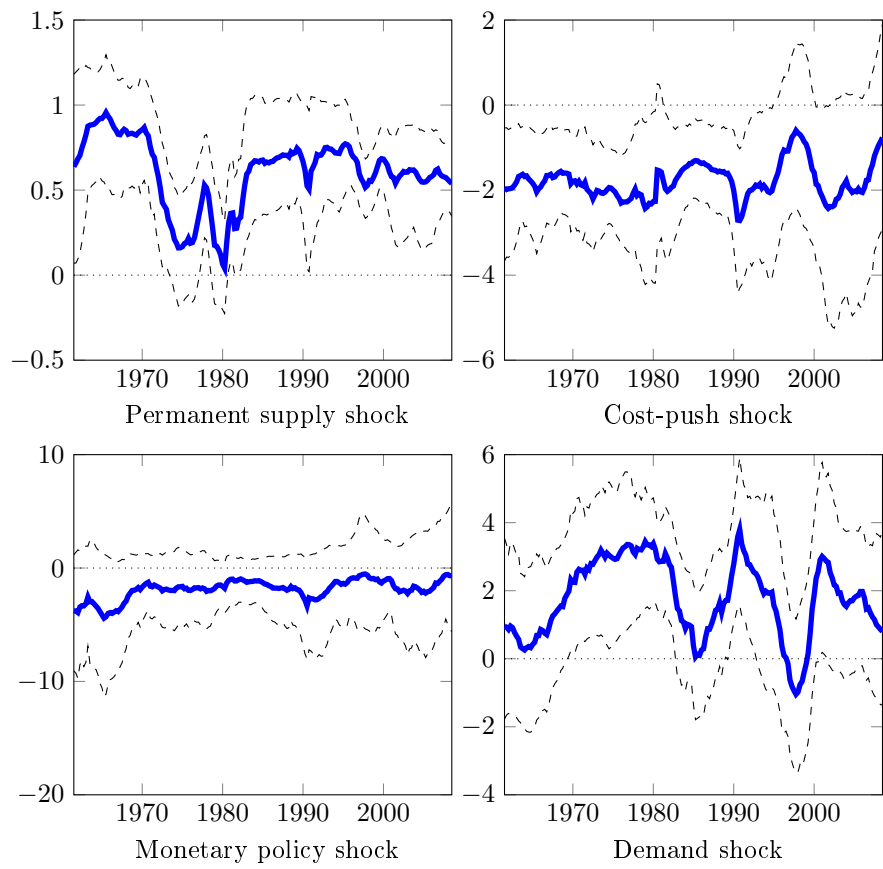


Figure 28: Vacancies: normalized time varying Generalized Impulse Response Functions (Bps)

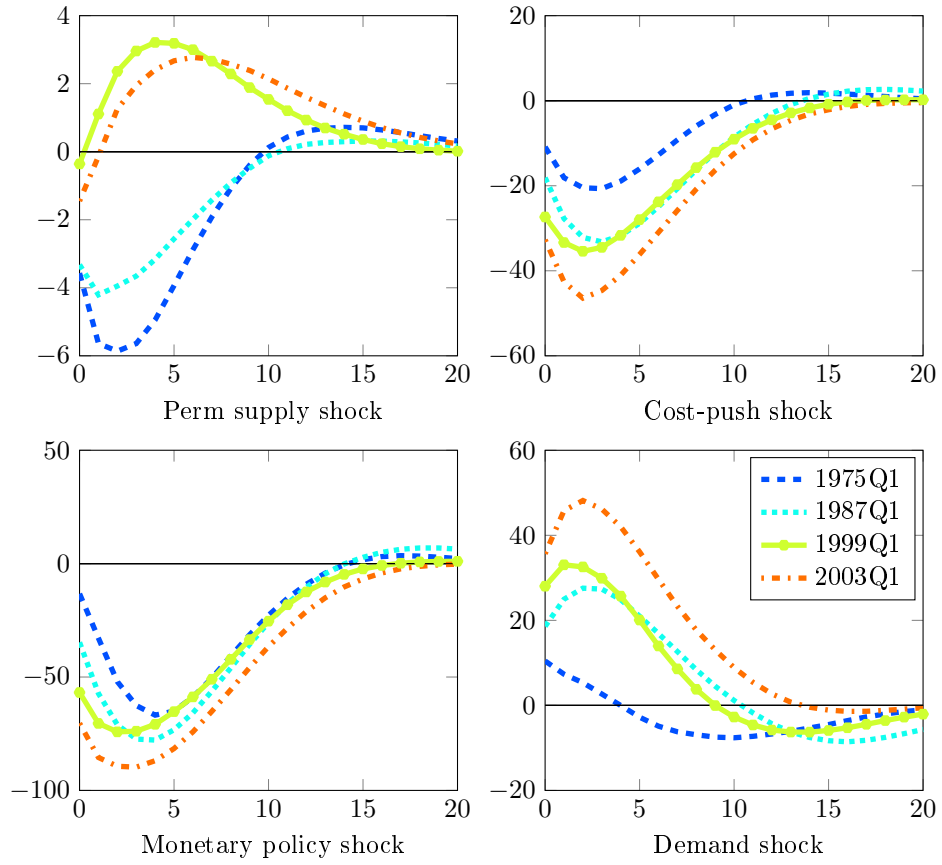


Figure 29: Vacancies: time-varying conditional and unconditional correlations

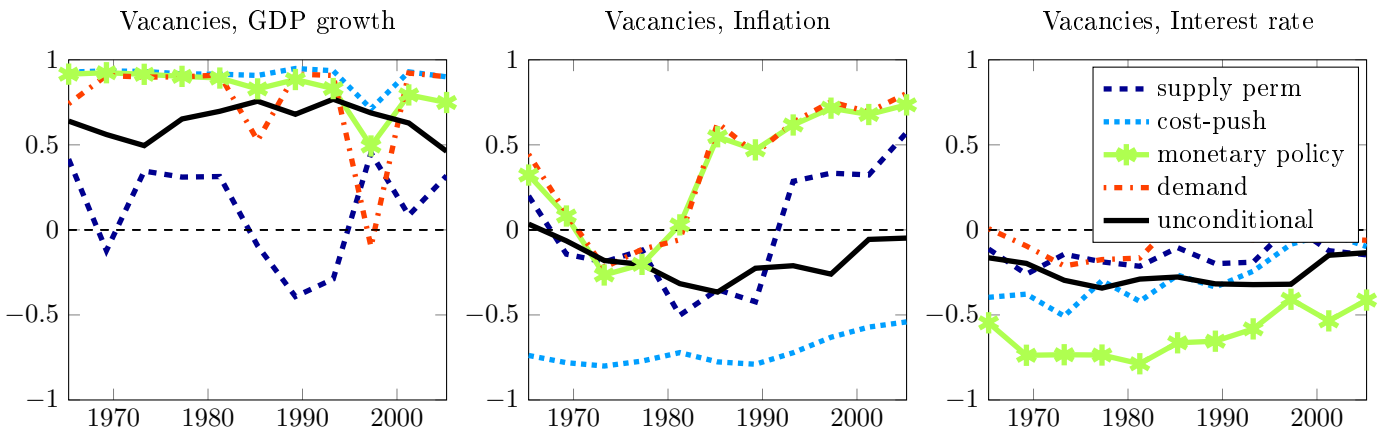


Figure 30: Time-varying conditional and unconditional variance at business cycle horizon

