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Aversion au risque et concurrence bancaire: disponibilité des crédits et cycle économique

Caroline Ninou Bozou

Sous la direction de Sébastien Lotz, Professeur, Université Paris II.

Membres du jury :
Jean-Bernard Chatelain, Professeur, Paris School of Economics.
Matthieu Darracq-Pariès, Directeur adjoint de la prévision et de la modélisation des politiques, Banque Centrale Européenne.
Marianne Guille, Maître de conférences, Université Paris II.
Lise Patureau, Professeur, Université Paris-Dauphine.
Gauthier Vermandel, Maître de conférences, Université Paris-Dauphine.

Avertissement

À Henri Bozou

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Résumé

Dans cette thèse, nous nous concentrons sur deux déterminants de la disponibilité du crédit et plus largement, du cycle des affaires: la structure du marché bancaire et les préférences des agents à l'égard du risque et du temps. Dans un premier chapitre, nous démontrons une relation empirique négative entre la concentration du marché bancaire et la disponibilité des crédits aux entreprises. Nous montrons également que l'ampleur de cette relation dépend des caractéristiques des firmes et des banques. Dans un second chapitre, théorique, nous comparons, dans le cadre d'un modèle d'Equilibre Général Dynamique Stochastique (DSGE) non linéaire, différentes structures du marché bancaire et analysons leurs effets respectifs sur la stabilité financière et sur le bien-être des ménages. Un marché bancaire oligopolistique avec une forte concentration atténue la transmission des chocs financiers et améliore le bien-être des ménages par rapport aux autres structures de marché. Enfin, dans un dernier chapitre nous analysons, via un modèle DSGE non linéaire, l'effet d'une augmentation de l'aversion au risque des agents sur la transmission des chocs économiques. En outre, en considérant la variabilité temporelle du paramètre d'aversion au risque, nous analysons les mécanismes de transmission d'un choc d'aversion à l'ensemble de l'économie.

Descripteurs :
Disponibilité du crédit, concurrence bancaire, aversion au risque, cycle des affaires

Abstract

In this thesis, we focus on two determinants of credit availability and more broadly, the business cycle: banking market structure, and risk and time preferences. First, in an empirical chapter, we demonstrate a negative relationship between the concentration of the banking sector and the availability of credit. We also show that this relationship depends on the specific characteristics of firms and banks. Secondly, in a theoretical chapter, we compare, in the framework of a nonlinear Dynamic Stochastic General Equilibrium (DSGE) model, different banking market structures and we analyse their respective impact on the business cycle and households' welfare. We find that a concentrated oligopolistic structure mitigates the transmission mechanism of financial shocks and improves the households' welfare compared to other market structures. In the final chapter, we analyse, through a nonlinear DSGE model, the impact of an increase in the degree of risk aversion on the transmission mechanisms of economic shocks. Moreover, considering the time-varying nature of risk aversion, we evaluate the transmission mechanisms of risk aversion shocks to the whole economy.

Keywords :
Credit availability, bank competition, risk aversion, business cycle

Avertissement

Mise à part l'introduction générale et la conclusion générale rédigées en français, les différents chapitres de cette thèse sont issus d'articles de recherche indépendants, rédigés en anglais et dont la structure est autonome. Par conséquent, certaines informations, notamment certains éléments de la revue de littérature et du modèle, sont répétés d'un chapitre à l'autre. Par ailleurs, les annexes propres à chaque chapitre sont insérées à la fin de ceux-ci.

Notice

Apart from the general introduction and the general conclusion written in French, the different chapters of this thesis are drawn from independent research articles written in English. Therefore, some information, including the literature review and some model features, are repeated across chapters. In addition, the Appendix specific to each chapter are inserted at the end of the chapters.

Sommaire

Introduction générale

Le secteur bancaire, par sa fonction d'intermédiaire financier et de création de la monnaie bancaire, joue un rôle essentiel dans l'activité économique. Les réglementations ainsi que les différentes politiques concurrentielles menées dans ce secteur influencent le cycle des affaires. Ainsi, la compréhension de son fonctionnement est essentielle pour les décideurs et l''utilisation des modèles macroéconomiques est un outil efficace pour parvenir à cette compréhension.
Dès leur apparition dans les années 50, les modèles macroéconomiques sont reconnus comme étant des outils exceptionnels d'aide à la décision. Toutefois, ces modèles ont connu de vives critiques à partir du début des années 70 face à leurs difficultés à expliquer le phénomène de la "stagflation" ainsi que leurs limites théoriques mises en avant par Lucas (1976) [1]. L'élaboration des modèles Dynamiques et Stochastiques en Equilibre Général (DSGE) rentre dans une démarche d'amélioration du cadre d'analyse. En particulier, ils utilisent la méthodologie de l'équilibre général, basée sur des comportements d'optimisation, permettant ainsi d'échapper à la critique de Lucas. De plus, ces modèles prennent en compte de nombreux mécanismes théoriques (rigidité des prix et des salaires, concurrence imparfaite sur le marché des biens et services, efficacité de la politique monétaire) assurant ainsi une meilleure adéquation des modèles aux données. [2]
Les modèles DSGE sont aujourd'hui largement utilisés dans les recherches macroéconomiques théoriques et empiriques, les banques centrales ayant très largement accompagné ce processus [3]. Au début des années 2000, ces modèles se développent afin de prendre en compte les effets des frictions financières sur la transmission des chocs économiques. A la lumière de la crise financière de 2008 et face à leur incapacité à prédire et analyser les effets des chocs financiers, de nouveaux développements apparaissent afin d'intégrer divers aspects du secteur bancaire tels que la concurrence monopolistique, les chocs de taux d'intérêt ou encore, les réglementations macro prudentielles. Toutefois, certaines questions relatives à la concurrence et aux comportements des agents ne sont pas encore résolues par cette littérature. En effet, alors que l'évidence empirique révèle un marché bancaire en situation d'oligopole dans la plupart des pays développés, cette hypothèse est rarement prise en compte dans les modèles. De plus, s'il est admis que les comportements d'aversion au risque et les préférences inter-temporelles des agents influencent leurs comportements d'épargne, d'emprunt et de consommation, peu de modèles évaluent la nature et l'intensité de cette relation.

L'objectif de cette thèse est d'analyser ces deux points de manière structurelle et empi-

1. Lucas formule une critique des modèles dans lesquels les agents ne changeraient pas leur comportement malgé les changements de politiques économiques menées.

2. les modèles DSGE remplacent progressivement les modèles macro économiques des années 1980 pour deux principales raisons : l'équivalence observationnelle et l'identification des paramètres. Voir Chatelain and Ralf (2019) pour une explication détaillée.

3. La plupart des institutions chargées de la politique économique disposent de leur modèle DSGE. Par exemple, la Banque Centrale Européenne utilisait le modèle NAWM de Smets and Wouters (2003) jusqu'en 2010 puis par la suite le modèle EAGLE de Gomes et al. (2012). La Federal Reserve utilisait le modèle SIGMA de Erceg et al. (2006), puis par la suite le modèle EDO de Chung et al. (2010).

rique. Le premier chapitre étudie la relation entre la concurrence bancaire et la disponibilité du crédit pour les entreprises. Le deuxième chapitre analyse les effets de la concurrence bancaire sur la stabilité financière et le bien-être des ménages. Le troisième chapitre consiste à prendre en compte les comportements d'aversion au risque et au temps dans les mécanismes de transmission des chocs économiques et financiers d'une part, et analyse les effets sur le cycle des affaires d'une variation des préférences d'autre part.

Les concepts clefs présents dans les trois chapitres de cette thèse sont présentés dans la suite de l'introduction. La première partie de l'introduction donne un bref aperçu des différents modèles DSGE prenant en compte les frictions financières et le secteur bancaire. La deuxième partie pose la question de l'analyse de la concurrence sur le marché bancaire, enfin, la troisième partie introduit le concept de préférences pour le risque et le temps.

0.1 Les modèles DSGE : frictions financières et marché du crédit

L'activité financière influence l'économie réelle. Cette affirmation est à l'origine de la multiplication des modèles DSGE prenant en compte les frictions financières et le secteur financier. Une première vague de modèle apparaît à la fin des années 90 et considère les facteurs financiers comme des éléments clefs des cycles économiques. Deux approches sont utilisées afin d'introduire les frictions financières : la prise en compte des problèmes d'agence et l'introduction des contraintes de collatéral (Bernanke et al., 1999; Kiyotaki and Moore, 1997; Iacoviello, 2005). Ces modèles cherchent à analyser la contribution de ces frictions dans la propagation des chocs économiques considérant que la détérioration des conditions du marché du crédit n'est pas seulement le résultat d'un ralentissement de l'activité, mais en constitue elle-même un facteur majeur. La deuxième vague de modélisation, apparait à la suite de la crise financière de 2008 et considère les intermédiaires financiers comme des acteurs essentiels des variations du cycle économique. Ainsi, les principaux travaux de cette littérature (Gerali et al., 2010; Brzoza-Brzezina et al., 2013) donnent une place importante au secteur bancaire en accordant aux banques un pouvoir décisionnel dans la fixation des taux d'intérêt. De plus, ces modèles permettent d'étudier l'effet des chocs dont l'origine est le secteur bancaire (notamment les scénarios de rationnement de crédit) et sont ainsi plus à même d'expliquer les événements économiques des dernières décennies. Dans ce qui suit, nous présentons les principales évolutions des modèles DSGE en matière de prise en compte des relations de crédit.