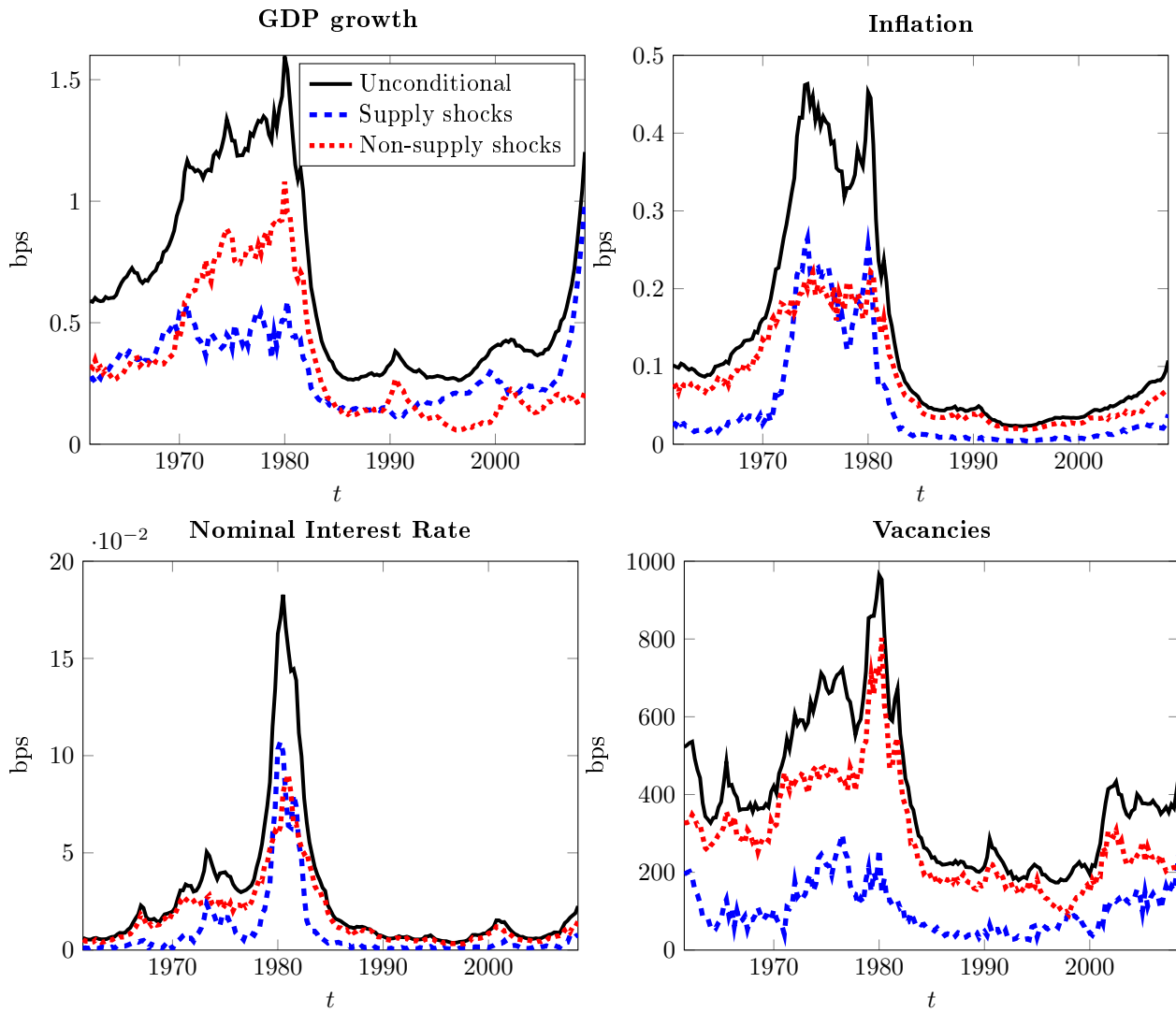


Figure 31: Vacancies: Forecast Error Variance Decomposition

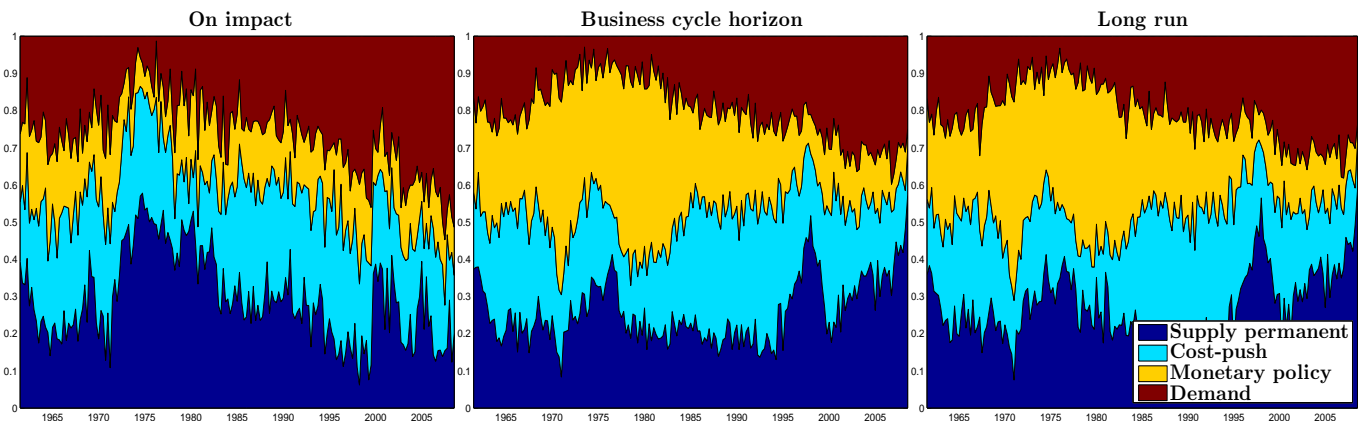


Figure 32: Model based IRFs

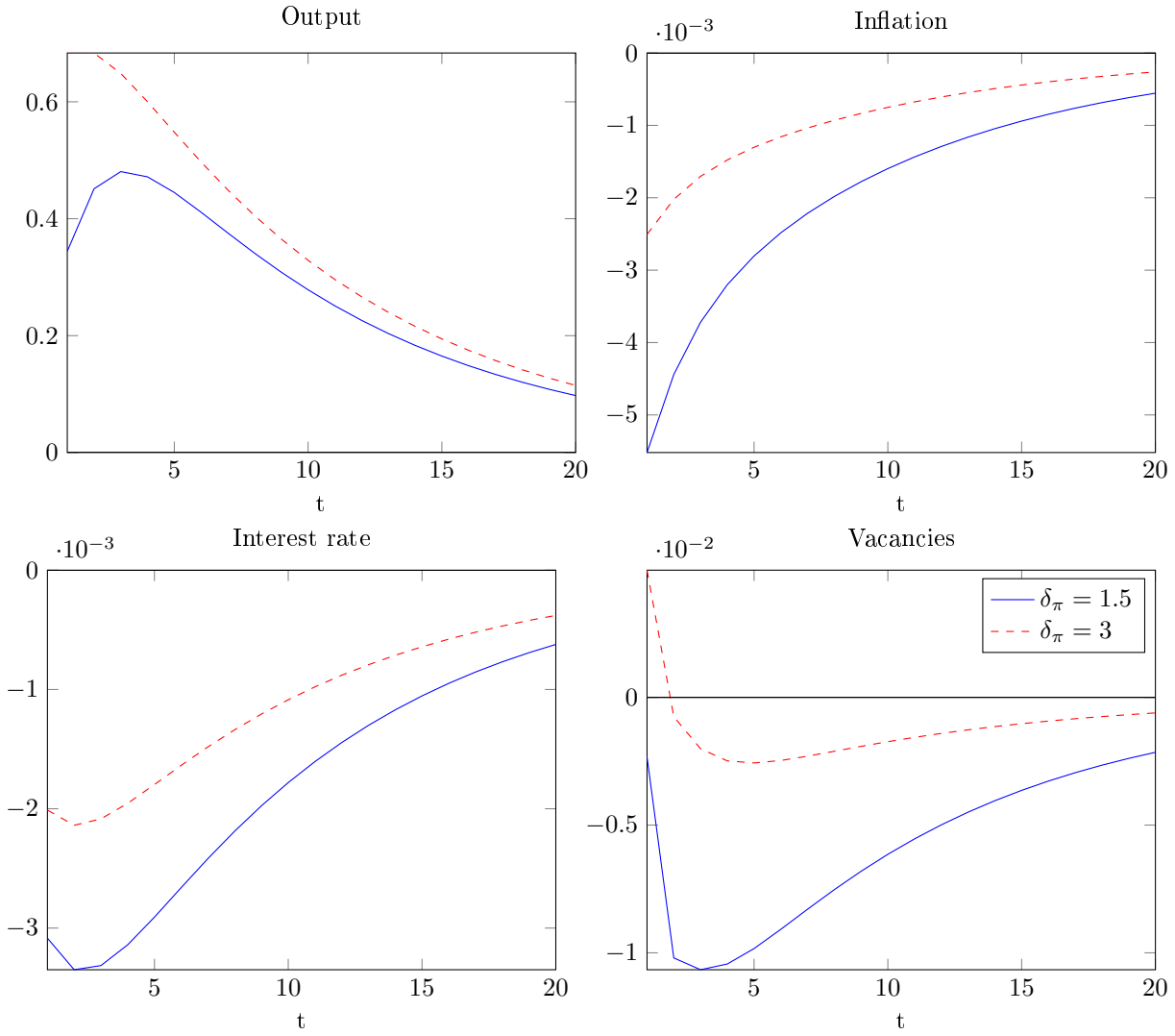


Figure 33: Model based IRFs

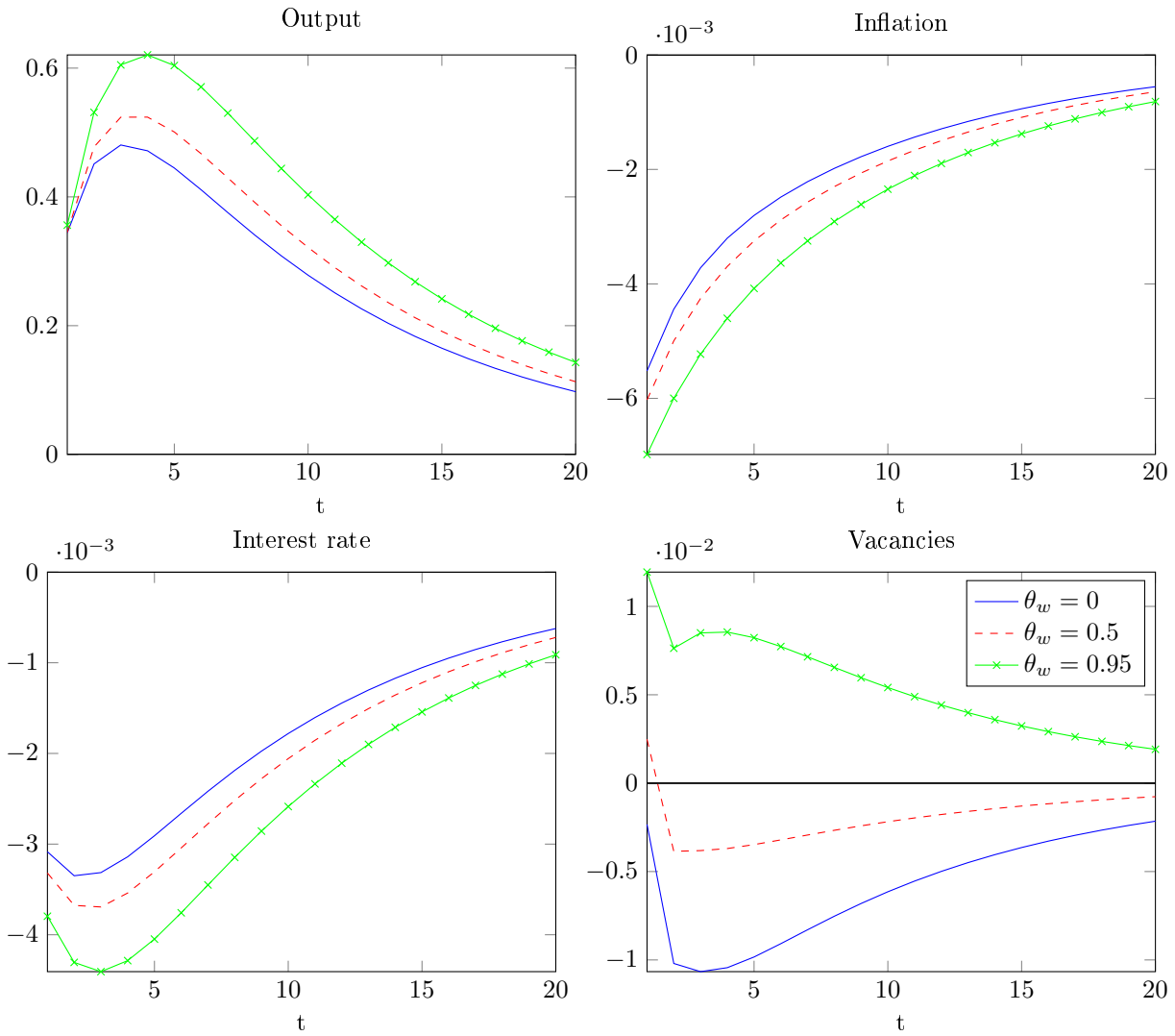
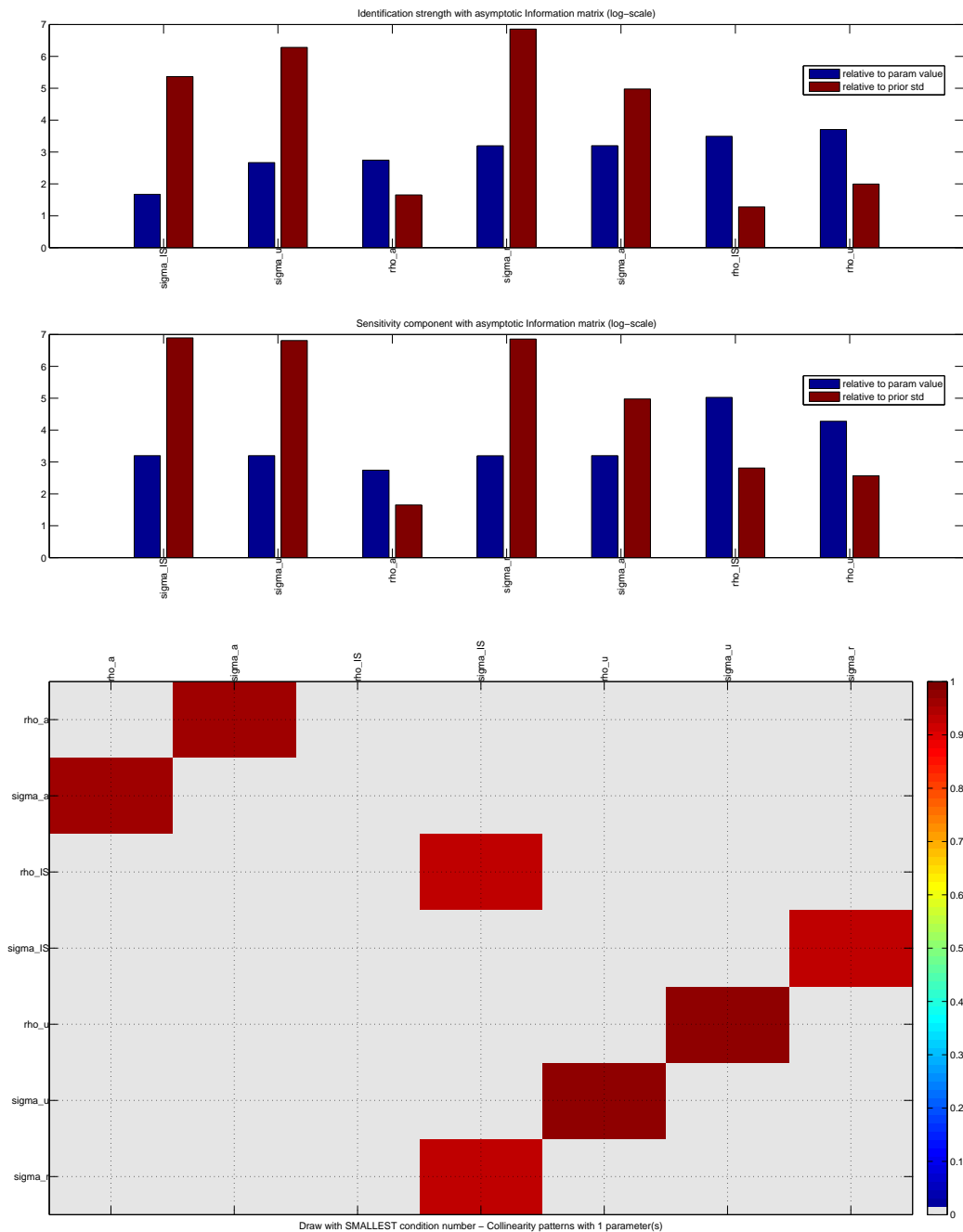


Figure 34: Strength of identification of shocks given the time series



First panel depicts the identification strength with asymptotic information matrix (log-scale). The second panel depicts sensitivity component with asymptotic information matrix (log-scale). The third panel depicts the draw with smallest condition number for collinearity patterns with 1 parameter.

Chapter 3 : Chapter 11 and Demand for Loan Covenants (with Garence Staraci ⁵⁵)

20 Chapter 3 : Introduction

Creditors in order to exert their rights and controls on borrowing firms may *ex ante* include restrictions in their loan contracts. These restrictions are usually called *covenants*. Covenants are broadly categorized as being affirmative or negative. The affirmative ones are lender-imposed guidelines the borrower must follow in the operation of its business, whereas the negative ones are prohibitions on the borrower's ability to change the nature of its business without the lender's consent.

Covenants are thus central to the control and ownership rights of creditors *outside* bankruptcy, meaning breach of any covenants is interpreted as a technical default, shifting the ownership right to creditors by accelerating their payment schedules. However, *inside* bankruptcy, the relationship between creditors and their associated borrowing firms are dictated by the U.S. Bankruptcy Code, which provides numerous provisions for debtors to address their debt-overhang problem.

The aim of this paper is to link creditor control both inside and outside bankruptcy to provide a novel interpretation of why covenants are included. Our central claim is that covenants are

⁵⁵Yale School of Management

not only included as a means of shifting the governance from debtors to creditors once they are breached (i.e. outside bankruptcy), but to also potentially address the concern creditors might have about how the bankruptcy law is practiced, if ever the borrowing firm goes bankrupt.

To put it more simply, the bankruptcy law can be practiced in favor of debtors and vice versa. Creditors are then concerned about how the law is practiced. If the law is practiced in a more debtor-friendly manner, meaning the decisions in general are more in favor of borrowers, creditors will then “protect” their interests by putting more covenants. We thus introduce a new rationale for covenants inclusion by creditors, namely the impact of the legal environment on the design of loan contracts. We also claim that the legal consideration ultimately impacts the cost of credit, through this channel of covenant inclusion.

To illustrate the concept further, suppose a lender has extended a credit line against the cash flow of a borrowing firm, on an unsecured basis, with one covenant forbidding the pledging of assets to anyone. This is obviously an attempt to maintain the strength of the creditors’ unsecured position in the event of default or liquidation (Tirole, 2010). The same reasoning can be applied to how the law is practiced. If secured creditors perceive that their power in bankruptcy is weakened following a debtor-friendly shift in bankruptcy practices, they may try to retain their control on the firm’s assets by introducing covenants forbidding any further liens on assets to anyone. Thus, the practice of bankruptcy law could influence the way creditors design their loan contracts, and thus could have an influence on the cost of credit *in fine*. In particular, creditors might impose stricter loan contracts to the borrowers if the current state of the bankruptcy practice is not perceived to be friendly to them, and vice-versa ⁵⁶.

The road-map of the analysis for our claim is the following. We first document the evolution of the bankruptcy law. This evolution has been characterized by the adoption of more creditor-friendly bankruptcy clauses with the purpose of liquidity provisions. In this paper we consider the Chapter 11 Case Administration Section of the U.S. Bankruptcy code, which encompasses five major liquidity clauses (Section 361-Section 365) that set the rights of both debtors and creditors

⁵⁶Hart (1995) argues three rationales for bankruptcy law: ex-post efficiency, binding ex-ante disciplinary role of debt and preserving the absolute priority. These three have been shown to have an impact on the debt pricing. It is for instance a widely accepted view that debt is a cheaper form of finance for companies and a rationale for bankruptcy law is to preserve the ex-ante disciplinary role of debt, which are mutually inclusive.

during the bankruptcy process. These clauses allow debtors to release collateral in order to make new credit liens, or permit the lift of the automatic stay for creditors to provide debtor-in-possession (hereafter DIP) financing.

We then define the notion of covenant intensity as being the number of covenants included in the contract (at loan origination). A standard rationale for covenant intensity (or strictness) is that strict covenants are not only implemented to price default risk but also to allocate bargaining power through renegotiation. As we will show, while the renegotiation and default risks determinants do play a role in the choice of contract strictness, an additional effect, namely the consideration of the legal environment, also plays an important role.

We finally show that creditors' considerations of legal practices explain a significant part of their choices in determining the covenant intensity, and this induced strictness has a sizable impact on the cost of credit. To do so we provide a stylized model in which creditor control inside and outside bankruptcy are reunited under a single framework: the monitoring lens. We then use the frequency of implementation of several bankruptcy practices as instruments, in order to isolate the legal effect played on creditor's determination of covenant intensity. After instrumenting the covenant intensity, we find this legal effect to have a non-negligent financial cost reflected in the spread charged to the borrower.

Our identification strategy relies on the fact that outside bankruptcy, shifts in the bankruptcy practice solely impacts the demand function of the creditor for covenant and spread. It also relies on the investigated claim that the fundamental driver of our time series bankruptcy proxies is judicial discretion, which ensures that no link exists between the financial contracting process and the potential bankruptcy outcome. Our results show that as the law becomes more debtor-friendly, the associated decline of including an additional financial covenant in the contract is 23 basis points.

This paper also provides further evidence on the current work of the Commission to Study the Reform of the Chapter 11, i.e U.S. Corporate Reorganization, which has recently analyzed the creditor-friendliness of the current corporate bankruptcy practice⁵⁷. The report of the Com-

⁵⁷The Commission's view is reflected in their statement of purpose: "in light of the expansion of the use of secured credit, the growth of distressed-debt markets and other externalities that have affected the effectiveness of the current Bankruptcy Code, the Commission will study and propose reforms to Chapter 11 and related statutory provisions." The commission argues that since

mission could recommend shifting power among company executive, shareholders, judges, unions and regulators. However, loan market participants are worried that the Commission seems to be especially focused on the concern that a proliferation of secured lending in the growth of the claims trading market could negatively impact the reorganization process (Loan Syndication and Trading Associations - LSTA 2014). They have warned through different testimonies that any changes to the law could have “significant and unintended effects on the loan market and loans’ prices” (LSTA 2014) ⁵⁸. This in turn affects investors’ willingness to provide capital ex-ante and the firm’s choice of capital structure as well as the cost of capital (Hotchkiss et al., 2008). We claim that any amendment to the Code that would limit the creditors’ rights during bankruptcy would have an impact on the pricing of syndicated debt by modifying the covenant structure of loan contracts.

The paper is structured as follows. Section 2 is entirely devoted to the legal component of our work, and both the justification and the construction of our legal instruments. Section 3 introduces syndicated loans and their associated covenants, together with our notion of covenant intensity. In Section 4, we provide a stylized model for understanding our main hypothesis. Section 5 is solely devoted to the empirical testing of our claim. In Section 6, we conclude our work by providing further insights arising from our main result.

21 Corporate Bankruptcy and Its Evolving Practice

21.1 From Debtor To Creditor-Friendly Practices

Over the past three decades, two strands of legal literature have documented a transformation in the *practice* of the US bankruptcy law. The first wave of legal scholars have debated the debtor-friendliness of the bankruptcy law; within this group are the works of Roe (1983); Bebchuk (1988); Rasmussen (1992); Adler (1993a); Adler (1993b); Schwartz (1998) and Schwartz (1999) (the latter advocating the privatization of the bankruptcy process through a means of a market-based approach). As pointed out in the work of Bradley and Rosenzweig (1992), the bankruptcy practice became debtor-friendly after the adoption of the Bankruptcy Act of 1978.

In the early 2000s however, another strand of literature emerged and pointed to more creditor-
bankrupt firms have little or no equity at the time of filing, the rights of other claimholders such as employees, tort claimants and trade creditors should be improved during bankruptcy phase.

⁵⁸They claim that if lenders aren’t comfortable with their investment protections, they will simply raise the price of credit. For example, the managing director of GSO capital market testified how “weakening the rights of secured creditors in bankruptcy would impede the credit market and increase the cost of capital”.

friendly bankruptcy practices. [Baird and Rasmussen \(2002\)](#) emphasize that contemporary bankruptcy practices use bankruptcy law as a means of selling assets. Other legal scholars have also documented the dominant corporate governance role of senior lenders in contemporary bankruptcy practices ([Skeel Jr, 2003](#); [Warren and Westbrook, 2003](#); [Adler, Capkun and Weiss, 2013](#)).

To get an intuition on why such a change of practice has occurred, we must first return to the predominant theoretical foundation of corporate bankruptcy law. It is the so-called Creditor's Bargain Theory ([Jackson \(2001\)](#)), which as a normative theory claims that the scope of bankruptcy law, when firms face financial distress, should be limited to solving the problems caused by multiple and uncoordinated creditors with various interests. This theory solely focuses on the resolution of the common-pool problem, which should be the primary justification of bankruptcy law. It describes how a collective proceeding is a requirement for solving it, together with maximizing recovery rates during the process. Hence the departure of bankruptcy law from, for instance, state debtor-creditor law under which the general creditors of the defaulting debtor are satisfied on a "first-in-time, first-in-right principle" ([Jackson, 2001](#)). As a legal ground designed to fulfill this economic consideration, the Creditor's Bargain theory contains an element which will be fundamental in this paper: the Normative Butner Principle.

This principle, which was coined by [Ayotte and Skeel \(2013\)](#) after the Supreme Court case *Butner v United States*⁵⁹ claims that substantive rights in bankruptcy are defined by nonbankruptcy law except when bankruptcy law dictates otherwise. As a legal support for the resolution of the common-pool problem, it acknowledges that bankruptcy law is justified in altering the secured creditor's procedural rights. It may thus properly prevent the secured creditor from having the collateral seized once the debtor files for bankruptcy, but it must however defend the substantive value of this right (namely the secured creditor's priority to the extent of the collateral's value). We will return to this principle in a more applied context in Section 4, as it will be a fundamental component of our model.

21.2 Bankruptcy Law As a Liquidity Provider

To provide a rationale for the change in bankruptcy practices, we will adopt throughout this work

⁵⁹440 US 48 (1979)

the parallel view on the goal of bankruptcy law: a liquidity providing mechanism. The underlying idea, which is associated with [Ayotte and Skeel \(2013\)](#), is that liquidity and creditor-coordination issues are tightly linked. By focusing on two causes of illiquidity, namely debt-overhang and adverse selection problems, the authors' analysis reveals that many of the bankruptcy rules (which have been previously studied in isolation), can be recast as an attempt to create liquidity by solving debt-overhang and/or adverse selection issues.

It then follows that a proper-functioning law of corporate bankruptcy requires (and actually *already possesses*), rules that are intended to increase a debtor's liquidity in order to maximize the value of the estate. Introducing liquidity at the core of bankruptcy law can also explain the recent trend toward creditor control of Chapter 11: the trend can be cast as an attempt by secured creditors to create illiquidity for strategic advantage. This is the so-called "strategic illiquidity" notion (Ayotte and Skeel, [2013](#)) implemented by secured creditors to obtain tremendous bargaining power when the debtor faces liquidity problems.

21.3 Bankruptcy Provisions of Interest

As we embrace the liquidity interpretation of bankruptcy law, we are interested in the Sections 361-365 of the US Chapter 11 Bankruptcy Code (the so-called Case Administration). These provisions dictate how a bankrupt firm can raise liquidity and introduce plans to maximize the ongoing concern value of the firm. We now provide a simplified and condensed description to some of these, and will later illustrate how crucial they are within our financial framework.

Section 361, namely *Adequate Protection*, refers to the relief created to protect the value of a secured creditor's lien so that it does not diminish during the bankruptcy proceeding. For instance, if there is a possibility of a diminution of a creditor's collateral interest, a debtor may be required to provide the creditor with adequate protection, such as periodic cash payments. It is the discretion of the court to declare a relief as adequate.

Section 362, or *Automatic Stay*, helps to protect a debtor from creditor's action of initiating a judicial proceeding. It is an injunction granted by a court in a bankruptcy proceeding, and operates as a stay against the continuance of any action by any creditor against the debtor. It will thus automatically stops lawsuits, foreclosures, and all collection activity against a debtor. It

remains in effect until a judge lifts the stay at creditor’s request.

The *Debtor-In-Possession Financing (DIP)* is part of Section 364. Companies entering Chapter 11 reorganization generally continue to be run by their existing management. The ongoing entity is the so-called DIP. As previously explained, in Chapter 11 most pre-bankruptcy creditors are stayed from enforcement remedies. They do not receive any payment while the company seeks to restructure its balance sheet. Since most of its pre-bankruptcy liabilities are frozen, the DIP will need credit after initiating Chapter 11, and seek a DIP loan to immediately cover the payroll and the up-front costs of stabilizing the business. The DIP loans are typically asset based, which help the company to restore both confidence and its ability to maintain its liquidity.

Apart from the Case Administration provisions ⁶⁰, other bankruptcy provisions have been considered. The *Key Employee Retention Plan* (hereafter KERP) is a benefit plan employed by a debtor company as incentives for upper management to continue working for the company throughout the bankruptcy procedure. It helps maximizing the ongoing concern value of the firm by helping in the retention of key competent executives, pending the restructuring of the firm in bankruptcy. Finally, the release of *Cash Collateral* includes any negotiable assets that may be converted into liquid assets if necessary. It is used to discharge part of the outstanding indebtedness.

21.4 Bankruptcy Data and Proxy Construction

The evolution of each specific bankruptcy practice has been documented from the LoPucki Bankruptcy Database. This database summarizes several variables for different industry sectors (except the financial one) such as the date of petition filing (by the parent company in the case of subsidiaries), the date of emergence, the amount of assets and liabilities at the time of filing and prior to it, the nature of bankruptcy (prepackaged, pre-negotiated etc.), its outcome (reorganized or liquidated), the duration of the bankruptcy, etc.

LoPucki database gathers 998 firms (including multiple filings) with assets equaling more than \$100 million at the time of the bankruptcy filing ⁶¹. These cases will be of interest, as firms with

⁶⁰Section 363 is related to the sale of assets as a going concern. It won’t be incorporated in this work since these provisions are very infrequently implemented within our sample. Section 365 or *Executory contracts and unexpired leases*, which allows debtors to reject a certain set of contracts and unexpired leases, won’t be incorporated in this work since the underlying value of such rejected contracts are not known in our database.

⁶¹It is measured in 1980 constant dollars using the CPI deflator.

assets above that threshold correspond to the most involved corporate bankruptcy procedures in terms of duration and litigation. As far as the time period is concerned, and even though the database includes data from 1980 to 2013, we only focus on cases that have been filed after 1990 for the sake of availability of their bankruptcy proceedings.

In this work, we solely focus on bankrupt manufacturing firms, identified with their SIC codes from the LoPucki database. We do so in order to rule out any possible industry effects, jointly with a willingness to illustrate our claim for one specific sector as far as the law practice is concerned. Our manufacturing bankrupt firms database contains 370 cases from 1990 to 2012, whose docket proceedings have been extracted from Bloomberg Law / PACER for the purpose of identifying further bankruptcy practices.

Tables 16 and 17 (Appendix A) tabulate for each year the number of bankruptcy cases under which a successful implementation of a given bankruptcy practice has occurred, for each of the following ten provisions: DIP financing, cash collateral, adequate protection, adoption of KERP, rejection of unexpired contracts and leases, prepackaged/pre-negotiated bankruptcy practices, partial/complete lift of the automatic stay, 363 asset sales and the appointment of equity and unsecured committees. On an aggregate level, one can see that the bankruptcy frequencies are highly procyclical: they have strongly increased following the 2000 and 2007 crises.

[Insert Figure 35 Here]

[Insert Figure 36 Here]

In Figure 35, we represent the frequencies of implementation of DIP financing within our sample. As observed, DIP financing has become the dominant bankruptcy practice since 1999 in line with previous legal studies ⁶², after which above 70 percent of bankruptcy cases have successfully

⁶²

Numerous legal studies have pointed out the importance of DIP financing in bankruptcy procedures. Chatterjee, Dhillon and Ramirez (2004) scrutinize DIP financing's effects on debt holders and the associated possibility of wealth expropriation using stock and bond prices for a sample of DIP loans. Skeel Jr (2003) argues that DIP lenders have used their leverage to fill a vacuum in governance created by the law enacted in 1978. Ayotte and Skeel Jr (2009); Ayotte and Skeel (2013) argue that DIP financing allows creditors to raise liquidity to address their debt over-hang problem. Also, Ayotte and Morrison (2009) use a sample of 153 firms filing for Chapter 11 in 2001 to provide strong evidence that creditors control most major decisions in Chapter 11.

implemented it. This proliferation highlights the importance of DIP financing as a mean of raising liquidity for financially distressed firms, since DIP lenders enjoy the highest priority when lending to them.

As shown, the adoption of the KERP plan was common in the years between 1999 and 2005, but since then has declined. Adoption of such plans could be beneficial since retaining certain key employees might have a positive impact on the firm's successful reorganization outcome. As documented in the legal literature, due to the impact of the Bankruptcy Abuse Prevention and Consumer Protection Act (2005) the KERP has been substantially reduced. [Capkun and Ors \(2009\)](#) argue that higher plan payout results in shorter Chapter 11. We hypothesize this could ultimately impact the pricing of debt since longer and costly bankruptcy procedures may decrease the probability of emergence and creditors may avert extending their credit lines.

The adequate protection could relieve the debtors' debt-overhang problem as noted by [Baird and Jackson \(1984\)](#); [Jackson \(2001\)](#) and [Ayotte and Skeel \(2013\)](#). As depicted in [Figure 35](#), adequate protection has become an important bankruptcy practice since 1999, after which above 50 percent of cases have successfully exercised this option. As argued by legal scholars such as [Baird and Jackson \(1984\)](#); [Jackson \(2001\)](#) and [Ayotte and Skeel \(2013\)](#) among others argue that adequate protection can relieve debtors from their debt over-hang problem by raising liquidity during the bankruptcy period.

Lifting the automatic stay has also gained considerable momentum in recent years. Automatic stay prevents creditors' run to grab their assets. However, the same stay can be lifted if the interests of the creditors are not adequately secured. As illustrated in [Figure 35](#), the partial/complete lift of the automatic stay started to gain a positive trend in 1999, albeit at a slower pace compared to DIP financing and Adequate protection. The implications of this trend are important; if the interests of creditors are not adequately secured, they may decline to extend their credit to the debtors, which amplifies the debt over-hang problem ([Ayotte and Skeel, 2013](#)). They may also ask as a consequence, a higher premium, which could further deteriorate the financial condition of the borrowing firm. Hence, this partial lift could be creditor-friendly, with important implications on debt pricing and the determination of debt contract intensity.

As shown in [Figure 36](#), releasing cash collateral has been more common since 1999, after which

above 40 % of cases have successfully exercised this provision. Cash collateral, like adequate protection, permits financially distressed firms to raise liquidity. This liquidity provision could increase the probability of a successful reorganization outcome and as such, could have an important ex-ante impact on contract intensity.

Finally, the adoption of pre-packaged/pre-negotiated bankruptcy practices has remained invariable over the time. There are numerous advantages of prepackaged reorganization such as less uncertainty associated with exit strategy and higher probability of emergence. However, the approach has risks such as firms cannot invoke the automatic stay ⁶³.

22 Syndicated Debt and Covenant Intensity

22.1 Syndicated Loan Financing

In this paper, we consider the cost and structure of syndicated loan contracts, which are financing built for a single borrower by multiple lenders. They now constitute the largest source of external financing for non-financial corporations in the US, and have rapidly grown into a multi-trillion dollar market. A few reasons justify such a rapid growth over sole-lender deals: compliance with lending limits, diversification of lending risks, relatively lower costs of borrowing, etc. To initiate a syndication, a lead bank institution (or lead arranger) receives a mandate from the borrower to form a lending syndicate, and subsequently prepares an information memorandum on behalf of the borrower which includes descriptive and financial information about the borrower. The lead arranger then decides on the number and the identities of the prospective syndicate members, together with the possible loan contribution amounts that will be offered by each of them ⁶⁴. After disclosure of this information, the final syndicate composition will be determined and the loan

⁶³

Other potential disadvantages is the cash requirement to pay the necessary fees, informing the business community of the firms' problems and providing time for creditors to undertake collection efforts in anticipation of default (Salerno and Hansen, 1991). Since the implementation takes several weeks, and if liquidity is a major concern, then pre-packaged bankruptcy might lose its edge compared to other bankruptcy clauses such as DIP financing. Generally, prepackaged plans are not a feasible approach if the company will not be either reinstating or paying in full pre-petition trade, lease rejection, employee or union claims. These groups of creditors typically are difficult to identify outside of Chapter 11. Hence, due to such reasons, the variation of pre-bankruptcy implementation is small, and this practice is less popular than the commonly practiced bankruptcy laws provision.

⁶⁴Lee and Mullineaux (2004) provide an extensive study on the factors in influencing commercial lending syndicates.

terms are announced among all the participants.

On the legal side, even though each member of the loan syndicate has a separate claim on the debtor, there is a single loan agreement. Moreover, if one of the syndicate members fails to meet its obligation, the other members do not have any legal responsibility to provide these funds to the borrower. Not only to mitigate the possibility of such an event, but also because it often holds a portion of the loan in its own portfolio, the lead arranger is the most active in monitoring the financial and operating activities of the borrower, together with the evaluation of the borrower's credit worthiness.

The pricing of syndicated loans is made of two principal components: a margin and fees. The margin is a spread over a floating rate benchmark (typically taken to be the LIBOR) on the portion of the loan being drawn. Additionally, the syndicate members receive various fees which could be broadly categorized as arrangement, underwriting or service fees ⁶⁵ Margin and fees are not the only type of compensation that lenders can demand in return for providing the private syndicated financing instrument. Collateral and covenants also offer further compensation by building a bridge between the various loan premia and the associated corporate practices.

23 Covenants Purpose and Intensity

Covenants are traditionally rationalized as a means of preventing, in certain states of the world, wealth transfers from the lender to the borrower. As such, they govern the on-going relationship between both parties during the life span of a loan, by moderating firm's behaviors in exchange for a granted credit line. Financial covenants, the sole type of covenants considered in this work, establish financial and accounting guidelines for the operation of the borrower's business. A borrower's failure to comply with a covenant triggers a default and the lender's right to either accelerate or terminate the loan, or foreclose on assets which are serving as collateral.

Literature has offered many theories for covenants inclusion. For example covenants are included in contracts to define, ex-ante, the allocation of control rights among the firm's claimants through their ability to mitigate agency problems ([Dewatripont and Tirole, 1994](#); [Aghion and Bolton, 1992](#))

⁶⁵See [Angbazo, Mei and Saunders \(1998\)](#); [Berg, Saunders and Steffen \(2014\)](#) for further information on fees.

Covenant renegotiations also allow creditors to exercise control rights in state-contingent manner, outside of default. (such as (Roberts and Sufi, 2009b) Chava and Roberts (2008); Nini, Smith and Sufi (2012) and Denis and Wang (2014) among others). Creditors to address the uncertainty in the loan contract may also alter the “tightness of covenants”⁶⁶ (Murfin, 2012; Demiroglu and James, 2010)⁶⁷. On the rationale and impact of covenant tightness and intensity, Gorton and Kahn (2000) show how strict covenants are not implemented to price default risk but rather to allocate bargaining power in later renegotiations. Garleanu and Zwiebel (2009) analyzed the notion that debtholders may receive stronger decision rights (in the form of tighter debt covenants), in order to protect them from informational symmetry.

In this work, we will focus on covenant intensity Bradley and Roberts (2004) in order to get a broader measure of covenant restriction, and will define it as being the total number of financial covenants included within a loan. The financial covenants in this paper capture the major accounting and key ratios, which firms must respect.