Première vague : les frictions financières

La prise en compte des frictions financières comme déterminant du cycle des affaires s'est développée bien avant la crise financière de 2008, les premiers modèles datant de la fin des années 1990. Deux approches alternatives sont utilisées pour introduire ces frictions

financières : les problèmes d'agence (Carlstrom and Fuerst, 1997; Bernanke et al., 1999) et les contraintes de collateral (Kiyotaki and Moore, 1997; Iacoviello, 2005). Bien que cette littérature se soit fortement développée, il n'existe à ce jour aucun consensus sur le meilleur moyen d'introduire ces frictions.
La première approche, basée sur les travaux de Bernanke et al. (1996), introduite dans un cadre DSGE par Bernanke et al. (1999), consiste à modéliser le concept de l'accélérateur financier par la prise en compte des problèmes d'agence. Ils considèrent en particulier, que les frictions surviennent parce que le suivi d'un demandeur de prêt est coûteux (afin de limiter les asymétries d'information), ce qui crée un écart endogène entre le taux de prêt (dites prime d'agence ou de financement externe) et le taux sans risque, cet écart agissant comme un accélérateur financier. En effet, les chocs exogènes sont amplifiés en raison de la modification de la richesse nette des emprunteurs, le mécanisme de transmission fonctionnant comme suit : une diminution de la valeur nette des emprunteurs entraine une augmentation de la divergence d'intérêt entre prêteurs et emprunteurs, et donc contribue à accroître la prime de finance externe. Etant donné le caractère pro-cyclique de la valeur nette des entreprises, il est possible de conclure à une prime de finance externe contra-cyclique renforçant la réponse de l'investissement et ainsi, amplifiant la réponse initiale du choc. Ce mécanisme permet ainsi d'évaluer l'effet sur l'économie de tout choc exogène affectant la richesse nette des emprunteurs (choc de productivité, choc de politique monétaire et choc d'inflation). Finalement, le principe de l'accélérateur financier reposant sur une relation contra-cyclique entre prime de financement externe et richesse nette des entrepreneurs est à la base de nombreux modèles DSGE (Choi and Cook, 2004; Christiano et al., 2003; Motto et al., 2010).
La seconde approche est fondée sur le papier de Kiyotaki and Moore (1997). Les auteurs introduisent le concept de contrainte de collateral qui sera étendu à un cadre DSGE par Iacoviello (2005). Le modèle fait l'hypothèse que les agents ont un taux de préférence pour le présent hétérogène, ce qui les divise entre prêteurs et emprunteurs (les ménages impatients et les entrepreneurs, emprunteurs, ont une préférence pour le présent plus élevée que les ménages patients, prêteurs). Le secteur financier sert d'intermédiaire entre ces deux groupes et crée des frictions en exigeant que les emprunteurs fournissent une garantie pour leurs emprunts, basée sur la valeur de leurs actifs. Ainsi, le prix des actifs est à l'origine des variations de la richesse nette des agents et donc de leurs comportements d'investissement et de consommation.
Finalement, l'introduction de frictions financières dans les modèles DSGE permet d'analyser le rôle des imperfections du marché du crédit dans la transmission des chocs économiques. Au total, il apparaît que ces modèles permettent de mieux expliquer les variables macroéconomiques réelles que les modèles standards de la littérature, ne prenant pas en compte les frictions financières [4]. Si Brzoza-Brzezina and Makarski (2011) montrent

4. Les modèles avec frictions financières permettent une meilleure correspondance entre les données empiriques et théoriques. Ils permettent aussi de retracer certaines particularités du cycle des affaires telles que la forme de la réponse de l'investissement et de la consommation (Brzoza-Brzezina and Makarski,

que certains effets indésirables (incompatibilité avec les données empiriques par exemple) peuvent survenir dans le cadre des modèles avec contraintes de collateral, de nombreux modèles se sont développés utilisant alternativement l'une ou l'autre des deux approches sans qu'un réel consensus sur la meilleure approche n'émerge. Malgré la supériorité du modèle de l'accélérateur financier démontrée par Brzoza-Brzezina and Makarski (2011), le modèle avec contrainte de collateral s'avère plus propice à l'introduction de certaines de nos hypothèses. En particulier, dans le modèle de Bernanke et al. (1999) les entrepreneurs sont neutres au risque par hypothèse ce qui ne nous permettrait pas d'introduire les comportements d'aversion pour ces agents. Ainsi, les modèles DSGE présentés dans les chapitres deux et trois de cette thèse prennent en compte les frictions financières via l'existence de contraintes de collateral.

Deuxième vague : intermédiaires financiers et chocs de rationnement de crédit

Une nouvelle vague de modèles DSGE apparait à la suite de la crise financière de 2008 et considère les intermédiaires financiers comme des acteurs majeurs de l'apparition de crises et de leur propagation (Guerrieri and Iacoviello, 2015; Brunnermeier et al., 2013; Angeloni and Faia, 2013; Kiley and Sim, 2017; Kollmann et al., 2011; Gerali et al., 2010; Meh and Moran, 2010). Toutefois, certains de ces modèles utilisent les intermédiaires financiers uniquement comme un outil de modélisation (Guerrieri and Iacoviello, 2015) et ne leur accordent aucun pouvoir de décision dans la fixation des taux d'intérêt. C'est en ce sens que l'article de Gerali et al. (2010) rompt avec la littérature existante. En considérant que les banques sont en concurrence monopolistique, ils leurs attribuent des parts de marché à l'origine de leurs décisions de fixation des taux d'intérêt. En plus d'attribuer un pouvoir de décision aux banques, introduire la concurrence monopolistique présente certains avantages. Elle permet par exemple de prendre en compte la rigidité des ajustements de taux en réponse aux variations des taux directeurs. De plus, elle permet de modéliser le rationnement du crédits via l'introduction d'un choc exogène sur les marges d'intérêt bancaire.
Toutefois, le modèle de Gerali et al. (2010) montre certaines limites mises en avant par Angelini et al. (2014a), notamment la difficulté du modèle à reproduire les corrélations empiriques positives entre la consommation et les taux d'intérêt d'une part, et entre l'investissement et les taux d'intérêt d'autre part. La prise en compte, dans le troisième chapitre de la thèse, d'un paramètre d'aversion variable dans le temps permet de combler certaines de ces lacunes. En effet, le poids du choc de productivité est atténué dès lors que l'on considère un choc d'aversion dans le modèle permettant finalement de trouver une correlation positive entre la consommation et les taux d'intérêt. De plus, certaines hypothèses intrinsèques à la concurrence monopolistique (absence de barrières à l'entrée, biens homogènes, absence d'interactions stratégiques) peuvent paraître irréalistes lorsqu'elles sont appliquées

2011)

au marché bancaire, notamment pour les pays où le marché bancaire est fortement concentré (comme c'est le cas dans la plupart des pays industrialisés Fig.0.1). Afin de combler ces lacunes, nous construisons dans le deuxième chapitre de la thèse, un modèle DSGE prenant en compte la concurrence oligopolistique sur le marché bancaire. Chaque banque maximise son profit en considérant le comportement des autres banques, permettant ainsi de considérer les interactions stratégiques. De plus, ce type de concurrence suppose que les banques produisent des biens homogènes.

0.2 Concentration du marché bancaire

Si l'analyse de la concurrence apparaît comme une question centrale dans l'histoire de la recherche économique, son application au secteur bancaire laisse subsister de très nombreuses interrogations. Après avoir présenté la notion de concurrence et son évolution historique, nous montrerons que la littérature, bien que très vaste, ne s'accorde pas sur la nature de la relation entre concurrence bancaire et disponibilité des crédits ou même encore, sur la relation entre concurrence bancaire et stabilité financière. Cela nous amène à poser notre principale question de recherche : faut-il favoriser la concurrence dans l'industrie bancaire ?

Conception historique de la concurrence

La question de la concurrence anime le débat économique depuis de nombreuses années. Si on remonte aux origines de l'économie politique, nous pouvons citer les travaux de Smith (1776) qui se veulent défenseurs de la liberté individuelle et de ce fait, de la libre concurrence. En effet, au travers de sa théorie de la "main invisible", il affirme que la poursuite de multiples intérêts individuels améliore l'intérêt général.
La vision de la concurrence dans l'économie néoclassique est contrastée parmi les économistes. En effet, si l'ensemble des économistes néoclassiques défendent l'économie de marché reposant sur la propriété privée et la liberté individuelle, leurs approches en matière de concurrence diffèrent d'une école de pensée à l'autre. [5] L'école de Lausanne prônent la concurrence pure et parfaite (CPP) telle qu'elle est définie par Knight (1921) (le marché admet un certain nombre d'hypothèses telles que l'atomicité, la libre entrée et sortie sur le marché, la libre circulation des facteurs de production et la transparence de l'information). Cette école de pensée s'articule autour des travaux de Walras (1874) et montre que la CPP aboutit à un état d'optimum de Pareto, c'est-à-dire, une situation dans laquelle on ne peut pas améliorer le bien-être d'un individu sans détériorer celui d'un autre. Il prône ainsi l'existence d'un équilibre général statique, modélisé plus tard par Arrow and Debreu (1954), dont l'hypothèse centrale est la CPP.