24 The Model

We propose a simple stylized model to illustrate the interaction between bankruptcy practice and contract intensity. We consider a single debtor (firm) which borrows to finance an investment, and its associated lender (bank) which is considered to be a senior (un)secured syndicated creditor⁶⁸. Suppose a corporate borrower seeks to finance an investment opportunity I , through a syndicated loan offered by its creditor. At the initial step, two possible outcomes characterize this loan: either this loan fulfill its initial goal with probability θ , or the borrower eventually goes bankrupt with

⁶⁶

Broadly speaking, covenant tightness refers to the distance between the level of the covenant variable at loan origination and the min (or max) covenant threshold permitted by the loan contract.

⁶⁷

Murfin (2012) investigates how lender-specific shocks impact the tightness of loan contracts, and Demiroglu and James (2010) find that riskier firms and firms with fewer investment opportunities are associated with tighter financial covenants.

⁶⁸In this work, and especially within our empirical framework in Section 5, we assume that the choice of securitizing the loan is exogenous. However, we do acknowledge that this choice is in fact endogenous in many regards. If taken into account, this endogeneity would create a causal loop between the practice of bankruptcy law and the loan contract design. A careful consideration of this problem is beyond the scope of this paper and is delegated to future research.

probability $1 - \theta$, which is equivalent of saying that the investment failed (or the loan extended for investment turned out to be non-performing) ⁶⁹.

In this model, let $\alpha \in [0, 1]$ stands for the covenant (contract) intensity of the loan. This parameter quantifies how stringent the loan contract is in terms of covenants. In agreement with our interpretation of contract intensity, the higher α is, the larger the number of covenants included within the loan. The extreme values of this parameter, namely $\alpha = \{0, 1\}$ represent no covenant inclusion and the maximum number of covenants respectively.

As depicted in Figure 37, if the investment is ultimately successful it leads to a monetary return X while the spread charged by the borrower is given by R . We also assume that $X = uR$ with $u > 2$ a constant, so that $(X - R) = R(u - 1) > R$. Whether we look from the debtor or the creditor's point of view, there are two rationales for the inclusion of contract intensity within the payoff. First, the assumption that outside bankruptcy the borrower's performance is affected by the contract intensity directly follows from the debt contract literature: borrowers are always tempted to divert a fraction of the returns for personal use ⁷⁰. Creditors try to mitigate this moral hazard consideration by more monitoring, or by designing the loan contract in such a way to constraint the borrower to reveal its true financial situation (the so-called revelation principle). Contract intensity captures this idea: if it decreases, so does the monitoring effort and vice-versa, which in any case ultimately affects the performance of the loan on both sides of the contract.

Now, with probability $1 - \theta$, the investment fails and the firm files for Chapter 11 Bankruptcy ⁷¹. We then assume that the reorganization procedure is debtor-friendly with probability π , and creditor-friendly with probability $1 - \pi$.

[Insert Figure 37 Here]

Despite three decades of legal research documenting a shift in Chapter 11 bankruptcy practices from debtor to creditor-friendly (Section 2.1), no unified framework exists as far as their exact

⁶⁹In this set-up the firm receives a package of loan to conduct an investment, so if the loan becomes non-performing then the firm becomes bankrupt.

⁷⁰Such the models introduced in [Diamond \(2007\)](#) and [Tirole \(2010\)](#)

⁷¹Because of the nature of our data and our topic of study, we do not consider any liquidation procedures. Including those would require a full treatment of the notion of secured loan, since the liquidation likelihood and procedures are to a great extent contingent on how much the loan is secured. This topic is beyond the scope of this paper.

classifications is concerned. In order to be coherent with the global picture described by legal scholars and practitioners, we assume that a practice is more creditor-friendly if its primary beneficiaries are the creditors of the loan. For instance, we consider the adoption of DIP financing as a creditor-friendly practice: senior or secured syndicated creditors give their consent to DIP loan because of super-priority and/or a possible more important position within the firm after the reorganization process. Next, we consider the partial or complete lift of the automatic stay as being a creditor-friendly practice since its adoption allows creditors a direct access to the assets of the firm. Classifying the adequate protection clause as a creditor-friendly practice is certainly clear. Next, we assume that the release of cash collateral is a debtor-friendly practice, since after its implementation the debtor can have access to the released cash amount to address litigation costs. As explained in Section 2.4, the KERP is a type of pay-to-stay plan for debtors to keep the most valuable employees on the management side. Since these employees might be the most competent at securing the highest returns post bankruptcy, we regard the KERP adoption as a more debtor-friendly practice. Again, the probabilities π and $1 - \pi$ quantify the likelihood for these practices to be adopted: if for instance DIP and/or a lift of automatic stay are implemented, we consider being on the $1 - \pi$ outcome. It is then understood that if those creditor-friendly practices are not adopted, a more debtor-friendly environment emerges as a consequence (π). Even though these probabilities are, in our model, explicitly characterized in terms of returns and adoption of some practices, they are in fact to some extent subjective, since they also represent the perception of the parties involved. Moreover, a central result in this framework is the fact that π is a *constant*, that is, independent of α . This directly follows the Normative Butner Principle, as exposed in Section 2.

The outcome of the bankruptcy resolution consists of a monetary return X_1 and a spread R_1 in the eventuality of a debtor-friendly practice. Otherwise, a return X_2 and a spread R_2 will be granted upon the creditor-friendly resolution of the claim. We assume that the net profit for the debtor in bankruptcy satisfies $(X_1 - R_1) > (X_2 - R_2)$ for obvious reasons. It is important to notice that α does not play any role among the returns inside bankruptcy. Indeed, according to the Normative Butner Principle (Section 2.2), contractual rights and therefore covenants are nullified during bankruptcy. However, as we shall see shortly, the randomness in bankruptcy outcome

ultimately affects the contract intensity at loan origination. We finally assume that independently of any outcome, a administrative fee F associated with the underwriting process is paid by the borrower.

Noticing that θ could equivalently be interpreted as a function of the monitoring exerted by the creditor, and assuming a linear specification for the contract intensity together with a quadratic monitoring cost, the monitoring problem of the bank *outside* bankruptcy is given by

$$\max_{\alpha \in [0,1]} \alpha \theta R - \frac{1}{2} \beta \theta^2 \quad (61)$$

with $\beta \in]0, R]$ being a fixed, parameterized cost which is specific to the firm. The optimization follows from the inability of the creditor to monitor *inside* bankruptcy, monitoring only occurs during the life span of the loan. Hence the bank sets the following optimal monitoring effort outside bankruptcy:

$$\theta^* = \theta^*(\alpha) = \frac{\alpha R}{\beta} \quad (62)$$

which, as expected, is increasing in α and decreasing in β . Next, still from the bank's point of view, the optimal contract intensity depends upon the value of the investment *outside* and *inside* bankruptcy. Here we want to emphasize that even though, according to the Normative Butner Principle, contractual rights are nullified during bankruptcy, these same contractual rights affect the optimal level of monitoring *outside* bankruptcy, which ultimately affects the likelihood of a the firm to find itself *inside* bankruptcy. At the second stage, the bank specifies the contact intensity in such a way that she will be indifferent between the bankruptcy and the non bankruptcy outcome:

$$\max_{\alpha \in [0,1]} \left(\alpha \theta^* R - \frac{1}{2} \beta (\theta^*)^2 - I + F + (1 - \theta^*) ((1 - \pi) R_2 + \pi R_1) \right)$$

$$\text{subject to } \theta^* \alpha (X - R) + (1 - \theta^*) (\pi (X_1 - R_1) + (1 - \pi) (X_2 - R_2)) - F \geq 0 \quad (63)$$

$$I = \alpha \theta^* R + (1 - \theta^*) ((1 - \pi) R_2 + \pi R_1) \quad (64)$$

Equation 63 stands for the borrower's incentive compatibility constraint, which will be binding. The zero-profit condition of competitive lending is given by 64. We are left with the following optimization problem:

$$\max_{\alpha \in [0,1]} \left(\alpha \theta^* (X - R) + (1 - \theta^*) (\pi (X_1 - R_1) + (1 - \pi) (X_2 - R_2)) - \frac{1}{2} \beta (\theta^*)^2 \right) \quad (65)$$

which yields, after using 62, the following optimal contract intensity:

$$\alpha^* = \frac{\pi [(X_1 - R_1) + (X_2 - R_2)] + (X_2 - R_2)}{2(X - R) - R} \quad (66)$$

and we observe that $\alpha^* \in [0, 1]$ as required. The most important feature of 66 is that the optimal contract intensity is *increasing* in π . That is, as the bankruptcy practice becomes more debtor-friendly, the optimal covenant intensity increases, and the creditor will have incentives to introduce more covenant within the loan contract. This automatically translates a willingness of the creditor to intensify his monitoring effort. Hence in this model, at loan origination the creditor will take into account the bankruptcy practice ex-ante by adjusting the contract intensity depending on its perception with regards to how favorable the practice is to him.

A final scrutiny of the model provides an intuition on how the covenant intensity, the spread and the bankruptcy practice interact with each other. First of all, we notice that Eq 66 can be rewritten as:

$$\alpha^* = \frac{\pi [(X_1 - R_1) + (X_2 - R_2)] + (X_2 - R_2)}{(2(u - 1) - 1) R} \quad (67)$$

with $u > 2$ as initially assumed. This immediately tells us that for a *fixed* π , a higher spread R implies a smaller contract intensity α^* . Next, we first recall that in this model π is exogenous and known to the creditor at loan origination. Furthermore, the loan spread R is known when the creditor's determines the associated optimal contract intensity α^* . In agreement with actual practice, this spread can be readjusted once the syndication process is closed.

With these facts in mind, suppose that we consider the same investment opportunity, but with a legal environment that has shifted to more debtor-friendly bankruptcy practices, that is π has increased. As previously explained, we can see in 67 that this implies a higher contract intensity α^* . Now, if the creditor's want to keep the same equilibrium monitoring θ^* , then we see in 66 that an increase in α^* directly requires a decrease in R . Therefore, a more debtor-friendly environment implies a higher covenant intensity from the creditor's side which translates to a smaller loan spread ($\pi \uparrow \Rightarrow \alpha^* \uparrow \Rightarrow R \downarrow$). Conversely, a more creditor-friendly bankruptcy practice ($\pi \downarrow$) implies a smaller contract intensity $\alpha^* \downarrow$ which translates to a higher spread $R \uparrow$.

25 Empirical Framework and Testing

To illustrate the mechanism behind our model and test the central hypothesis, an exogenous source of variation in the legal practice that solely impacts the creditor is required to measure the link between covenant intensity and the associated loan spread. To identify such a link, we need to find a variable (instrument) that would affect the creditor demand for covenants without directly affecting the loan spread. We claim that our bankruptcy liquidity provisions exposed in Section 2.4 provide natural candidates for such instruments.

26 Identification Strategy

Figure 38 illustrates the mechanism behind our identification strategy. It represents the demand curves that are induced at loan origination by the creditor and the borrower, in terms of covenant intensity and loan spread.

The creditor demand curve is upward sloping: a higher covenant intensity is linked to a higher spread on the loan. This translates the fact that for a creditor, a higher covenant intensity is associated with a higher cost of monitoring which is ultimately transmitted to the borrower. On the other hand, the demand curve for the borrower is downward sloping: the borrower being subject to a higher level of monitoring will require, as a *compensation*, a lower spread on the loan. This downward sloping curve also fits well with competitive financial market narratives. The intersection of both curves results in an equilibrium covenant intensity and spread (R^*, α^*) for which both parties have agreed upon. We can further study these demand relationships under the perspective of our model of Section 4. As we solely consider the demand side of this interaction, a positive shift in the parameter π (a more debtor-friendly perceived bankruptcy practice) will induce a positive shift of the creditor's demand curve for covenant intensity (dashed curve in 38).

[Insert Figure 38 Here]

A new equilibrium $(\tilde{R}^*, \tilde{\alpha}^*)$ will emerge, with $\tilde{\alpha}^* > \alpha^*$ and $\tilde{R}^* < R^*$ leading to our model's prediction: $\pi \uparrow \Rightarrow \alpha^* \uparrow \Rightarrow R \downarrow$. To further justify our identification strategy, we claim that a shift in the bankruptcy practice (or shift in π) does not lead to a shift in the borrower's demand curve.

This claim first arises from our model (see Section 4), in which the borrower’s incentive compatibility constraint is binding: the borrower will accept the loan specification independently of π , as long as it leads to a positive monetary return. Outside of bankruptcy, the lender is the only party which is sensitive to the level of π , because he is the provider of the funding and since if ever the borrower defaults, the latter will decide on the state of bankruptcy filing. Outside of bankruptcy, the borrower is thus insensitive to fluctuations in α , and shifts in the state of the bankruptcy practice will thus solely impact the demand curve of the creditor, as exposed in our model and in Figure 38.

A final claim is involved in order to validate our identification strategy: that our bankruptcy proxies, which we want to use as instruments, are uniquely driven by fluctuations in legal practices. On a practical (and even theoretical) ground, the emergence of trends in the practice of the law can be explained using frameworks of non cancellation of “judges’ decisions”. Since our bankruptcy proxies are nothing but a stack of judges’ decisions, the latter generate the shift toward more debtor or more creditor friendly practices. It is these shifts in judge’s decisions that might induce a “forum shopping” towards certain states, which ultimately contributes to the variations in our bankruptcy practices ⁷². In our sample New York and Delaware have contributed positively to the bankruptcy’s law trend (Figure 39 and 40).

[Insert Figure 39 Here]

[Insert Figure 40 Here]

In order to test to which extent our bankruptcy proxies are driven by judicial decisions we adopt the approach used by Chang and Schoar (2006) ⁷³. Since our bankruptcy proxies of Figures 35

⁷²Forum shopping implies where bankrupt estates file in. There is a vast legal literature to understand the forum-shopping. Skeel Jr (1998) argues that the rise of venue shopping is closely related to the rise of corporation law in Delaware, a phenomenon better known as charter competition. LoPucki (2006) have documented that 95 percent of bankruptcy filings are voluntarily done by debtors. This frequent voluntary filing by debtors, together with the increasing phenomenon of forum shopping, naturally leads to question whether an agency problem might be occurring between the firms and the bankruptcy courts (or judges). However, Ayotte and Skeel (2004) empirically investigate the factors behind forum shopping and found no evidence of agency problem. Instead, the authors give more weight to court specific characteristics in terms of filing

⁷³The authors take into account four creditor friendly motions (such the lift of automatic stay) plus three debtor friendly one (such as the release of cash collateral). Since authors have gathered

or 36 are nothing but a stack of judges' decisions, we can let **BankruptcyProxy** $_{t,j}$ denote, for a given practice, its (lack of) success of implementation, depending on the time t and the judge j associated with the bankruptcy filing. It is precisely both the time series and the cross-sectional variations (the latter characterized by the identities of judges) that will drive the fluctuations of a given practice's occurrence over time. To study which of these two types of variation is mainly responsible for the overall variation in **BankruptcyProxy** $_{t,j}$, we consider the following model:

$$\mathbf{BankruptcyProxy}_{t,j} = \alpha + \beta X_t^{\text{Controls}} + Judge_j + Time_t + \epsilon_{t,j} \quad (68)$$

where $Time_t$ and $Judge_j$ are year and judge fixed effects, respectively, the index $j = \{1, \dots, n\}$ representing the identity of a given judge. In addition, X_t^{Controls} stands for a vector of macroeconomic covariates, taken to be: unemployment rate, GDP growth, BBB-AAA credit spread. A judge fixed effect can be seen as the relative rate at which each judge grants or denies a particular provision.

The regression in Eq 68 has been implemented under various settings, for each of the four bankruptcy practices considered in Figure 39, using the entire set of bankruptcy filings at our disposal (see Section 2) and on a yearly basis. The results of several specifications of Eq 68 are exposed in Table 12. For each of the four bankruptcy proxies of interest (Partial/Complete Lift of Automatic Stay, Adoption of KERP, Release of Cash Collateral and Granting of Adequate Protection), the R^2 associated with the regression (Eq. 68) is reported with and without time/judge fixed effects included in the regression specification. In addition, the p -value of F -test associated with the joint-significance of judge fixed effects are reported. From Table 12, we observe the predominance of judge fixed effects in explaining the variability of the bankruptcy proxies, for which time fixed effects and macroeconomic conditions only play a minor role. Furthermore, the F -test unambiguously assesses the importance of judge decisions in the frequency of occurrence of the mentioned bankruptcy practices.

Theoretical models also support our claim. In [Gennaioli and Rossi \(2010\)](#), the authors study a model of judicial discretion in corporate bankruptcy explaining why the resolution of financial

enough observations per judge, they were able to say a word on the systematic behavior of judges (i.e. if a judge is more creditor friendly given one creditor friendly provision, will s/he show the same behavior towards other creditor friendly provisions. They draw a significant systematic behavior of judges in terms of their discretion.

distress varies across bankruptcy courts. Authors present a simple demand-and-supply model of judicial discretion that parsimoniously rationalizes why idiosyncratic differences across courts do not average out within a given code, a fact that cannot be explained by the standard view. We can thus observe trends, that emphasize a more debtor or creditor friendly evolution of the law’s practice, since judges might have pro-debtor or pro-creditor biases (Gennaioli and Shleifer, 2008; Gennaioli, 2013).

27 Hypothesis Testing Strategy

Using our bankruptcy proxies as instruments, the impact of covenant intensity on loan spread could be estimated following a Two-Stage Least Squares procedure. Equations (69) and (70) correspond to the first and second stages, respectively. In the second stage, fitted values of covenant intensity obtained in the first stage are used. Estimations are performed on a quarterly basis, and two quarterly recession time dummies are introduced. In agreement with the NBER benchmarks, the first recession dummy corresponds to the first and the second quarters of 2000, whereas the second dummy is associated with the last quarter of 2007, all of 2008 and of the first quarter of 2009.

For robustness purposes, we will also test our hypothesis using limited information maximum likelihood (LIML), which is less affected by potential finite sample bias, and the generalized method of moments (GMM), which is the least restrictive in terms of model assumptions.

$$\mathbf{CovenantIntensity}_{i,t} = \alpha_1 + \beta_1^T X_{i,t}^{\text{Control}} + \gamma^T \underbrace{\mathbf{BankruptcyProxies}_t}_{\text{Instruments}} + \epsilon_{i,t} \quad (69)$$

$$\mathbf{Spread}_{i,t} = \alpha_2 + \beta_2^T X_{i,t}^{\text{Control}} + \delta \underbrace{\mathbf{CovenantIntensity}_{i,t}}_{\text{Predicted Values from the First Stage}} + \nu_{i,t} \quad (70)$$

We now discuss the choice of instruments. Among the five possible candidates of Section 2.5, we select Partial/Complete lift of the automatic stay (I_1), NKERP (I_2), Adequate Protection (I_3) and NCashCollateral (I_4) as our four instruments, where NKERP and NCashCollateral refer to the inverse of KERP and Cash Collateral proxies respectively. They are computed as $NKERP = (100 - KERP)\%$ and $NCashCollateral = (100 - CashCollateral)\%$. We do not use the DIP proxy as an instrument, but rather as a control variable. Among all the considered bankruptcy practices, it is the one which could indirectly affect the supply of loans, and therefore their prices. To leave

any ambiguity aside, we choose to not use it as an instrument. If our theoretical predictions are correct, in the first stage regression (Eq. 69) we should observe a negative coefficient in the estimated $\hat{\gamma}$ associated with all statistically significant instruments. This would translate the creditor-friendliness impact on the covenant intensity, as outlined in Section 4. We should then observe, in the second stage (Eq. 70), a statistically significant and negative $\hat{\delta}$, which will be our estimate on the causal link induced by the legal environment indirectly on the loan spread through the covenant intensity.

28 Dataset Description

Each observation in our analysis corresponds to a separate loan agreement extended between 1998 and 2012 and extracted from the Loan Pricing Corporation’s DealScan database. We refer to this sample as the working sample, in contrast with the complete sample that includes all data since 1993. These loans involve 940 borrowers which are US manufacturing firms (SIC code 20-39). The treatment variable, or covenant intensity, is the sum of all financial covenants included for each of these loans.

As detailed in Table 18, a maximum of thirteen covenants is theoretically possible, whereas in practice the more intense loan in our sample is made of six financial covenants, for an average of two covenants per loan (Table 13). We can observe in Table 19 that more than eighty percent of our loan sample includes the following four covenants: Maximum Debt/EBITDA, Fixed Charge Coverage Ratio, Interest Ratio Coverage and Capital Expenditure Ratio.

The all-in-drawn spread (the amount paid by the borrower in basis points over LIBOR for each dollar drawn down) is retained as our measure of loan spread. Our loan sample has subsequently been merged with Compustat dataset to extract borrower-specific characteristics. We use some of these financial and accounting variables to control for factors that might affect: (a) the level of moral hazard between the borrower and the lender, (b) the impact of the borrower’s reputation, (c) the monitoring costs associated with each loan agreement and other firm’s characteristics. Summary statistics for all these controls are provided in Table 13.

Our choice of control variables is motivated by the literature on corporate loan’s pricing. They encompass the firms’ and loan specifics. The firms’ specific ones are enlisted below:

- Moral hazard has widely been acknowledged in the literature to affect loan's pricing ([Jensen and Meckling \(1976\)](#), ([Myers, 1977](#))). These phenomena are particularly enhanced in firms with higher growth opportunities, in which the conflict between shareholders and debtholders over the investment cycle might be greater ([Krishnaswami, Spindt and Subramaniam, 1999](#)). As proxies to capture such an effect we use (log of) sales, invested capital ([Himmelberg, Hubbard and Palia, 1999](#)), operating profit margin (high free cash-flows could concentrate greater agency problems) and market-to-book ratio ([Barclay and Smith, 1995](#)).
- The notion of firm's reputation has a strong impact on the price of credit through information asymmetries ([Diamond, 1991](#)). To convey the idea that larger firms are more likely to be reputable in the market, which are usually considered as safer investments, we use proxies as the "book value of equity" and the "market capitalization". This reputable status could be granted because of a larger asset base, higher likelihood of diversified assets and/or greater proportion of tangible assets ([Datta, Iskandar-Datta and Patel, 1999](#)).
- For the cost of monitoring, we use the borrower's leverage ratio, Altman's Z-score and working capital. The underlying motivation consists of a possible monotonic relationship between higher leverage and/or default risk and the need for frequent monitoring ([Blackwell and Kidwell, 1988](#); [Berger and Udell, 1990](#); [Hoshi, Kashyap and Scharfstein, 1993](#)).
- We also control for firm's profitability by using the ratio of EBITDA⁷⁴ to total assets. In addition we use the borrower's asset tangibility as a proxy for firm's asset pledgeability, which could serve as a credit multiplier by supporting more borrowing, as a higher amount of hard assets implies an easier monitoring, and could more easily serve as collateral in debt contracts.

Our choice of loan's characteristics are defined in the following:

- The size of syndicates, i.e. the number of bank participants. The rationale behind is bigger syndicates are associated with longer term loans and smaller ones emerge when the loan is secured. Moreover, [Lee and Mullineaux \(2004\)](#) found that holding the loan amount constant,

⁷⁴Earnings Before Interests, Taxes, Depredation and Amortization

the number of institutions in a syndicate is positively related to the amount of information available about the borrower.

- The loan's amount will be included as a control in order to take into account possible economies of scale in the design of the operation, with a higher dilution of fixed costs for larger operations (Krishnaswami, Spindt and Subramaniam, 1999).
- The maturity of loans: the rationale behind is the relationship between corporate loan spreads and maturities has so far been understood as a mix of two opposite hypotheses (Helwege and Turner, 1999): trade-off (higher spreads for longer maturities in the context of corporate public debt) and credit quality (lower spreads for higher maturity as a means of controlling agency problems)⁷⁵.
- Loan purpose dummies: working capital, takeover and any other purposes (including debt repayment and corporate purposes).
- A dummy accounting for the existence of collateral will be used to capture the idea whether or not the loan is secured (Stulz and Johnson (1985) and Berger and Udell (1990); Boot, Thakor and Udell (1991); Carey and Nini (2007)). Collateral minimizes the agency problems for riskier borrowers.

29 Empirical Testing and Results

Table 14 provides the results of the first stage regression (Eq. 69). This regression focuses on the explanatory power of the four instruments (I_1, I_2, I_3 and I_4) on the covenant intensity within our sample. We first notice that three of these are statistically significant, namely the automatic stay (I_1), the NKERP (I_2) and the NCashCollateral (I_4), at 5%, 0.1% and 5% respectively. Moreover,

⁷⁵Dennis, Nandy and Sharpe (2000) found inconsistency with the former for revolvers, and Berger and Udell (1990) associate themselves with the latter. In Dennis and Mullineaux (2000), loan maturity positively impacted the proportion of loan sold to participants through the syndication process, which is related to the idea that higher credit-risk on longer-term loans leads to a small and more concentrated syndicate. If however, an inverted yield curve for the loans is found, then we might observe larger and more diffuse syndicates for long maturity loans. Also, it could be possible that lead arrangers substitute monitoring duties by shortening loan maturities (as they require more frequent refinancing). Furthermore, it has been documented (Bradley and Roberts, 2004) that covenants act as an early warning device that allow lenders to shorten the maturity of a loan.

we observe that the negative signs of the associated coefficients are in perfect agreement with our theory. Indeed, this numerically translates the idea that an increase in the implementation of each of these practices, which would represent a more creditor-friendly legal environment, would reduce the level of covenant intensity within the loan contracts.

A first concern we will shortly address is the possibility of a many-weak-instruments estimation, which could provide inaccurate estimates of this first-stage regression. This eventuality could potentially lead, because of finite sample bias, so 2SLS estimates would be uninformative about the causal relationship of interest. As a first assessment of the likelihood of this outcome, a first-stage F -statistic testing the joint hypothesis that all first-stage coefficients of our many-instrument setup are zero was performed. The F -value was found to be 16.41, well above 10, the required threshold to rule out the eventuality of weak instruments (Stock, Wright and Yogo, 2002) . We can thus proceed to the second stage. Further investigations on the possibility of finite sample bias are delegated to the robustness section. In Table 14, we additionally notice the 10% significant coefficient of the DIP regressor, which is negative and thus again consistent with its economic interpretation.

[Insert Table 14 Here]

The core empirical result of this paper is presented in Table 15. In all regressions, the natural logarithm of the all-in-drawn spread is the dependent variable. Model (1) is the OLS version (using unconditional covenant intensity) associated with Model (2), which is our second stage estimation (15) (using fitted covenant intensity). Comparison of the two model estimates for the treatment variable illustrates the inherent bias present in the estimate if the joint determinants of covenant intensity and spread are not disentangled. It also shows the need for an identification strategy in order to isolate the many effects that could potentially run through each causality channel. In the second-stage estimation (2), we observe a strongly statistically significant coefficient on the fitted covenant intensity, which is also negative and thus confirms our narrative. An increase in covenant intensity due to a more debtor-friendly legal practice would lead to a decrease in the loan spread. This negative impact on the spread would be quite significant, since its estimated magnitude is one of the largest among the variables that influence the spread. Results show by instrumenting

the covenant intensity with our bankruptcy proxies, creditors reduce the spread by 26 basis points over LIBOR.

[Insert Table 15 Here]

30 Robustness

To attest the validity and the robustness of our IV estimation (Eq. 69 and 70), several statistical tests have been performed at both stages of the estimation. First of all, as an under-identification test we use an Lagrange Multiplier (LM) version of the Anderson (1951) canonical correlations test. Based on four instruments, hence four degrees of freedom, the associated chi-square value is less than 0.001%, which unambiguously rejects the null hypothesis that our estimation is under-identified. This was nonetheless expected based on the number of instruments at our disposal.

Next and more importantly, to avoid poor estimation of the coefficients, we want to test for weak identification which arises when instruments are correlated with the endogenous control variable, but only weakly. To do so we use the Cragg and Donald (1993) minimum eigenvalue statistic, which is identical to the F statistic obtained at the first stage since our model contains one endogenous regressor. More specifically, we use the F statistic in the context of the two characterizations of weak instruments outlined in Stock and Yogo (2005). The first is the concern that weak instruments cause IV estimators to be biased, the second is that hypothesis tests of parameters estimated by IV estimators may suffer from severe size distortions. Each of these tests is made of a null hypothesis stating the weakness of the instruments. To perform the first test, we must first choose the largest relative bias of the 2SLS estimator we are willing to tolerate. If the F -statistic exceeds the critical value, the instruments are not weak. The 5% maximal IV relative bias in our model has a critical value of 16.85, far below our F -statistic.

Hence, if we are willing to tolerate only a relative bias of 5% (and actually much less), we can conclude that our instruments are not weak. For the second test, we must first choose the largest rejection rate of a nominal 5% Wald test we are willing to tolerate. The 10% and 15% maximal IV size have critical values of 24.58 and 13.96 respectively. Hence if we are willing to tolerate

a rejection rate of at most 15% (or in fact even lower), we reject the null hypothesis of weak instruments. In summary, and considering the small size of our biases, we can certainly conclude that our 2SLS estimates do not suffer from the weak instruments curse.

Finally, the Sargan test for over-identifying restrictions ([Sargan, 1958](#)) was implemented and led to a Chi-Square statistic of 9.62, corresponding to a p -value of 0.02. Thus, we can immediately reject the null hypothesis of over-identifying restrictions and assess the orthogonality of our instruments with the error processes.

As a final robustness check, in [Table 15](#) we also fit our model using limited information maximum likelihood (LIML, Model 3) and GMM (Model 4). LIML has better small sample properties than 2SLS with weak instruments. We observe very similar estimates under models (2) and (3). Finally, efficient GMM (Model 4) brings with it the advantage of consistency in the presence of arbitrary heteroskedasticity (but at a cost of possibly poor finite sample performance). Similar estimates are once again obtained.

As a final robustness check we test, we statistically test the validity of the exclusion restriction assumption associated with our instruments, using the local-to-zero approximation method of [Conley, Hansen and Rossi \(2012\)](#). The result of this investigation is delegated to Appendix D, and unambiguously confirms the validity of our claim.

31 Coefficient Interpretation

Our model being well-specified, we can scrutinize the coefficient estimates of our controls for more insights ([Eq 70](#)). The DIP control is not only strongly significant but also carries a negative estimate both at the first and second stages. While the sign of this estimate is, for the first stage regression, justified by our model in Section 4, at the second stage we hypothesize that additionally to its legal interpretation, an increase in DIP implementation also contributes to increase the supply of loans in the economy, and as such contributes to decrease the cost of credit. The coefficient says DIP reduces the spread by a bit more than 20 basis points.

Moreover, and in agreement with theory, mitigation of moral hazard is an important determinant in the cost of debt as reflected by the significance of the operating income proxy. As the lack of statistical significance on the coefficients witnesses, higher growth opportunities do not contribute

to lower the spread with our specifications, and as such constitute a discarded parameter once all the other factors in our study are introduced. The reputation determinant is however in perfect agreement with the theory, as reflected by the estimated coefficient of the market value of the firm. Proxies associated with loan's monitoring costs also do impact the spread, as expected. Two of them, namely leverage and working capital, are strongly statistically significant, inducing as a consequence a positive contribution on the value of the spread.

On the loan characteristics side, the size of the loan syndicate does not play a role in our model, in a statistical sense ⁷⁶. The negative impact of the loan amount is a reflection of the economies of scale effect. Our estimation regarding the loan maturity suggests retaining the tradeoff hypothesis through an upward sloping term structure. This result could certainly be consistent with the notion of maturity shortening being allowed after the inclusion of covenants. The coefficient estimate of tangibility is consistent with its economic interpretation, a higher level of asset tangibility allows more (and better) collateral to be used and as such contributes to decrease the cost of credit. Finally, we notice the strong and positive impact on the spread of the existence of collateral attached to the loan. While a complete explanation of such an effect within our model is beyond the scope of this paper, our estimate suggests that secured loans with collateral are more likely to be demanded for riskier borrowers.