5. Les économistes néoclassiques sont regroupés dans trois écoles de pensée : l'école de Lausanne, l'école de Cambridge et l'école Autrichienne.

Par la suite, les travaux de l'école de Cambridge mettent en avant les imperfections du marché (Pigou, 1922) et justifient ainsi les interventions de l'état.
Enfin, les travaux de l'école Autrichienne remettent en cause ceux de l'école de Lausanne. En particulier Hayek (1945) rejette le concept de CPP lui reprochant d'avancer des hypothèses peu réalistes. De plus, l'école Autrichienne met en avant la force coordinatrice de la fonction entrepreneuriale. Ainsi, les économistes de l'école Autrichienne (Menger, Hayek, Von Mises) n'envisagent pas la concurrence comme un équilibre statique, comme c'était le cas de l'économie néoclassique jusqu'alors, mais comme un équilibre dynamique qui peut ne jamais être atteint. La fonction entrepreneuriale est aussi mise en avant dans les travaux de Schumpeter (1912) sur la "destruction créatrice". En effet, l'entrepreneur est à l'initiative des processus d'innovation. Grace aux innovations, il bénéficie, dans un premier temps, d'une situation de monopole, source de profit. Cette phase de monopole est appelée phase d'expansion car elle est marquée par la hausse de la production et de la productivité. Dans un deuxième temps, une phase de crise apparait marquée par la surproduction et la baisse des prix. Le monopole laisse place à une structure de marché concurrentielle. Ainsi, il met en avant l'idée que le monopole n'est pas une situation durable car il est progressivement évincé par la concurrence.

La question de la concurrence en économie industrielle

Au-delà du cadre purement théorique précédemment présenté, l'économie industrielle pose la question de la concurrence dans un cadre d'économie appliquée. Les réponses apportées présentent dès lors un intérêt pour les décideurs politiques. Etant donné la réalité des marchés, l'économie industrielle choisit comme cadre d'analyse la concurrence imparfaite.
Les premiers travaux d'économie industrielle proviennent de l'école d'Harvard. Ils se développent dans les années 30 et reposent sur des travaux essentiellement empiriques. Les auteurs de l'école d'Harvard, en particulier, Mason (1939) et Bain (1956), mettent en avant le paradigme de *structure-conduct-performance* (SCP) qui stipule que la structure du marché, c'est-à-dire ses conditions et caractéristiques déterminent le comportement des offreurs et donc ses performances. Ils prônent ainsi l'intervention des autorités afin de limiter la concentration des marchés (politique antitrust).
Par la suite, les travaux de l'école de Chicago préconisent la déréglementation des marchés (plutôt que la politique antitrust) afin de maintenir le processus concurrentiel. Au sein de cette école de Chicago, les travaux de Stigler (1983) inversent le paradigme SCP. En effet, il montre que ce n'est pas la structure du marché qui en détermine ses performances mais plutôt les performances des entreprises qui déterminent leurs parts de marché. Dans la lignée de ce courant, les travaux de Baumol (1982) élaborent la théorie des marchés contestables. Ils remettent définitivement en cause le concept de CPP en rejetant les principes néoclassiques d'atomicité et de libre entrée et de sortie du marché. Dans cette théorie, la simple absence de barrière à l'entrée et à la sortie du marché, permet de considérer que

les profits sont nuls même s'il n'y a qu'une seule entreprise sur le marché. En effet, la seule menace de nouveaux entrants dissuade l'entrepreneur d'augmenter ses prix. D'un point de vue de politique macroprudentielle, ils prônent ainsi l'absence d'intervention en matière de politique concurrentielle et s'opposent ainsi aux préconisations de l'école d'Harvard.
L'économie industrielle va de nouveau se développer dans les années 1980-1990, notamment avec les travaux de Tirole (1988). L'apparition de nouveaux cadres d'analyse tels que celui de la théorie des jeux permet d'introduire les interactions stratégiques entre les entreprises et de modéliser ainsi des jeux non coopératifs auxquels les entreprises sont parfois confrontées et qui étaient jusqu'ici ignorés par les différents courants de pensée. Cette modélisation permet en particulier de considérer les structures de marché oligopolistiques avec asymétries d'information. Ce courant remet ainsi en question le paradigme SCP précédemment établi par l'école d'Harvard, jugé incapable de retracer la réalité et la complexité des marchés.
Finalement, si une grande partie des économistes se rejoint sur les bienfaits de la politique concurrentielle, il existe encore de vives interrogations quant à sa forme et son intensité. De plus, si les marchés des biens et services sont correctement appréhendés par les différentes théories, ce n'est pas le cas du marché bancaire, jugé "spécial" du fait de ses caractéristiques propres (rôle de l'information sur le secteur bancaire, risque d'apparition de crises à caractère systémique). Dans ce contexte, les recommandations en matière d'intervention de la politique concurrentielle sur le marché bancaire doivent aussi être appréhendées différemment.

La concurrence dans le secteur bancaire

La concurrence sur le marché bancaire est jugée "spéciale" du fait du rôle joué par les imperfections de marché et de son extrême vulnérabilité aux potentielles instabilités.

Concurrence bancaire et disponibilité des crédits

La question de la concentration et de ses implications pour la disponibilité des crédits fait l'objet d'un important débat, à la fois théorique et empirique dans la littérature. Ce débat existe notamment du fait du rôle important joué par l'information dans ce secteur. En effet, comme le démontre Akerlof (1970), la concurrence sur le marché peut ne pas conduire à des résultats efficaces si l'information est asymétrique. Si Akerlof (1970) le démontre avec le marché des voitures d'occasion, Stiglitz and Weiss (1981) l'appliquent au marché bancaire. En effet, les asymétries informationnelles sur le marché bancaire existent car l'emprunteur a une meilleure connaissance de son projet d'investissement que le prêteur. De cette asymétrie résulte les phénomènes bien connus d'aléa moral et d'antisélection. Une hausse du coût du crédit conduirait les investisseurs aux projets les moins risqués à abandonner leurs projets d'investissement (antisélections) ou à conserver leurs projets les plus risqués afin de bénéficier d'un meilleur rendement (aléas moral). Ainsi, un prêteur qui ne parviendrait pas à évaluer le risque d'un projet d'investissement pourrait choisir de rationner le crédit. Les banques sont apparues afin de limiter les problèmes d'asymétrie d'information entre les prêteurs et les emprunteurs ce qui confirme leur caractère "spécial". Comment la concurrence bancaire pourrait-elle influencer les conditions de crédit ? Sous certains aspects, la concentration bancaire devrait entraîner un durcissement des conditions d'octroi de crédit. Cette vision est notamment présentée par Pagano (1993) et Guzman (2000) et porte le nom d'*hypothèse de pouvoir de marché*. Dans une seconde approche, celle de l'*hypothèse d'information*, l'accroissement de la concentration bancaire devrait au contraire assouplir ces conditions. Cette deuxième approche est basée sur le rôle joué par les relations de crédit entre prêteurs et emprunteurs. Il apparaît qu'un marché bancaire concentré impliquerait un environnement plus propice pour former des relations de clientèle stables, ce qui assouplirait les conditions d'octroi de crédit (Petersen and Rajan, 1994, 1995; Dell'ariccia and Marquez, 2006).

Des travaux empiriques ont été menés afin de tester ces deux hypothèses. Une première série d'étude valide l'*hypothèse de pouvoir de marché*. Par exemple, Beck et al. (2004) trouvent qu'une forte concentration du marché bancaire – mesurée par les parts de marché des trois plus grandes banques domestiques - accroît les obstacles pour obtenir des prêts mais uniquement dans les pays à faible développement économique et institutionnel. Dans la même lignée, les travaux de Love and Martínez Pería (2015) donnent les mêmes conclusions avec l'utilisation de l'indice de Lerner [6] et de Boone [7] comme mesures de la concentration du marché bancaire. Cependant, ils trouvent que la relation négative entre la concentration du marché bancaire et la disponibilité des crédits dépend de l'environnement dans lequel évoluent les banques. Certaines caractéristiques de l'environnement telles qu'un développement financier accru et de meilleurs outils de partage de l'information en matière de crédit, peuvent atténuer l'impact négatif de la faible concurrence. Les travaux de Leon (2015) utilisent des données d'entreprises de pays émergents et trouvent que les contraintes de crédits des entreprises sont atténuées par la concurrence. Enfin Carbó-Valverde et al. (2009) utilisent des données d'entreprises pour l'Espagne et montrent l'existence d'une relation négative entre la disponibilité des crédits et le pouvoir de marché de la banque lorsque le pouvoir de marché est mesuré via l'utilisation du Lerner. Toutefois, cette relation s'inverse dès lors que l'on utilise un autre indicateur tel que le Herfindal Hirschman Index (HHI) [8].

Une autre série de travaux empiriques valide l'*hypothèse d'information*. C'est le cas notamment des travaux de Marquez (2002). Il montre que les informations détenues sur les emprunteurs sont plus dispersées dans les marchés bancaires fortement concurrentiels. L'existence d'asymétries d'information conduit les banques à durcir les conditions de cré-

6. L'indice de Lerner est une mesure du pouvoir de marché, calculé comme la différence entre le prix de production et le coût marginal (rapportée au prix).

7. L'indice de Boone est une mesure du degré de compétition, calculé comme l'élasticité des profits rapportée au coût marginal.

8. L'indice HHI est une mesure de concentration du marché, calculée comme la somme des carrés des parts de marché des banques concurrentes sur le marché.

dits. Zarutskie (2006) montre que les jeunes entreprises ont un historique de crédit restreint ce qui accroît leur difficulté à obtenir des prêts. Cette relation est d'autant plus vraie que le marché est fortement concurrentiel. Cetorelli and Gambera (2001) et Bonaccorsi di Patti and Dell'Ariccia (2004) trouvent qu'une forte concentration du marché bancaire est positivement corrélée avec la croissance des secteurs industriels plus dépendants de la finance externe. Enfin, Fungáčová et al. (2017) utilise un panel de 20 pays européens sur la période 2001-2011 et montrent qu'une concurrence bancaire accrue augmente le coût du crédit, en particulier pour les petites entreprises.

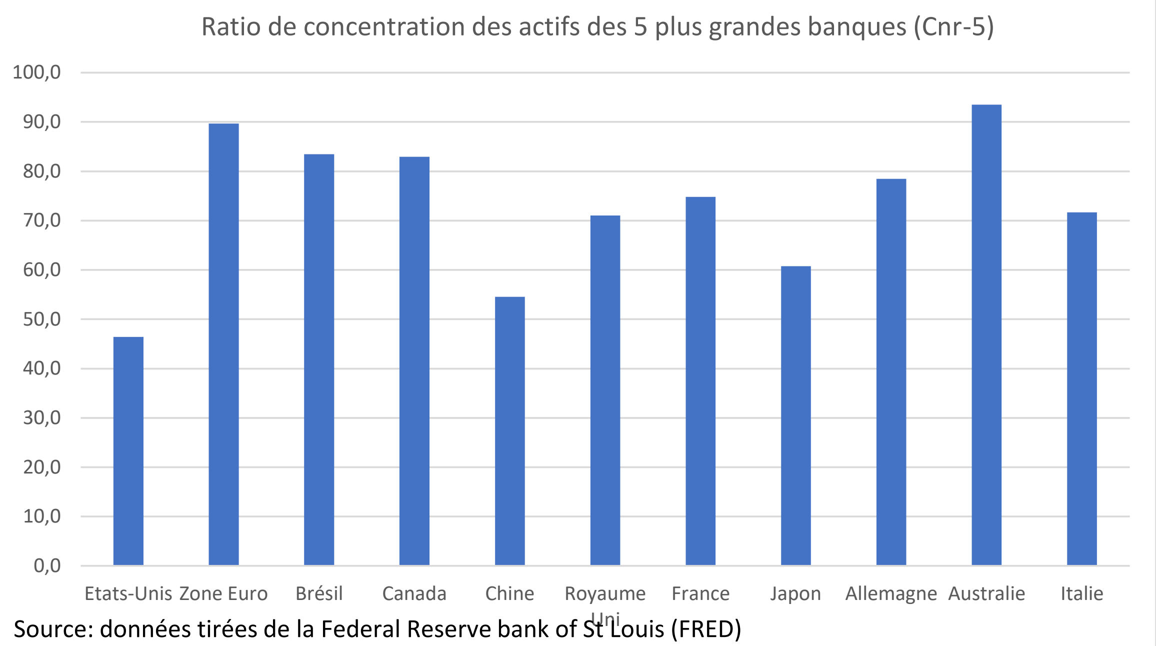
Le premier chapitre de cette thèse étudie empiriquement la relation entre la concurrence bancaire et la disponibilité du crédit pour les entreprises de la zone euro sur la période 2010-2016. Il se différencie de la littérature existante en utilisant une méthode innovante consistant à relier chaque entreprise à son banquier principal. Cette méthode permet de tester de quelle manière le pouvoir de marché de chaque banque (mesuré par l'indice de Lerner) affecte les conditions de crédit des entreprises qu'elle finance. Nous pouvons ainsi considérer la concurrence bancaire à un niveau local alors qu'elle était appréhendée à un niveau régional ou national par les précédentes études. De plus, le raffinement des données dont nous disposons permet de différencier l'effet des parts de marché des banques sur la disponibilité du crédit en fonction des caractéristiques des entreprises et des banques. Finalement, nos résultats sont en ligne avec l'*hypothèse de pouvoir de marché*, selon laquelle un accroissement de la concentration bancaire conduit à un durcissement des conditions de crédit.

Concurrence bancaire et stabilité financière

L'instabilité du secteur financier tient particulièrement à la principale raison d'être des banques mise en avant par Gurley and Shaw (1960). En effet, l'introduction des intermédiaires financiers a pour but de fournir des liquidités aux agents en déficit de financement, et dans ce contexte, doit faire correspondre les préférences des agents, en termes de maturité et de risque. La banque collecte des capitaux à court terme auprès des agents à capacité de financement, averses au risque, et redistribue des capitaux à long terme aux agents en besoin de financement. Ainsi elle transforme la maturité des liquidités et mutualise le risque. Toutefois, cette mission fait peser sur la banque un ensemble de risques, dont les plus notables sont le risque de liquidité et le risque de crédit. Le risque de crédit apparaît lorsqu'un grand nombre d'emprunteurs font défaut, d'où l'importance pour la banque de sélectionner en amont les projets d'investissement. Le risque de liquidité survient lors de retraits soudains des fonds par les déposants ne permettant plus à la banque d'honorer les demandes de remboursement. Le marché bancaire se révèle ainsi source d'instabilité. Historiquement, il a été à l'origine de nombreuses crises financières, devenues crises systémiques par phénomènes de contagion. La plus notable et la dernière en date étant la crise financière de 2008, survenue à la suite d'un dérèglement sur le simple marché des prêts hypothécaires Américain.

Une fois admis l'instabilité et la fragilité du secteur bancaire, la question est de savoir si la concurrence bancaire peut influencer la prise de risque des principaux acteurs financiers. Là encore, la réponse ne fait pas consensus dans la littérature. A ce titre, deux visions ont émergé. D'un côté la *concurrence-fragilité* qui fait valoir une relation négative entre la concurrence et la stabilité financière (Keeley, 1990; Allen and Gale, 2004). L'argument principal étant qu'une concurrence accrue sur le marché bancaire entraîne une baisse des marges d'intermédiation incitant ainsi les banques à accroître leur prise de risque. Opposés à cette vision, on trouve les tenants de la *concurrence – stabilité*. Ils reprochent à la *concurrence-fragilité* de ne pas prendre en compte l'effet des parts de marché. Ainsi, ils prônent qu'un marché bancaire concentré renforce le pouvoir de marché ce qui permet aux banques d'augmenter leurs taux d'intérêt incitant les emprunteurs à prendre plus de risques via un effet d'aléa moral (Boyd and de Nicoló, 2005). Si les conclusions sont contrastées au niveau théorique, c'est aussi le cas des analyses empiriques. Il existe une vaste littérature reliant la concurrence bancaire avec des mesures d'exposition au risque de la banque mais les résultats ne font pas consensus. En lien avec la vision de la *concurrence – fragilité*, les travaux de Beck et al. (2006) définissent l'occurence des crises bancaires comme un indicateur de fragilité. Ils trouvent que le ratio de concentration bancaire (HHI) est négativement lié à la probabilité d'une crise bancaire. Alors que la concurrence bancaire baisse les marges bénéficiaires des banques, celles-ci sont encouragées à effectuer des investissements plus risqués afin d'accroître leurs bénéfices. Cependant, certains travaux empiriques suggèrent, au contraire, qu'un secteur bancaire plus concentré pourrait aggraver l'instabilité du système financier. Berger et al. (2009a) montrent à partir d'une étude sur les banques russes, sur la période 2001- 2007, qu'un resserrement de la concurrence (mesuré par l'indice de Lerner) accroît la fréquence des faillites bancaires, ce qui conforte la vision de la *concurrence-stabilité*. Ainsi, même au niveau empirique, les résultats ne semblent pas confirmer ou infirmer l'une ou l'autre des deux théories.

Le second chapitre de cette thèse contribue à cette littérature en analysant l'effet de la concurrence bancaire sur la stabilité financière et le bien-être des ménages dans un cadre d'équilibre général. En comparant les mécanismes de transmission des chocs économiques et financiers selon quatre types de concurrence bancaire (concurrence pure et parfaite, concurrence monopolistique, oligopole de Cournot et oligopole de Bertrand), nous trouvons que l'oligopole atténue la transmission des chocs financiers renforçant ainsi la stabilité financière. De plus, notre cadre d'analyse permet d'introduire le nombre de banques dans la détermination des marges d'intermédiation. Une variation du nombre de banques modifie ainsi la transmission des chocs économiques et financiers. Finalement, nous trouvons que la concentration du marché bancaire renforce la stabilité financière et accroît le bien-être des ménages, validant ainsi la vision de la *concurrence-fragilité*.