32 Some Financial and Legal Perspective

Recent debates have occurred on a possible reform of the US Bankruptcy Code. The Chapter 11 Commission intends to increase the rights of other stakeholders throughout bankruptcy. The LSTA argues that such reforms could lead to a higher cost of capital (LSTA, 2014). However, how the law could affect the cost of capital has yet to be fully investigated. We argue that the impact of such reforms would result in creditor's transforming the covenant structure, which would then be transmitted onto the debt price.

Giving more rights to other stakeholders is a decision based on the idea of fair distribution. However, designing bankruptcy law on a fair distribution basis would also affect the covenant structure.

⁷⁶Ivashina (2009) measures a positive asymmetric information effect of the lead bank share on the loan spread. This share won't be incorporated within our analysis since we only have this information in negligible amount within our sample.

Whether we take only the conventional players (i.e. equityholders, managers and creditors) or more stakeholders as envisaged by a distributional goal reform, the consequence would remain the same. Only distributional goals could justify violating absolute priority, but using a bankruptcy system to pursue such a goal is questionable since parties can circumvent, with contracts, the distributional goals through price terms (Schwartz, 2005). For example, if the Bankruptcy Code is amended to shift wealth from secured creditors to junior creditors, secured creditors will respond with more rigorous lending terms. Hence, any envisaged reforms based on distributional ground would affect the covenant structure.

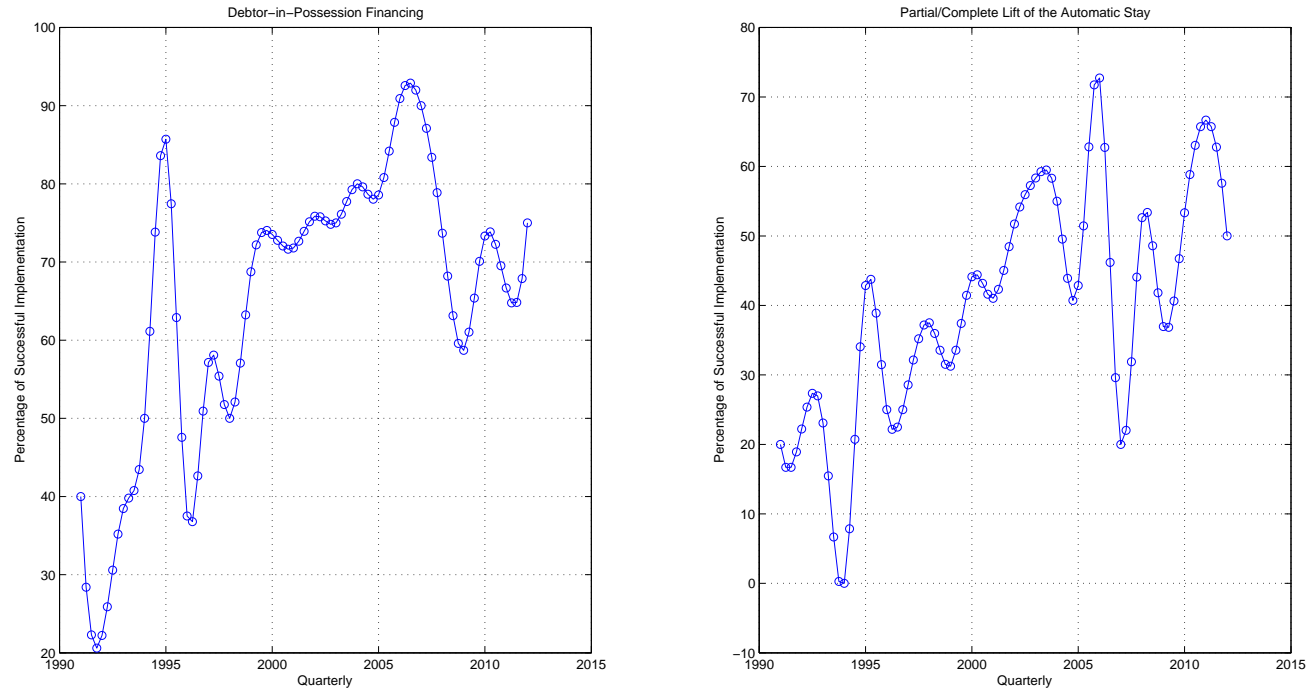
Given the current state of the Code, the practice of bankruptcy law could change the covenant structure through *Normative Butner Principle*, which conceptualizes the possibility that bankruptcy law does affect the contractual rights inside bankruptcy. It acknowledges that bankruptcy law could alter the secured creditors' procedural rights, while defending the substantive rights (Ayotte and Skeel, 2013). If one considers contractual rights as substantive rights, then in bankruptcy the Code does not extend the same protection to the holders of covenants. Outside bankruptcy, upon breaching a covenant, the procedural rights of creditors are respected in terms of calling in the loan or accelerating the rate of repayment. However, such procedures are completely disregarded during bankruptcy, and only the substantive rights are recognized. Given the recognition that procedural (i.e. contractual here) rights are altered in bankruptcy, one could argue that outside bankruptcy such contractual rights might also get altered depending on how the law is practiced. If creditors cannot enforce the covenants in their contracts during bankruptcy, whether secured or not ⁷⁷ they would have less incentive of including covenants in the first place. This would ultimately affect the covenant structure of loan contracts, as reflected within paper.

⁷⁷Secured creditors can also create strategic illiquidity for their debtors. Strategic illiquidity could be due to debt-over hang problem and asymmetrical information (Ayotte and Skeel, 2013). Debt overhang problem prevents debtors of raising credit in financial markets. The problem can be mitigated if the existing lenders write off a portion of the fund for higher gains. The strategic illiquidity due to information asymmetry is that a senior lender may refuse to lend since he has better information on the investment. A refusal to lend might be a sign of financial distress in the company for other creditors, hence other creditors might refuse to lend. Creating an environment of illiquidity conveys two advantages to bank. When bank has the ability to overcome coordination problems and make new loans, the new loan can be made at attractive terms that are not constrained by competition from other lenders like Creditor. Second, illiquidity may prevent continuation loans, thus creating a fire sale that is in Bank's interest when Bank cannot make the loan itself.

33 Concluding remarks

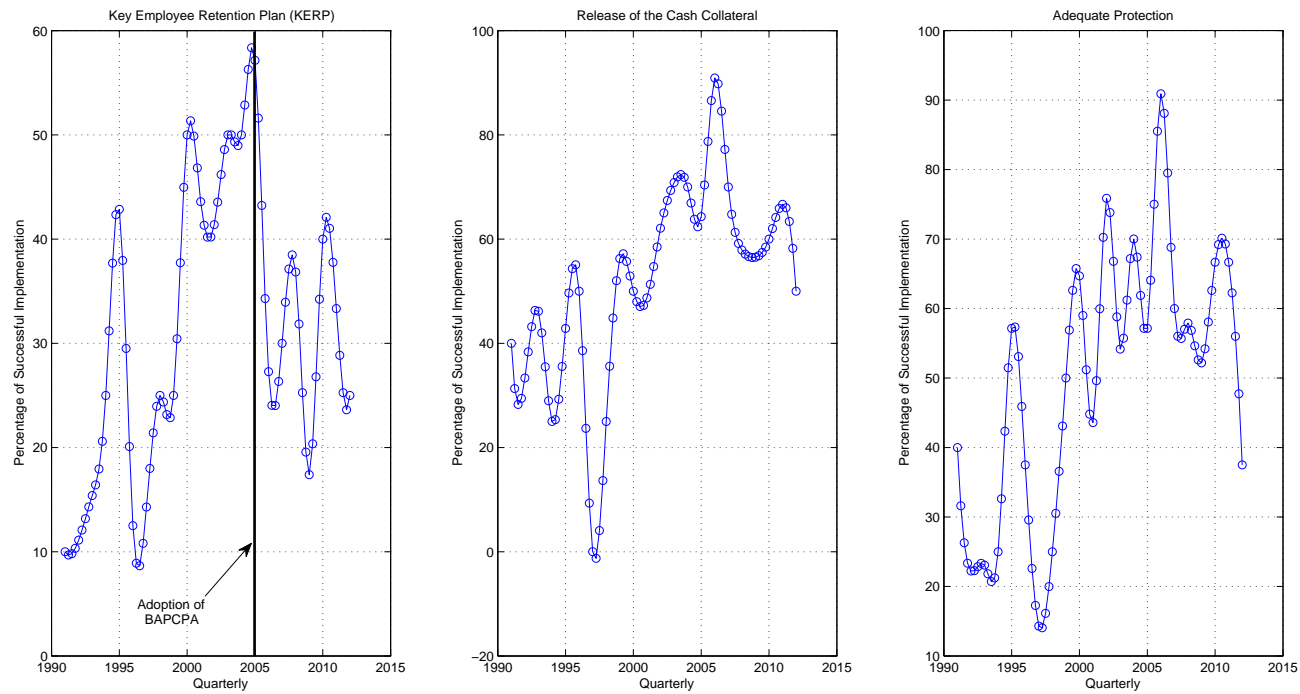
In this work we have established and estimated the legal effect of covenant strictness which arises from creditor's perception of the bankruptcy law. After providing a framework linking creditor control inside and outside of bankruptcy, we have used some bankruptcy practices as instruments in order to show that such an effect accounts for a sizable portion of the cost of credit. In addition to the traditional rationales for covenants, i.e. to secure their position via conventional control and ownership, we argue such covenant inclusions might reflect concerns creditors' might have about how the law is practiced. To do this, we first document the evolution of the bankruptcy law by focusing on five provisions, the DIP financing, release of cash collateral, providing adequate protection, the KERP and the lift of automatic stay. We then empirically show, by instrumenting the covenant intensity with bankruptcy proxies, creditors will forgo more than 20 basis points as compensation to make borrowers engaged in the contract.

Figure 35: DIP and Lift of the Automatic Stay Evolution



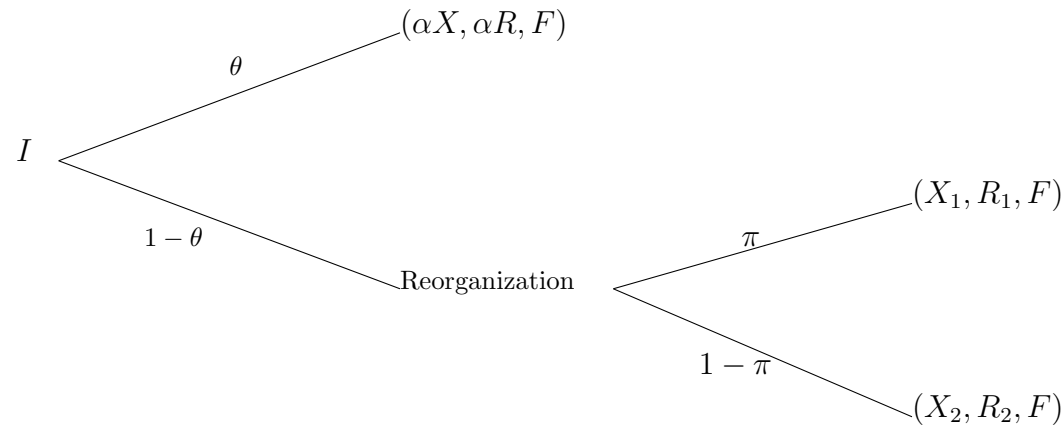
The implementation percentages of Debtor-in-possession (DIP) and Partial/Complete Lift of the Automatic Stay. §364 of the Bankruptcy Code details DIP provisions and §362 details the Automatic Stay that deals effectively with creditor’s run to grab their assets when the firm files for bankruptcy. The proxies are created on an quarterly basis as follows. For each practice, the proxy value at year t is the average number of this practice implemented among all bankruptcy cases within our sample, during year $t - 1$. Cubic splines are then used to convert the proxies into a quarterly basis.

Figure 36: Adequate Protection, KERP and Release of Cash Collateral Evolution



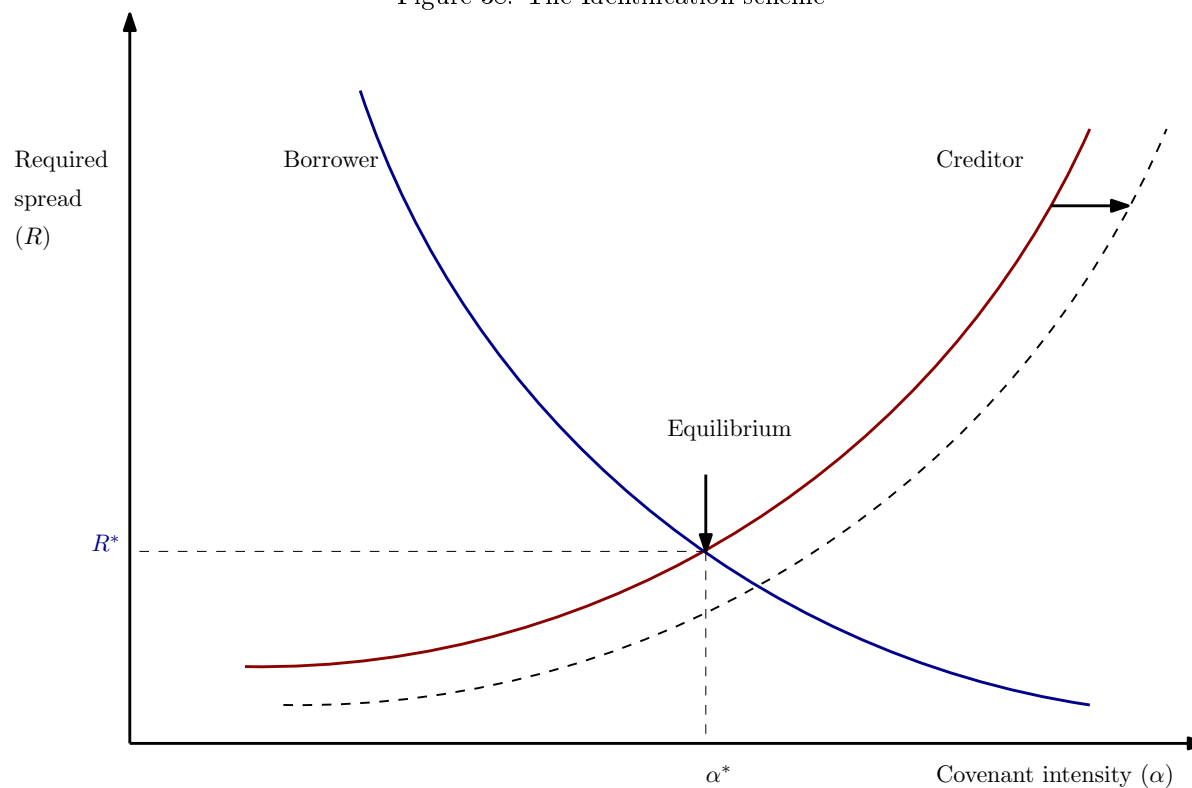
Key Employee Retention Plan (KERP), Adequate Protection and Release of Release of Cash Collateral proxies. KERP is a pay-to-say type of plan. Following the adoption of the Bankruptcy Abuse Prevention and Consumer Protection Act of 2005 (BAPCPA), the KERP drastically falls. §361 details the adequate protection provision: the trustee is required to make (periodic) cash payments to such entity. The Release of Cash Collateral permits debtors to create liens for further liquidity provisions. The proxies are created on a quarterly basis as follows. For each practice, the proxy value at year t is the average number of this practice implemented among all bankruptcy cases within our sample, during year $t - 1$. Cubic splines are then used to convert the annual proxies in a quarterly basis.

Figure 37: The static Model



The model. An investment opportunity I , funded via loan syndication, either succeeds or forces its borrower to file for Chapter 11 Bankruptcy. The latter outcome leads to either a creditor or a debtor-friendly resolution of the claim. If the loan performs (i.e. it does not default, the returns and performance are αR and αX respectively where α is the contract intensity. The fee is designated by F . If investment fails, a reorganization plan starts. With π the bankruptcy law is more debtor-friendly, and with $1 - \pi$ it is more creditor friendly. For creditor friendly the performance of the project would be X_2 and X_1 for debtor-friendly. Conveniently it is assumed that $X_1 - R_1 > X_2 - R_2$.