Source: données tirées de la Federal Reserve bank of St Louis (FRED)

L'absence de consensus sur les bienfaits de la concurrence sur le marché bancaire laisse planner un doute quant aux bienfaits de la mise en place d'une politique concurrentielle (ou non) sur ce marché. Si les évidences empiriques récentes montrent que la plupart des pays industrialisés ont un marché bancaire concentré (Fig.0.1), la question visant à stimuler ou non la concurrence dans le secteur bancaire garde toute son importance.
Pour certains pays, la concentration du marché bancaire résulte de la politique macro prudentielle à l'œuvre. C'est le cas par exemple du Canada et de l'Australie où les décideurs politiques maintiennent un marché bancaire concentré prenant pour argument la stabilité financière engendrée par cette concentration. Depuis le début des années 1920 jusqu'a la fin des années 1980, le Canada s'est efforcé de maintenir un oligopole dans le secteur bancaire montrant ainsi des résultats en terme de stabilité financière supérieurs à ceux des pays cherchant à éviter la concentration bancaire. Ces résultats sont en liens avec les travaux de Amable et al. (1997). Ils montrent, à l'aide d'un modèle de croissance endogène, que les réglementations visant à instaurer des barrières à l'entrée du marché bancaire sont sources de stabilité financière et de bien-être social. De plus, les évidences empiriques récentes du Canada et de l'Australie montrent encore aujourd'hui une forte concentration du marché bancaire. En 2015, plus de 80% des prêts et dépôts sont détenus par les 5 plus grandes banques (voir Fig.0.1). Ces evidences s'expliquent par les politiques mises en place par les autorités, visant à mixer une politique concurrentielle interdisant la fusion des grandes banques entre elles avec une politique de stabilité visant à maintenir une structure bancaire oligopolistique. La réglementation bancaire dans ces pays semble avoir porté ses fruits en matière de stabilité financière, ceux-ci ayant montré une plus grande résilience à la crise financière de 2008 (Bakir, 2017). Afin de justifier la mise en place de ce type de politique, notre deuxième chapitre analyse la relation entre concurrence bancaire, stabilité financière et bien-être social.
Au-delà de cette constatation, la question de la concurrence sur le marché bancaire fait l'objet d'un débat d'actualité en Europe qui confronte les partisans et les opposants à l'Union bancaire. Les fusions et acquisitions promettant des économies d'échelle dans la production de services financiers (Wheelock and Wilson, 2012; Hughes and Mester, 2013), les banques européennes voient de plus en plus la consolidation comme une réponse stratégique à la concurrence croissante des grands prêteurs américains et des grands groupes du marché du crédit, de l'assurance et de la gestion de patrimoine (Carstens, 2018; Arnold et al., 2018). En outre, la transition vers une union bancaire et la création d'un marché bancaire commun renforcent les incitations à la consolidation bancaire transfrontalière dans l'UE (Schoenmaker, 2015). Certains décideurs politiques se félicitent de la consolidation bancaire transfrontalière, considérée comme un vecteur d'intégration financière et comme un moyen de réduire les capacités excédentaires (Nuoy, 2017). Cependant, on se préoccupe moins des conséquences négatives d'une plus grande concentration des banques sur l'accès des entreprises au crédit alors même que la consolidation bancaire a longtemps été associée à une réduction de la disponibilité des crédits, en particulier pour les petites et moyennes entreprises (PME) (Berger et al., 1998; Bonaccorsi Di Patti and Gobbi, 2007).

Compte tenu de la contribution importante des PME à l'emploi et à la production dans un grand nombre de pays européens, une concentration accrue dans le secteur bancaire européen pourrait donc avoir des coûts économiques importants (Berger et al., 2017). Afin de contribuer au débat sur l'union bancaire, notre premier chapitre analyse empiriquement la relation entre concurrence bancaire et disponibilité des crédits des entreprises.

0.3 Préférences des agents vis-à-vis du risque et du temps

Si la plupart des modèles macroéconomiques considèrent les préférences à l'égard du risque et du temps comme des paramètres constants, de nombreux travaux d'économie comportementale se sont développés, remettant en cause cette hypothèse. Ainsi, après avoir rappelé quelques notions concernant la modélisation de ces paramètres, nous présentons les développements récents liés aux préférences pour le risque et le temps. Cela nous amène à évoquer notre seconde question de recherche : Quel est l'effet des préférences inter et intra temporelles sur le cycle des affaires ?

Modélisation des préférences

Les décisions économiques des agents dépendent de leurs préférences. La littérature admet communément deux types de préférence, les préférences liées au temps et celles liées au risque (Weil, 2002). Les préférences liées au temps donnent lieu à un lissage inter-temporel de la consommation alors que celles liées aux risques donnent lieu à un lissage de la consommation entre deux états de la nature. [9] Dès lors que l'économie est modélisée dans un cadre dynamique, les questions de lissage inter-temporel montrent toute leur importance. Un individu est dit averse aux fluctuations inter-temporelles s'il ne désire pas voir sa consommation varier dans le temps. Mathématiquement, cela correspond à considérer une fonction d'utilité concave [10].
Les modèles macroéconomiques traditionnels utilisent communément les fonctions d'utilité de type CRRA (constant relative risk aversion) pour modéliser les coefficients de préférence

9. Un individu averse au risque ne désirera pas voir sa consommation varier selon que l'un ou l'autre des états de la nature se réalise. Par exemple, "est averse au risque un individu qui ne désire pas voir sa consommation varier selon que sa maison est brulée ou non, que sa monnaie se déprécie ou non" (Weil, 2002).

10. La concavité de la fonction est calculée par le rapport que Arrow (1962) et Pratt (1964) nomment le coefficient d'aversion relatif pour le risque (RRA).

à l'égard du risque et du temps[11]. Cette fonction d'utilité admet une relation négative et de même intensité entre ces deux types de lissage de telle sorte que l'inverse du coefficient d'aversion pour le risque (RRA) soit égal à l'élasticité de substitution inter-temporelle (EIS).

Les développements récents liés à la notion de préférence

Un certain nombre d'hypothèses, mises en avant par la littérature, peuvent être avancées concernant l'aversion des agents. Nous en relevons trois types.
La première hypothèse consiste à remettre en cause la relation de même intensité entre le coefficient RRA et le coefficient EIS. Cette distorsion a été mise en avant par Weil (2002) qui affirme dans son analyse qu'un agent peut être à la fois neutre au risque et désirer conserver un profil de consommation lissé à travers le temps. C'est ce constat qui a donné naissance à la fonction d'utilité Epstein and Zin (1989) qui permet, par sa structure, de différencier les deux coefficients de sorte que les deux désirs de lissage ne soient pas liés. Malgré la multiplication des travaux théoriques et empiriques sur ce sujet, nous ne prenons pas en compte cette dimension. Nous supposons un choc affectant dans le même sens et avec la même intensité les deux types d'incertitudes ce qui nous permet ainsi de modéliser une situation d'après crise où les individus seraient à la fois plus averses au risque et au temps. Cela simplifie également la résolution et l'estimation du modèle.
La deuxième hypothèse consiste à admettre des coefficients de préférences hétérogènes entre les agents. Les degrés d'aversion pour le risque et pour le temps dépendraient des caractéristiques des agents. C'est notamment le cas des travaux de Guiso and Paiella (2008) et de Alan and Browning (2010). S'attachant principalement à la dimension d'aversion pour le risque, ils montrent que l'aversion au risque diffère d'un individu à l'autre et que ces différences sont essentielles pour expliquer l'hétérogénéité des comportements entre individus. Enfin, Attanasio and Weber (1989) ainsi que Vissing-Jørgensen (2002) font l'hypothèse d'un coefficient hétérogène pour l'EIS.
La troisième hypothèse concerne la constance de ces coefficients (RRA et EIS). En effet, si la littérature macroéconomique traditionnelle considère par construction que ces coefficients sont constants dans le temps, cette hypothèse est remise en question par les travaux de Malmendier and Nagel (2011) et de Cohn et al. (2015) qui affirment le caractère contracyclique des préférences. En effet, l'aversion au risque serait gouvernée par la peur. Or, la peur dépend des circonstances conjoncturelles et peut être modifiée au cours de la durée de vie de l'agent (à la suite par exemple d'un changement de la conjoncture économique, en fonction d'éléments de la vie : naissance, décès, maladie. . .). Dans ce contexte, l'hypo-

11. Ce type de fonction prend la forme suivante :

$$u_c = \frac{c^{1-\sigma}}{1-\sigma} \tag{0.1}$$

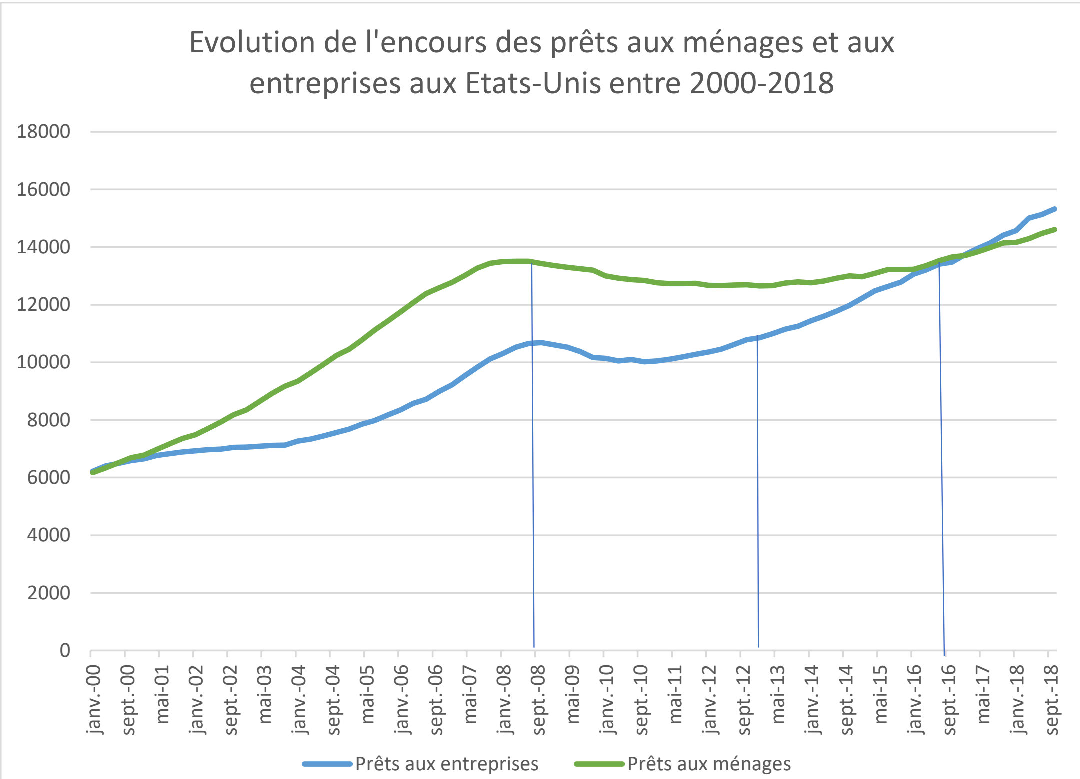
avec u_c la fonction d'utilité, c la consommation et σ le coefficient d'aversion relatif pour le risque.

thèse de paramètres constants peut être remise en cause. Ainsi, la variabilité temporelle du coefficient d'aversion est de plus en plus prise en compte dans les modèles macroéconomiques mais très peu de travaux, à notre connaissance, l'introduisent dans un cadre DSGE (Benchimol, 2014; Bretscher et al., 2019; Torul, 2018).

Le troisième chapitre de cette thèse introduit ainsi ces hypothèses dans un modèle DSGE. Il se différencie des modèles existants en considérant un coefficient d'aversion hétérogène entre quatre types d'agent (ménages épargnants, ménages emprunteurs, entrepreneurs et banquiers) alors qu'il était jusqu'à présent uniquement modélisé pour les ménages. De plus, l'hypothèse de variabilité temporelle du coefficient nous permet d'introduire un choc de RRA pour chaque agent et d'étudier son effet sur le cycle économique.

Quel est l'effet des préférences inter et intra temporelles sur le cycle des affaires ?

La crise de 2008 a fait chuter l'encours des crédits bancaires pour les entreprises et les ménages. Il faudra attendre 2012 pour que les crédits aux entreprises retrouvent leur niveau d'avant crise, et la fin de l'année 2016 pour les crédits aux ménages (voir Fig.0.2) ; cela, alors même que la Fed mène une politique monétaire ultra accommodante et use de mesures dites "non conventionnelles" pour relancer le crédit. La modification des préférences des agents peut être avancée comme un argument justifiant la lenteur de la reprise. En effet, au lendemain d'une crise économique, les prêteurs apparaissent moins enclins à prêter et les emprunteurs, moins enclins à emprunter. Les travaux de Delis et al. (2014) vont dans ce sens. Les auteurs utilisent des mesures d'enquête sur la confiance des consommateurs et des entreprises et montrent que les prêts bancaires réagissent négativement à l'anxiété des agents. Ainsi, un changement dans les préférences des agents (à l'égard du risque et du temps), qui peut survenir à la suite d'une crise économique par exemple (Cohn et al., 2015), devrait influencer leurs comportements. Les agents averses vont choisir de se protéger contre les variations de revenu et prennent ainsi des décisions qui influencent l'emprunt, la consommation et l'investissement. Si les effets d'une variation des préférences sont analysés dans le cadre d'équilibres partiels ou statiques, la littérature laisse peu de place à l'analyse de cette notion dans des modèles dynamiques d'équilibre général. Ainsi, le troisième chapitre introduit dans le cadre d'un modèle DSGE, un paramètre de préférence pour le risque et le temps, hétérogène et variable dans le temps, nous permettant ainsi d'étudier son effet sur la dynamique de l'ensemble de l'économie.



Source: données tirées de la Federal Reserve bank of St Louis (FRED)

0.4 Problématique et structure de la thèse

Les deux premiers chapitres de cette thèse apportent des réponses à la fois théoriques et empiriques sur la nature de la relation entre la concurrence bancaire et la disponibilité des crédits d'une part, et entre concurrence bancaire, stabilité financière et bien-être social d'autre part. Ces travaux visent à répondre à notre première question de recherche : faut-il favoriser la concurrence dans l'industrie bancaire ? Le premier chapitre de la thèse analyse empiriquement l'effet de la concurrence bancaire sur la disponibilité des crédits. Le deuxième chapitre analyse l'effet de la concurrence sur la stabilité financière et le bien-être social à l'aide d'un modèle DSGE non linéaire.
Le troisième chapitre vise a répondre à notre seconde question de recherche : quel est l'effet des préférences inter et intra temporelles sur le cycle des affaires ? Les hypothèses d'hétérogénéité et de variabilité temporelle des degrés d'aversion au risque et au temps sont introduites dans un modèle DSGE non linéaire. La prise en compte de ces hypothèses nous permet dans un premier temps de mesurer l'effet d'un changement des préférences sur la transmission des chocs économiques et financiers, et dans un deuxième temps, d'analyser l'effet d'un choc d'aversion sur les principales variables macroéconomiques
Les trois chapitres, les méthodes utilisées ainsi que les principaux résultats sont résumés ci dessous.

Chapitre 1 : Does bank market power worsen credit conditions ? Bank-firm level evidence from Euro Area [12]

Les arguments en faveur d'une consolidation accrue des activités bancaires européennes dans plusieurs pays européens ont ravivé le débat sur les effets de la concurrence bancaire sur l'allocation de crédit. Nous contribuons à cette littérature en testant l'effet du pouvoir de marché des banques sur les conditions de crédit des entreprises en utilisant une base de données au niveau des banques - 900 banques appariées à près de 60 000 entreprises - couvrant 11 pays de la zone euro entre 2010 et 2016. Nous constatons que les entreprises financées par des banques à fort pouvoir de marché obtiennent moins de crédit bancaire, comptent davantage sur les crédits fournisseurs (trade credit) et font face à des coûts de financement plus élevés que les entreprises financées par des banques à faible pouvoir de marché. L'effet négatif du pouvoir de marché des banques est plus important pour les petites entreprises opaques, mais plus petit pour les entreprises financées par des banques communautaires petites et locales. Les résultats concordent avec *l'hypothèse de pouvoir de marché*, selon laquelle une faible concurrence bancaire aggrave les conditions de crédit des entreprises, et suggèrent qu'une plus grande consolidation bancaire dans la zone euro pourrait avoir des conséquences négatives en termes de disponibilité de crédit.

12. Pietro Grandi and Caroline Ninou Bozou, "Does bank market power worsen credit conditions ? Bank-firm level evidence from Euro Area" (Working paper, LEMMA, septembre 2019)

Chapitre 2 : On the desirability of banking competition [13]

La crise financière a conduit à s'interroger sur la transmission des chocs financiers à l'économie réelle. Dans ce contexte, la structure du marché bancaire peut apparaitre comme un rempart, ou un vecteur de la crise financière. Dans le cadre de la vision traditionnelle *concurrence-fragilité*, une hausse de la concurrence sur le marché bancaire devrait mener à une baisse des marges et donc une prise de risque accrue des intermédiaires financiers. Cette vision s'oppose à la *concurrence-stabilité* qui considère qu'une hausse de concurrence bancaire entraine une baisse des taux d'intérêt conduisant les emprunteurs à choisir des projets d'investissement moins risqués. Ce chapitre contribue à cette littérature en comparant quatre types de compétitions bancaires, modélisées dans un cadre DSGE non linéaire avec frictions financières : la concurrence parfaite, la concurrence monopolistique, l'oligopole de Cournot et l'oligopole de Bertrand. Le but de ce travail est de déterminer la structure du marché bancaire qui permet de mieux préserver l'économie des chocs financiers et maximiser ainsi le bien-être social. Le résultat de nos simulations révèle que la structure du secteur bancaire est déterminante dans la transmission des chocs. En particulier, les chocs financiers sont atténués dans un contexte bancaire oligopolistique favorisant ainsi la stabilité financière et le bien-être des ménages. Ces résultats sont renforcés à mesure que le marché est concentré. Ce chapitre contribue ainsi au débat, en se positionnant du côté de la vision de la *concurrence-fragilité*, justifiant ainsi les interventions politiques visant à renforcer la concentration du marché bancaire.