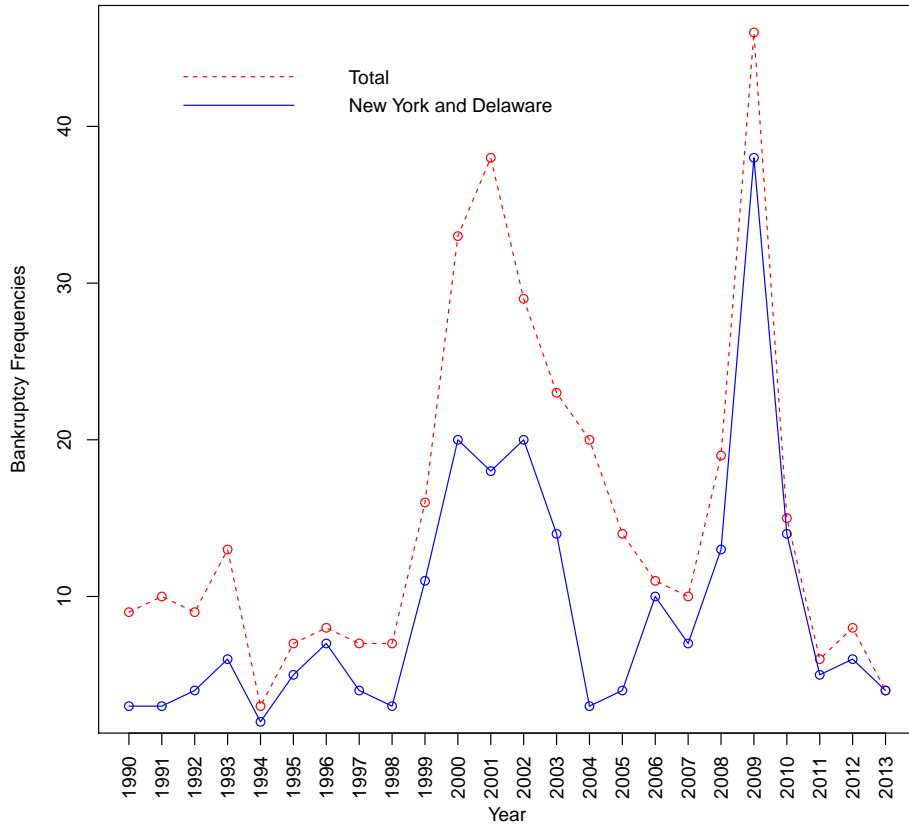
Figure 38: The Identification scheme



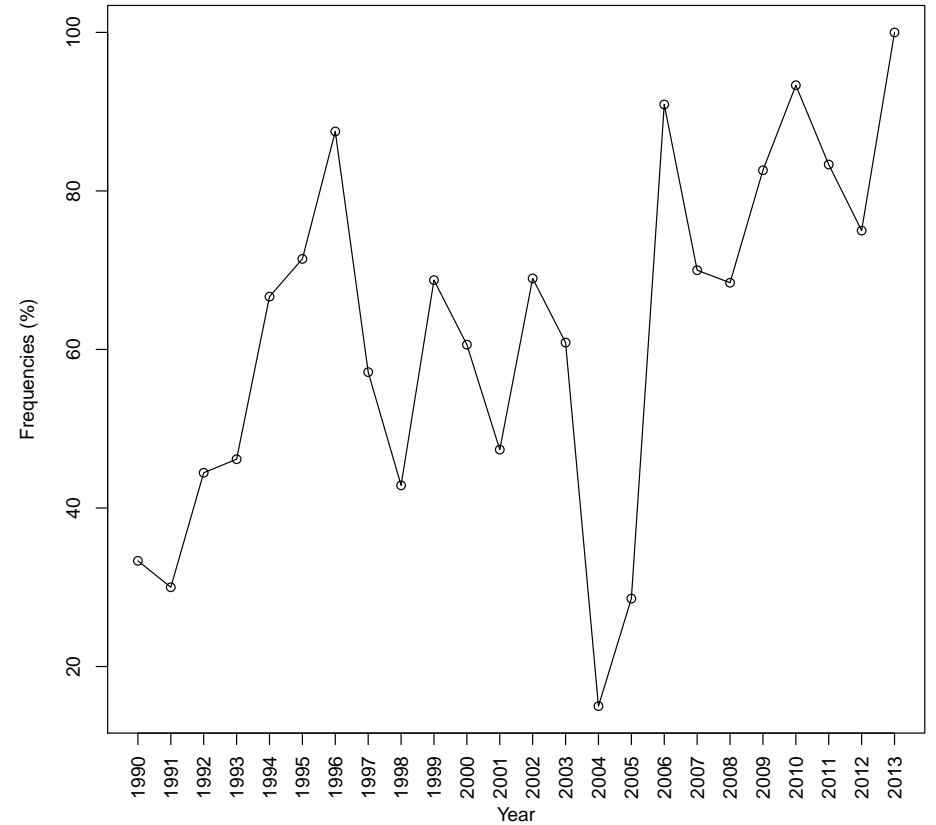
An equilibrium covenant intensity and loan spread (R^*, α^*), which observable in the data, is the result of an interaction between the creditor's demand and the borrower's demand in terms of covenant intensity and spread. A change in the state of the bankruptcy practice will contribute to shift the demand curve of the creditor while leaving the borrower's demand curve fixed.

Figure 39: Forum Shopping

Annual Frequencies of Bankruptcy Filings



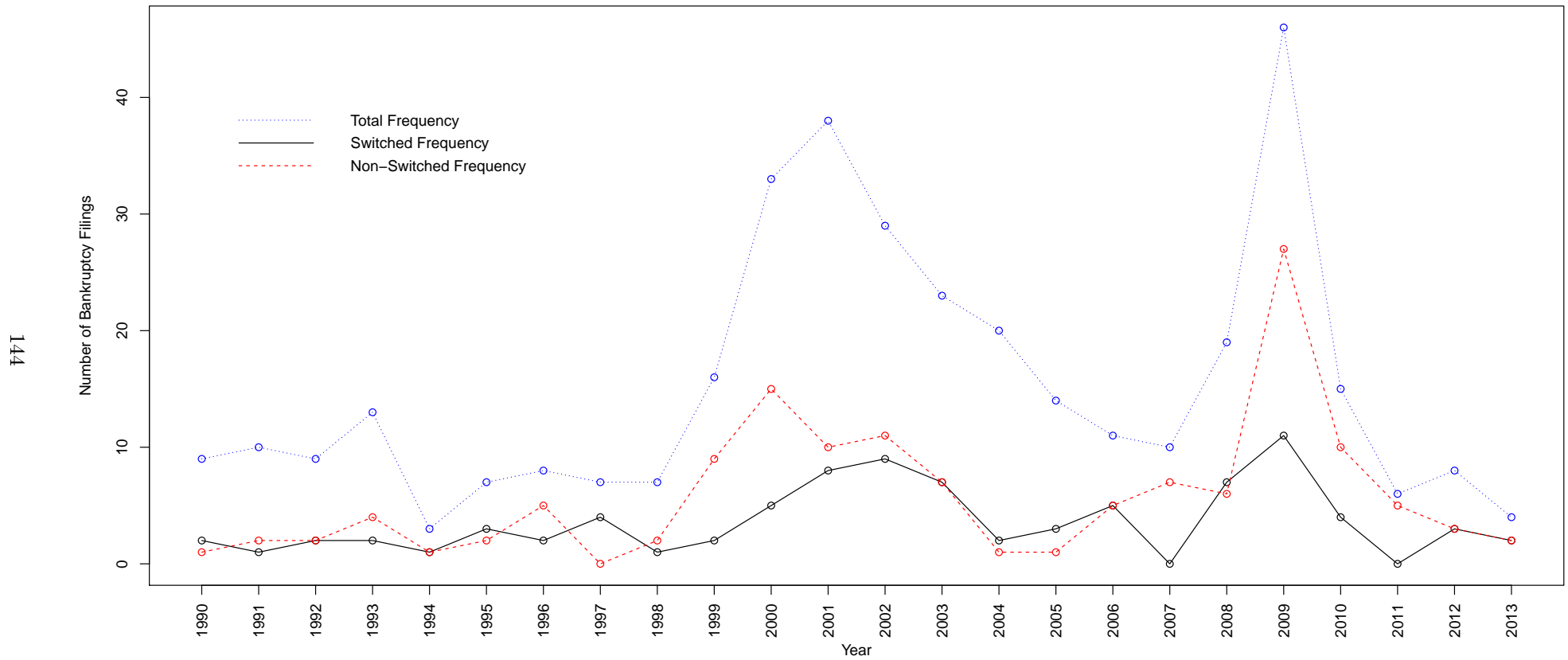
Percentage Of Bankruptcies Filed in New York and Delaware Courts



A first look at forum shopping, on an annual basis. In the left panel, the total number of bankruptcy filings (dashed) and the number of bankruptcy cases filed in New York and Delaware courts (solid) are represented. In the right panel, the percentage of bankruptcy cases that have been filed either in Delaware or New York is represented on an annual basis.

Figure 40: Forum Shopping

Frequencies of Bankruptcy Filings: The Case of Delaware and New York States



A second look at forum shopping, on an annual basis. The blue dotted curve represents the total number of bankruptcy filings within our sample. The red dashed curve represents the total number of bankruptcy filings for firms that have file either in New York or Delaware states, and have additionally been incorporated in one of these states. Finally, the black solid curve represents the total number of bankruptcy filings in either Delaware or New York, emerging from firms that have not been incorporated in any two of these states.

Table 12: Judge Specific Regression

Variable	Automatic Stay Specification			Cash Collateral Specification			KERP Specification			Adequate Protection Specification		
	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Year Fixed Effects	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Judge Fixed Effects	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
R^2	0.42	0.13	0.49	0.38	0.13	0.46	0.44	0.14	0.5	0.41	0.17	0.51
$P > F$			0			0			0			0

Regression results for model (68), including various specifications of time and judges fixed effects. Four bankruptcy practices are represented: Partial/Complete Lift of the Automatic Stay, Adoption of KERP, Granting of Adequate Protection and Release of Cash Collateral. The table also reports the p -value of a joint F test for all judge coefficients.

Table 13: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>Loan Spread (Bp)</i>	3421	220.917	146.963	12.5	1325
<i>Covenant Intensity</i>	3421	2.386	1.011	1	6
<i>Book Value Of Equity</i>	3421	1241.424	3834.494	-8398	108285
<i>Cash Flow Volatility</i>	3414	.006	.353	-3.475	19.408
<i>Market To Book Ratio</i>	3421	1.671	1.01	.435	11.593
<i>Working Capital</i>	3421	323.429	1644.405	-7109	35570
<i>Tangibility</i>	3421	.237	.155	0	.838
<i>Altman-Z</i>	3421	.706	1.667	-51.814	3.724
<i>Profitability</i>	3421	.01	.034	-.326	.156
<i>Leverage</i>	3409	.28	.223	0	2.794
<i>Operating Income</i>	3421	97.232	271.486	-1004	5172
<i>Invested Capital</i>	2980	1853.377	5652.464	-8398	151478
<i>ln(Sales)</i>	3418	5.351	1.657	.372	10.419
<i>ln(Market Value of Equity)</i>	3421	7.09	1.787	.945	12.435
<i>ln(Loan Size)</i>	3421	18.478	1.685	11.644	23.837
<i>ln(Loan Maturity)</i>	3403	3.737	.594	0	5.198
<i>ln(Syndicate Size)</i>	3421	1.624	1.054	0	5.081
<i>Loan Purpose (%)</i>		Work Capitalization	Takeover	Corporate Purp.	Other
		33.6	13	33	20.4
<i>Secured Dummy (%)</i>		Loan Secured (Dummy = 1)	Loan Unsecured (Dummy = 0)		
		66	34		

This table presents descriptive statistics for dollar-denominated loans and associated borrower characteristics. The complete sample of 3421 loan observations, from 1993 to 2012 is represented. All variables are defined in Appendix C. All borrower's characteristics are computed as of the earliest date prior to the origination of the loan.

Table 14: First Stage Regression (OLS)

<i>Regressor</i>	Coef.	<i>t</i> -stat	<i>Regressor</i>	Coef.	<i>t</i> -stat
DIP	-9.58e-03*	-2.36	PurposeWorkCap	-5.06e-03	-0.07
Book Value of Equity	6.73e-05**	2.61	PurposeTakeOver	2.4e-01*	2.9
Market to Book Ratio	-9.60e-02***	-4.24	PurposeOther	1.6e-01*	1.94
Working Capital	1.44e-05	1.37	PurposeCorpPurp	-4.45e-02	-0.59
Tangibility of Asset	-6.5e-02	-0.55	Automatic Stay (I_1)	-5.7e-03*	-2.57
Cash Flow Volatility	-3.32e-02	-0.62	NKERP (I_2)	-1.31e-02***	-7.76
Altman Z	3.24e-02**	1.44	Adequate Protection (I_3)	2.6e-03	1.05
Profitability	2.21 ***	2.98	NCash (I_4)	-1.01e-02*	-2.4
Leverage	6.1e-01***	4.81			
Operating Income	-2.43e-05	-0.15	R^2	.23	
Invested Capital	-5.53e-05**	-2.78	Observations	2941	
Ln(Net Sales)	-2.03e-01**	-5.28	Prob > F	0	
Ln(Market Value)	4.9e-02	1.25			
Ln(Loan Amount)	-8.37e-03	-0.4			
Ln(Maturity)	1.4e-01***	4.61			
Ln(Syndicate Size)	0.1***	3.98			
SecuredLoan	4.6e-01***	12.12			
RecessionOne	5.6e-01*	4.23			
RecessionTwo	-4.1e-02	-0.73			
Constant	4.2***	6.55			

This table presents results of the first-stage regression. The dependent variable is the covenant intensity associated with each loan. The sample is made of 2941 loans, originated between 1998 and 2012, to US manufacturing firms identified with SIC codes 20-39. All explanatory variables are defined in Appendix C. ***, **, * indicate p -values of 0.1%, 1% and 5% respectively. The table reports the result of a joint F test for all instruments (I_1, I_2, I_3, I_4) coefficients.