Chapitre 3 : Risk aversion, Credit and Banking : A nonlinear DSGE perspective [14]

Les développements récents de l'économie comportementale apportent les évidences d'un coefficient de préférence pour le risque et le temps hétérogène et variable dans le temps. Intégrant ces deux hypothèses dans un modèle Dynamique Stochastique d'Equilibre General non linéaire, nous différencions ce coefficient entre les ménages, les entreprises et les banquiers afin d'évaluer son influence sur le cycle économique. En estimant notre modèle via l'utilisation de méthodes Bayesiennes, nous confirmons la nature hétérogène et variable dans le temps des préférences. De plus, nous analysons deux catégories de résultats. La première consiste à simuler notre modèle en faisant varier le paramètre d'aversion pour chacun des agents respectivement. Ainsi, nous étudions la transmission des chocs économiques et financiers sous différents scenarii d'aversion. La deuxième consiste à évaluer l'impact d'un choc d'aversion sur le cycle des affaires. Finalement, l'aversion pour le risque des agents s'avère être un indicateur essentiel pour les décideurs. En effet, un niveau d'aversion au

13. Caroline Ninou Bozou, "On the desirability of banking competition" (Working paper, LEMMA, septembre 2019)

14. Caroline Ninou Bozou and Jonathan Benchimol, "Risk aversion, Credit and Banking : A nonlinear DSGE perspective" (Working paper, LEMMA, septembre 2019)

risque accru atténue généralement la réaction de la production aux chocs économiques et financiers. D'autre part, un choc d'aversion au risque positif influence considérablement l'économie réelle. Ce choc a également un effet sur les taux d'intérêt des banques centrales et des banques de détail par le biais d'un lissage de la consommation et de comportements de désendettement.

1 Chapter I: Does bank market power worsen credit conditions? Bank-firm level evidence from the Euro Area

1.1 Introduction

Does bank competition, or the lack thereof, hinder firms' access to credit ? Unlike most industries, the peculiar features inherent to the banking business and the key role of information preclude giving a straightforward answer. Indeed, economic theory makes conflicting predictions as to the relation between bank competition and credit availability. On the one hand, *the market power hypothesis* holds that weaker competition leads to lower and more expensive allocation of credit to firms (Pagano, 1993; Freixas and Rochet, 2008). On the other hand, the *information hypothesis* argues that banks are more likely to form long-term relationships with borrowers when operating in a non-competitive market. Strong competition between banks would then discourage relationship lending and impair firms' access to credit (Petersen and Rajan, 1994, 1995).

Given the existence of multiple theoretical predictions, determining how bank competition affects credit conditions remains an empirical issue, whose policy relevance is heightened in the context of revived interest in banking consolidation across the European Union (EU). As mergers and acquisitions hold promise for economies of scale in the production of financial services (Wheelock and Wilson, 2012; Hughes and Mester, 2013) European banks increasingly see consolidation as a strategic response to increasing competition from large U.S. lenders and big technology groups in the market for credit, insurance and wealth management (Carstens, 2018; Arnold et al., 2018). In addition, the move to a Banking Union and the creation of a common banking market increases the incentives for cross-border banking consolidation in the EU (Schoenmaker, 2015). Lastly, there is a widespread concern that the EU's over-reliance on banks has adverse implications for financial stability (Langfield and Pagano, 2016).[1] As a result, some policy makers welcome cross-border banking consolidation either as a vector of financial integration and as a way to reduce excess capacity (Nuoy, 2017). However, less attention is devoted to the potential negative implications of greater bank concentration in terms of firms' access to credit. Indeed, bank consolidation has long been associated to a reduction in lending availability, especially for small and medium enterprises (SMEs henceforth) (Berger et al., 1998; Bonaccorsi Di Patti and Gobbi, 2007). Given SMEs' large contribution to employment and output, higher concentration in European banking may thus have significant economic and social costs (Berger et al., 2017).[2]

In this paper we empirically investigate the impact of inter-bank competition on firms' access to credit using a database that matches almost 60.000 firms to 900 banks located in the euro area over the period 2010-2016. The structure of the data allows to directly test how a bank's market power – as measured by the Lerner index at the bank level – affects

1. The EU banking market is large by international standards : as of 2017 total banking assets accounted for 280% of GDP. By comparison, total assets of the US banking sector accounted for just 88% of GDP (Nuoy, 2017).

2. In 2017 SMEs contributed to 56.8% of value added and employed 66.6% of the work force in the EU (European Commission, 2017).

the credit availability of its customer firms. As in Amiti and Weinstein (2011) and Berger et al. (2017), our empirical strategy exploits the fact that some firms within an industry in a particular year borrow from banks with relatively high market power, while others borrow from banks with relatively low market power. We then use this within-industry-year variation to isolate how a firm's access to credit relates to its lender's market power. Insofar industry-year fixed effects absorb all time-varying industry supply-and-demand shocks shared by all firms within an industry, our strategy identifies how banks' market power affect their corporate customers' credit outcomes, while controlling for balance sheet characteristics at the firm and bank level.

Our results indicate that bank market power is associated with worse credit conditions for borrowing firms. Within the same industry-year, firms served by banks with high market power obtain less bank credit (both short and long-term), rely more on trade credit and face higher funding costs than firms served by banks with low market power. Importantly, the opposite effect on quantity and price of credit indicates that high market power translates into restrictions in loan supply by banks rather than lower credit demand by firms. Moreover, we find important heterogeneities across firms and banks. Among firms served by banks with high market power, small and opaque firms obtain less credit than large and transparent firms. Bank market power is also associated with more trade credit and higher funding costs for opaque firms. On the other hand, the reduction in credit availability associated with high bank market power is mitigated for firms served by small and local community banks, a finding partly supportive of the information hypothesis, whereby low competition increases banks' incentive to supply relationship loans. Nevertheless, the predominance of medium-large commercial banks lending to SMEs in our sample determines that the overall effect of bank market power on credit conditions is unequivocally adverse for most firms.

This paper is related to the broad literature assessing the relationship between bank competition and firms' access to credit. A direct application of standard to economic theory to the banking industry, the market power hypothesis maintains that weak competition between banks leads to restricted credit allocation at a higher price (Freixas and Rochet, 2008) by engendering X-inefficiencies in the absorption and intermediation of resources (Pagano, 1993; Guzman, 2000) and by stifling the pressure for innovation and the expansion of financial services to the pool of borrowers excluded from institutional finance (Vives, 2001).[3] By contrast, the information hypothesis argues that lower inter-bank competition is associated with higher credit availability. This view is centred on credit relationships between lenders and borrowers : since limited competition encourages relationship building and inter-temporal sharing of surplus between banks and firms, a monopolistic lender may be more willing to offer credit than a similarly placed lender in competitive market

3. In a model where banks have some monopoly power, each bank sets its credit supply so that Lerner indices are equal to inverse elasticities. Low inter-bank competition implies lower demand elasticities, which in turn widens the equilibrium markup rate on loans (Freixas and Rochet, 2008).

(Petersen and Rajan, 1994, 1995; Dell'ariccia and Marquez, 2006).[4] In this respect, this paper adds to the empirical research that test both theoretical predictions. Among studies that find evidence for the market power hypothesis, Beck et al. (2004) show that bank concentration – as measured by banking regulatory policies and by the market share of the largest three domestic banks – increases firms' reported obstacles to obtain finance in developed and developing countries. Similarly, Love and Martínez Pería (2015) find bank concentration – as captured by the Lerner and Boone indexes at the country level – to be negatively associated with firms' reported access to credit but significantly less so in countries with more developed private credit information sharing schemes. Leon (2015) uses firm level data on developing and emerging countries and finds that firms' credit constraint appears to be alleviated by bank competition. Using firm level data on Spanish SMEs matched to regional bank data, Carbó-Valverde et al. (2009) study how bank market power affects firm's reliance on trade credit – a proxy for financial constraint – and document a negative association between bank market power and credit availability when banks' competition is captured by the Lerner index, while results are reversed if the Herfindahl–Hirschman Index (HHI) is employed instead.[5] Other studies provide evidence according to the information hypothesis. Marquez (2002) shows that borrower-specific information tends to become more dispersed in more competitive banking systems, thus entailing a less efficient screening of borrowers and higher lending rates. Using U.S. Internal Revenue Service data on small firms, Zarutskie (2006) finds that newly formed firms have significantly less outside debt in more competitive banking markets, and suggests stronger competition may discourage lenders from financing new firms with unknown credit quality. Cetorelli and Gambera (2001) and Bonaccorsi di Patti and Dell'Ariccia (2004) find that higher concentration is positively related to growth in industrial sectors more dependent on external finance. More recently, using a panel of firms from 20 European countries covering the period 2001-2011, Fungáčová et al. (2017) find that stronger bank competition – measured by country-level metrics – increases firms' cost of credit, particularly for small companies.

We make two distinct contributions to this literature. First, to the best of our knowledge this is the first study using bank-firm level data to measure the effect of bank competition on corporate credit conditions.[6] Bank-firm level data allow us to measure directly how a

4. As noted by Mayer (1988) and Petersen and Rajan (1995), a monopolistic lender may be able to share in the future surplus of the firm through the future rents the former will be able to extract. For instance, the lender may back-load interest payments over time, so to subsidise the firm in bad times and extracting rents in good times. By contrast, a bank operating in a competitive market would expect a distressed firm may switch to cheaper funding alternatives as soon it recovers financial health, which would discourage the bank to provide funding to begin with.