Table 15: First Stage Regression (OLS)

Variables	OLS (1)		2SLS (2)		LIML (3)		GMM (4)	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
DIP	-2.2e-02***	-1.8e+01	-2.2e-02***	-1.5e+01	-2.2e-02***	-1.5e+01	-2.2e-02***	-1.5e+01
Book Value of Equity	-2.2e-05	-1.4	1.3e-06	6.2e-02	2.4e-06	1.1e-01	-1.4e-06	-6.7e-02
Market to Book Ratio	3.3e-02	1.4	-1.9e-02	-5.7e-01	-2.1e-02	-6.3e-01	-1.6e-02	-5.1e-01
Working Capital	2.7e-05**	2.7	3.1e-05**	2.7	3.1e-05**	2.7	3.1e-05 **	2.7
Tangibility of Asset	-4.0e-01***	-6.2	-4.1e-01***	-5.3	-4.1e-01***	-5.2	-4.0e-01 ***	-5.4
Cash Flow Volatility	2.1e-02	4.0e-01	1.1e-02	3.2e-01	1.1e-02	3.2e-01	1.3e-02	3.4e-01
Altman Z	-2.8e-02	-1.8	-1.6e-02	-1.7	-1.5e-02	-1.7	-1.6e-02	-1.7
Profitability	-1.8** *	-3.9	-1.1*	-2.3	-1.0*	-2.2	-1.1 *	-2.4
Leverage	3.7e-01***	5.2	6.1e-01***	7.6	6.2e-01***	7.5	5.9e-01 ***	7.5
Operating Income	-2.5e-04**	-3.0	-2.4e-04*	-2.2	-2.4e-04*	-2.1	-2.4e-04 *	-2.2
Invested Capital	2.3e-05	1.9	2.6e-06	1.6e-01	1.7e-06	1.0e-01	4.4e-06	2.7e-01
Ln(Assets)	2.0e-01***	3.6	1.5e-01*	2.1	1.5e-01*	2.0	1.5e-01*	2.2
Ln(Net Sales)	5.2e-02*	2.5	-1.7e-02	-6.4e-01	-2.1e-02	-7.3e-01	-1.1e-02	-4.3e-01
Ln(Market Value)	-2.8e-01***	-5.1	-2.2e-01**	-3.1	-2.2e-01**	-3.0	-2.2e-01 **	-3.3
PurposeWorkCap	-1.3e-01***	-3.8	-1.3e-01**	-2.9	-1.3e-01**	-2.9	-1.3e-01 **	-3.0
PurposeTakeOver	1.4e-01***	3.4	2.2e-01***	4.2	2.2e-01***	4.2	2.1e-01 ***	4.3
PurposeOther	-3.2e-02	-7.7e-01	3.2e-02	6.1e-01	3.4e-02	6.5e-01	2.8e-02	5.6e-01
PurposeCorpPurp	-8.7e-02*	-2.5	-1.1e-01*	-2.5	-1.1e-01*	-2.4	-1.1e-01 *	-2.5
Ln(Loan Amount)	-2.8e-02*	-2.5	-3.6e-02*	-2.6	-3.6e-02*	-2.6	-3.6e- 02**	-2.6
Ln(Maturity)	6.7e-02**	3.1	1.1e-01***	4.1	1.1e-01***	4.1	1.1e-01 ***	4.1
Ln(Syndicate Size)	-7.7e-02***	-5.2	-3.4e-02	-1.7	-3.2e-02	-1.6e+0 0	-3.8e-02	-1.9
SecuredLoan	4.9e-01***	2.0e+01	6.6e-01***	1.4e+01	6.7e-01***	1.3e+01	6.5e-01 ***	1.4e+01
Covenant Intensity	9.9e-02***	1.0e+01	-2.6e-01**	-3.3	-2.8e-01**	-3.3	-2.4e-01**	-3.1
RecessionOne	2.9e-02	3.0e-01	2.0e-01	1.8	2.1e-01	1.8	1.9e-01	1.7
RecessionTwo	-2.2e-01***	-5.6	-2.8e-01***	-5.8	-2.8e-01***	-5.7	-2.7e-01 ***	-5.8
Constant	6.9***	3.2e+01	7.9***	2.3e+01	7.9***	2.2e+01	7.8***	2.3e+01
R-squared	0.52		0.31		0.29		0.34	
N. of cases	2941		2941		2941		2941	

This table presents results of the second-stage regression and further model specifications. The dependent variable is the natural logarithm of the all-in-drawn spread associated with each loan. The sample is made of 2941 loans, originated between 1998 and 2012, to US manufacturing firms identified with SIC codes 20-39. All explanatory variables are defined in Appendix C. ***, **, * indicate p -values of 0.1%, 1% and 5% respectively.

Appendix A: Chapter 11 Bankruptcy Practice Sample Description

Table 16: Bankruptcy Practice Distribution
Frequencies of Implemented Bankruptcy Practices

Year	Total Sample Frequency	DIP	Cash Collateral	Adequate Protection	Partial Lift of Stay	KERP
1990	9	1	1	1	0	0
1991	10	4	4	4	2	1
1992	9	2	3	2	2	1
1993	13	5	6	3	3	2
1994	4	2	1	1	0	1
1995	7	6	3	4	3	3
1996	8	3	4	3	2	1
1997	7	4	0	1	2	1
1998	8	4	2	2	3	2
1999	16	11	9	8	5	4
2000	34	25	17	22	15	17
2001	39	28	19	17	16	17
2002	29	22	18	22	15	12
2003	24	18	17	13	14	12
2004	20	16	14	14	11	10
2005	14	11	9	8	6	8
2006	11	10	10	10	8	3
2007	10	9	7	6	2	3
2008	19	14	11	11	10	7
2009	46	27	26	24	17	8
2010	15	11	9	10	8	6
2011	6	4	4	4	4	2
2012	8	6	4	3	4	2
2013	4	3	3	3	3	1

In this table, the frequencies of different bankruptcy's liquidity provisions have been tabulated. The sample is made of U.S. manufacturing bankrupt firms, with assets more than \$100 millions at the time of filing, from 1990 to 2013. Debtor-in-possession (DIP) refers to §364, permitting debtors to raise additional liquidity through bankruptcy. Cash Collateral refers to the release of collateral to make further liens to raise fund, Adequate or Partial Lift refers to §361, permitting debtors to lift the automatic stay to grant adequate protection and raise liquidity, Key Employee Retention Plan (KERP) is the pay-to-stay plan to retain key employees to maximize and smooth the reorganization and bankruptcy process.

Table 17: Bankruptcy Practice Distribution
Frequencies of Implemented Bankruptcy Practices

Year	Total Sample Frequency	363 Asset Sales	Rejection of Unexpired Leases	Prepackaged Pre-Negotiated	Appointment of Equity Committee
1990	9	1	0	0	0
1991	10	4	3	3	1
1992	9	2	3	3	2
1993	13	5	2	5	1
1994	4	2	0	2	0
1995	7	6	3	0	0
1996	8	3	1	6	0
1997	7	4	1	2	1
1998	8	4	3	1	1
1999	16	11	7	4	3
2000	34	25	19	4	1
2001	39	28	22	7	3
2002	29	22	19	11	1
2003	24	18	15	6	3
2004	20	16	12	6	1
2005	14	11	7	2	1
2006	11	10	8	3	3
2007	10	9	6	3	1
2008	19	14	10	3	1
2009	46	27	18	16	6
2010	15	11	4	7	0
2011	6	4	3	2	0
2012	8	6	4	3	1
2013	4	3	3	2	0

Frequencies of different bankruptcy's liquidity provisions have been tabulated. The sample is made of U.S. manufacturing bankrupt firms, with assets more than \$100 millions at the time of filing, from 1990 to 2013. Asset sale through §363 refers to piecewise or whole asset sale of debtors. Rejection of Unexpired lease and contracts, refers to §365, which debtors are permitted to assume or reject unexpired leases and contracts to raise further liquidity. Prepackaged/Pre-Negotiated bankruptcy, where debtors and creditors agree to a bankruptcy procedure to minimize the problem of holdout, and The Appointment of Equity and Unsecured Creditor Committees to represent the claims of the corresponding parties.

Appendix B: List of Financial Covenants

Table 18: List of Financial Covenants Available in DealScan

Covenant Symbol	Covenant Name
C1	Max Debt/EBITDA
C2	Min. Fixed Charge Coverage Ratio
C3	Min. Current Ratio
C4	Max. Capital Expenditure
C5	Max. Debt/Equity
C6	Max. Debt/Tangible Net-Worth
C7	Max. Leverage Ratio
C8	Max. Senior Debt/EBITDA
C9	Min. Cash Interest Coverage
C10	Min. Debt Service Coverage
C11	Min. EBITDA
C12	Min. Interest Coverage Ratio
C13	Min. Quick Ratio

(C1) Max Debt/EBITDA: Debt ratio capturing how many years it would take for a firm to pay back its debt if the ratio is kept constant, (C2) Minimum required earnings to cover expenses, indicates firm's ability to satisfy fixed financing expenses such as interest rate, (C3) Liquidity Ratio, (C4) Ratio defining the maximum threshold for a company to spend its resources on upgrading its physical assets, (C10) Min. Debt Service Coverage: Ability to pay interest expense on outstanding debt, (C12) Min. Interest Coverage Ratio: Used to determine how a company can pay interest on its outstanding debt, (C13) Min. Quick Ratio: indicator of short term liquidity

Table 19: Distribution of Covenants used given year
The list of available of Financial Covenants

Year	(C1)	(C2)	(C3)	(C4)	(C5)	(C6)	(C7)	(C8)	(C9)	(C10)	(C11)	(C12)	(C13)	Total Frequency
1993	25	12,5	12,5	25	0	50	12,5	0	0	0	0	37,5	12,5	8
1994	27,2	47,2	18,2	0	20	14,5	23,6	1,8	5,4	0	0	65,4	0	55
1995	36,5	26,4	31,7	0,5	1,6	37	25,9	2,6	3,7	23,8	0	36	5,8	189
1996	37,7	33,2	33,2	0,5	1,6	37,3	21,7	2,6	1,57	18,3	0,3	39,5	13	382
1997	40,5	32,5	20,5	3,4	1,4	36,9	12,1	3,6	1,6	19,9	1	35,1	14,5	501
1998	62,1	47,6	14,8	12,9	1,3	22,4	10,7	9,8	0,3	15,8	6	42,6	6,6	317
1999	65,3	44,6	6,7	56,5	0,6	8,4	7,8	14,9	0,9	13,1	24,8	50,7	7,3	343
2000	58,3	43,9	9,7	54,8	2,2	13,8	10,3	11,9	3,4	9,4	16,9	43,9	8,1	319
2001	48,9	40,1	6,5	44,8	0,9	11,6	13,8	9,4	1,3	6,3	25,4	29	7,8	319
2002	54,8	45,48	7,3	50,7	0,3	9	11,3	12,5	1,2	5,5	26,2	40,5	8,7	343
2003	60,4	52,4	3,8	55,5	0,8	5	7,1	19,2	0	4,1	29,4	40,1	6	364
2004	61,3	44,3	3,5	45,7	0	7,7	8,4	16,5	2,1	5,6	13	40,5	4,6	284
2005	64,1	44,8	1,3	34,2	0	3,6	14,2	16,6	0,7	3	12,3	38,9	2	301
2006	73,2	42,2	1,3	39,5	0	1,3	5,5	15,3	1,3	1,3	17,9	39,6	1,7	235
2007	71	28	0,9	34,1	0	2,8	7	12,1	0,5	5,1	12,6	46,7	2,3	214
2008	65,2	37,3	0,6	21,1	0	3,7	10,5	6,8	0,6	6,2	18	31	7,4	161
2009	52	42,4	1,1	35,3	0	7	15,1	11,1	1	1	17	36,3	2	99
2010	69,64	25,9	0	26,8	4,5	0,9	10,7	5,3	0	0	6,2	58	3,5	112
2011	79,9	15,3	0	14,8	0,5	1	12,1	6,3	0,5	0	1	55,5	0,5	181
2012	72,1	24,4	0	15,1	1,16	2,32	5,8	12,8	0	0	1,2	54,6	0	86

In this table are represented, for all financial covenants (see Table 18), the percentage of all loans that have each specific covenants implemented in it through the entire sample period (1993-2012). As observed, covenants C1, C2, C4 and C12 are the most included. Data has been extracted from Loan Pricing Corporation Dealscan database.

Appendix C: Variables' Definition

Cash Flow Volatility: Ratio of the standard deviation of the past eight earnings changes to the average book size over the past eight quarters.

Covenant Intensity: Number of financial covenants associated with the facility.

Invested Capital (Total): Invested capital - (total + deferred) taxes and investment tax credit - minority interest.

Leverage: (Debt in current liabilities + total long-term debt) divided by total assets.

Loan Size: Total facility amount (\$ millions).

Loan Spread: Measured as all-in-spread drawn: the amount the borrower pays in basis points over LIBOR or LIBOR equivalent for each dollar drawn down. This measure adds the borrowing spread of the loan over LIBOR with any annual fee paid to the bank group.

Market Value of Equity: Common Shares Outstanding Price-Close-Quarterly-End.

Market Value: Market value of equity - Book value of equity + Total Assets

Market-to-Book: (Debt in current liabilities+total long-term debt+preferred stock carrying value deferred taxes and investment tax credit+stock price at the end of quarter common shares outstanding) divided by total assets.

Maturity: Facility maturity in months.

Operating Income (Before Depreciation): Total operating revenues - Total operation expense + Total maintenance expense + Total taxes other than income taxes.

Profitability: EBIDTA divided by total assets.

Purpose: Indicator variables for the following categories reported in DealScan: debt repayment, working capital, takeover or other.

Sales: Total Sales (net).

Secured: Dummy variable, 1 if facility is secured and 0 otherwise.

Syndicate Size: The number of lenders participating in the deal.

Total Assets: Total book assets in billions USD.

Tangibility: Net property, plant, and equipment divided by total assets.

Working Capital : Total Current Assets (excluding Cash) - Total Current Liabilities.

Z-Score = 3.3 Pretax operating income/total assets + sales/total assets + 1.4 retained earnings/tot

Appendix D: Local-to-Zero Approximation and Exogeneity

In our instrumental variable analysis, the exclusion restriction assumption is translated such that our bankruptcy proxies do not directly affect the syndicated loan spreads, while keeping the covenant intensity constant. In order to take into account any possible correlation between the dependent and instrumental variables, we adopt the Local-to-Zero approximation of Conley, Hansen and Rossi (2012). Hence, let us consider the following model:

$$Y = X\beta + Z\gamma + \epsilon$$

, where Y is an outcome vector, X is a matrix of endogenous variables, Z is a matrix of instruments and ϵ are the unobservables. The IV exclusion restriction is equivalent of the assumption (or prior) that $\gamma = 0$. An IV can be plausibly exogenous if γ takes any other prior other than zero. The idea is by specifying a prior for γ how inference on point estimates change. Conley et al (2012) introduced several methods to take into account a plausible exogenous analysis. Here we have adopted their Local-to-Zero approximation. The treatment produces the following approximation to the distribution of $\hat{\beta}$:

$$\hat{\beta} \underset{\text{Usual 2SLS Asymp. Dist.}}{\overset{\text{Approx}}{\sim}} \underbrace{\mathbb{N}(\beta, V_{2SLS})}_{\text{Usual 2SLS Asymp. Dist.}} + A\gamma$$

$$A = \left(X'Z (Z'Z)^{-1} Z'X \right)^{-1} (X'Z)$$

$$\gamma \sim F$$

where the first term in this expression, $\mathbb{N}(\beta, V_{2SLS})$, is the usual 2SLS asymptotic distribution. V_{2SLS} is the typical variance-covariance matrix. The second term, which is assumed independent of the first, reflects the influence of exogeneity error. The distribution of the exogeneity error term depends on sample moments in the matrix A and the specified prior distribution F for γ . Using a Gaussian prior for γ makes the final distribution easy to manipulate. As demonstrated by Conley et al (2012), if we assume a prior distribution of the form $\mathbb{N}(\mu_\gamma, \Omega_\gamma)$ the distribution for $\hat{\beta}$ would then be:

$$\hat{\beta} \underset{\text{Usual 2SLS Asymp. Dist.}}{\overset{\text{Approx}}{\sim}} \mathbb{N}(\beta + A\gamma, V_{2SLS} + A\Omega_\gamma A')$$

The convenience of this approach becomes evident: the relationship between the strenght of the instrument and the impact of exogeneity errors becomes transparent. The size of A determines how strongly the exogeneity errors influence the estimation, or inference of β . Since the contribution of the term $(X'Z)$ plays twice a role in the definition of A , any weak instrument thus increases the exogeneity error.

As far as the analysis of Section 5.4 is concerned, we need to assume negative priors on our instruments since we have defined them to be creditor-friendly. The goal is now to make sure than even with various priors on our instruments, the validity of the inference is not questioned. We thus run the specifications 69 and 70, assuming numerous values for the mean μ_γ and the variance δ^2 of γ . The results are provided in following table Table:

	Dogmatic Prior	No Prior for mean		Plausibly Exogenous		
	(1)	(2)		(3)		
Endogenous variable	$\gamma = 0$ (GMM)	$\mu_\gamma = 0$ $\delta = -0.01$	$\delta = -0.0025$	$\mu_\gamma = \delta$ $\delta = -0.005$	$\delta = -0.01$	$\delta = -0.0125$
Number of covenants	-0.28***	-0.29***	-0.49***	-0.682***	-1.06***	-1.25***
Number of observations	2941	2941		2941		

The results suggest that our claim is statistically validated. The small amount of biases associated with our instruments (and described in 5.4) leads to a slight perturbation in the values of the point estimate. Nevertheless, whether we use tight or loose priors on the instruments, the sign of the estimate is consistent with the theoretical model of Section 4 and its estimation in Section 5.4.

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