5. The Herfindahl-Hirschmann index of concentration is the sum of the squares of banks' market shares in terms of total assets, loans or deposits.

6. In this respect we follow Dwenger et al. (2018), Popov and Rocholl (2018) and De Marco (2019) who construct similar bank-firm level databases from similar sources to investigate the transmission of financial shocks from banks to their corporate borrowers.

firm's credit outcomes are related to its reference bank's market power while simultaneously controlling for firm, bank and industry-year factors. In contrast to previous research that measures bank competition either at the country (Beck et al., 2004; Ryan et al., 2014; Love and Martínez Pería, 2015; Fungáčová et al., 2017), region (Carbó-Valverde et al., 2009) or industry level (Bonaccorsi di Patti and Dell'Ariccia, 2004), we use Lerner indexes at the bank level to effectively capture the influence of banks' local market power on customer firms' credit conditions, since the relevant credit market for many banks is likely to be local in nature (Maudos and de Guevara, 2007; Berger et al., 2009b; Drechsler et al., 2017). For these reasons, we consider that this approach refines the measurement of the effect of bank competition on access to credit and improves on the identification strategy of previous studies.

The second contribution of this paper is to uncover important heterogeneities in how bank market power affects credit availability across firms and banks, thereby discerning the relative importance of market power and information effects. As noted by Bonaccorsi di Patti and Dell'Ariccia (2004), if both mechanisms coexist in the data, the aggregate impact of bank competition on firms' credit conditions will reflect their net effect. The use of bank-firm links allows disentangling the market power from the information hypotheses for the latter is predicated upon the importance of relationships between lenders and borrowers. As a result, our evidence corroborates and reconciles the findings that bank market power disproportionately worsens access to credit for small and opaque firms (Beck et al., 2004; Bonaccorsi Di Patti and Gobbi, 2007; Ryan et al., 2014) and that market power vested in community banks has less adverse consequences for corporate borrowers (Berger et al., 2005, 2017). From a policy perspective, our results imply that whether bank competition has an overall positive or negative impact on corporate credit conditions depends on the relative share of SMEs and local community banks in the economy. In this respect, our evidence implies that consolidation involving large banks will have a more detrimental impact on firms' credit conditions than consolidation involving smaller institutions (Berger et al., 2017).

The rest of the paper is structured as follows. In section 1.2 we present our database, while in section 1.3 we lay out our empirical strategy by discussing our choice of the Lerner index as a measure of bank market power (1.3.1), by defining testable predictions (1.3.2) and by presenting our identification strategy and econometric models (1.3.3). We present and discuss results in section 1.4 before offering concluding remarks.

1.2 Data

Our database combines bank data from Orbis Bank Focus with firm data from Amadeus and firm-bank links from Amadeus Banker. [7] Restricting our research to the Euro Area,

7. Orbis Bank Focus (previously Bankscope) contains information on over 40,000 public and private banks around the world, while Amadeus contains financial information on over 24 million public and

we extract annual information on 3.650 banks and 2.056.537 firms and keep only those with unconsolidated accounts or with consolidated accounts but no subsidiaries or affiliated entities. We then match banks to firms using the identity of firms' reference banks provided in Amadeus Banker as in Dwenger et al. (2018) and De Marco (2019).[8] After restricting the sample to banks for which the Lerner index could be estimated (see Section 1.3.1) we obtain a final sample with 59.023 firms matched to 901 banks (i.e. 3% and 25% of the original samples, respectively) covering 11 Euro Area countries for the period 2010-2016.[9]

While Amadeus Banker allows matching firms to banks, we do not observe the price or amount of credit lent by each bank. For the purpose of this paper, we hence consider reference banks reported in Amadeus Banker as the primary institutions from which firms obtain most of short and long-term credit (Ongena et al., 2015; Dwenger et al., 2018) and with which they build lasting relationships in the sense of Petersen and Rajan (1994, 1995).[10] Indeed, activities related to the provision of credit and monitoring allow reference banks and firms to form ties through repeated interaction over time and across multiple financial products. For instance, firms typically hold checking and savings account at their reference bank, while in turn banks support firms' initial public offering. The deep and complex dimension of bank-firm relationships facilitates the storing of information and may increase the availability of funds to the firm. For instance, by monitoring cash flows through its checking account the bank can learn about the firm's sales. In addition, the bank reaches cost efficiencies by spreading the fixed costs related to producing information over multiple products (Petersen and Rajan, 1994, 1995). In this regard, Appendix A.3 provides evidence that firms' total bank borrowing is strongly correlated to loans and key balance sheet variables of their reference banks.

Our database presents some advantages over other sources of firm-bank level data. While syndicated loans market data include only large firms (Ivashina and Scharfstein, 2010; Chodorow-Reich, 2014; Acharya and Steffen, 2015), financial accounts data covers a large number of SMEs (99% of our sample). Credit registry databases do include small firms, but they are only available for individual countries, thus precluding cross-country studies (Jiménez et al., 2012, 2014; Andrade et al., 2018; De Jonghe et al., 2019; Degryse et al., 2019). By using matched financial accounts firms and banks we go beyond a specific

private European companies. Both databases are compiled by Bureau Van Dijk, a Moody's Analytics company.

8. To do so we perform a fuzzy merge using bank names and country locations as reported in each database. We use the Stata ado file reclink2 written by Micheal Blasnik which uses a bigram string comparator to calculate the fraction of consecutive character matches between two string variables. To ensure accuracy, we also perform a clerical review of all matches.

9. Amadeus Banker provides reference banks' names only for a limited number of Euro Area countries. The final sample covers Austria, Cyprus, France, Germany, Ireland, Latvia, Malta, Netherlands, Portugal, Slovenia and Spain – the geographical coverage of the sample is reported in Table A.4. To minimise mismatches, we only keep domestic bank-firm links, i.e. relationships between banks and firms located in the same country.

10. As noted by Dwenger et al. (2018), if bank-firm matches only partly reflect genuine lending relationships, our estimates should be considered as lower bounds.

limitation of alternative sources by obtaining a Euro Area panel of firm-bank relationships that comprises a very large number of SMEs, which are most likely to be bank dependent and therefore sensitive to their banker's degree of market power.

On the other hand, our database has two important limitations. First, we only have information on bank-firm relationships as of 2016. In other words, bank-firm records are a snapshot of relationships at one point in time and are retroactively imputed for previous years. We note however that, using analogous data sources for Germany, Dwenger et al. (2018) show that relationships are very sticky : only 3% of sampled firms ever swap a lender for another, and less than 2% add or interrupt a relationship in any given year. Furthermore, the majority of firms in our sample are SMEs which are more likely to rely on a single lender and to face significant switching costs (Cressy and Olofsson, 1997). Consistent with this view, only 9% of firms in our sample are related to more than one bank. [11] For these reasons, and because our sample period is relatively short (7 years), we regard as tenable the assumption that bank-firm relationships were stable over our period of interest.

Second, we do not observe the amount lent by a bank to a specific firm, but rather the firms' end of year outstanding credit balances due to banks, and have no information on the exact share lent by each bank. We hence assume that the reference bank provides the largest share of bank credit in any given year. Available evidence supports this assumption. For instance, Cressy and Olofsson (1997) note that the main sources of finance for European SMEs are retained earnings, trade credit and credit from a single bank, while Petersen and Rajan (1994) report that US SMEs obtain between 75% and 95% of their loans from their main bank. Considering the bank-based nature of Europe corporate finance and the relative scarcity of non-bank alternatives for small business, these figures are likely underestimates in our Euro Area sample. Furthermore, 91% of firms in our sample are related to a single bank, which further validates our assumption as a reasonable approximation.

1.3 Empirical strategy

Our empirical strategy comprises three building blocks : first, we compute a Lerner index for each bank as a measure of market power (1.3.1) ; second, we specify three predictions based on the information hypothesis (1.3.2) that we set out to test with three econometric models (1.3.3).

1.3.1 Bank market power : the Lerner index

Studying the impact of bank market structure on firms' credit outcomes requires a measure of inter-bank competition. However, there is currently no consensus over the

11. Additionally, multiple-banks firms are on average almost twice as large as single-bank firms : on average, multi-bank firms have 6.1 million worth of total assets, while the figure for single-bank firms is €3.8 million.

best indicator. Broadly speaking, competition metrics can be classified into two categories : structural and non-structural indicators. The former are theoretically rooted in the Structure-Conduct-Performance view whereby bank concentration creates an environment that unfavourably affects bank competitive conduct and favours profitability. Related empirical research commonly uses structural measures of concentration such as the HHI or the n-firm concentration ratio to gauge market power (Berger and Hannan, 1989, 1992). Yet, recent empirical works cast doubts over the reliability of concentration as a proxy for bank competition (Bikker et al., 2012) and for the contestability of the banking sector. In particular, Claessens and Laeven (2004), Schaeck and Cihák (2012) and Love and Martínez Pería (2015) argue that concentration measures market structure rather than market conduct. Furthermore, structural indicators were found to lack consistency and robustness (Berger and Udell, 1995; Rhoades, 1995; Jackson, 1997; Hannan, 1997). In the attempt to remedy these shortcomings, a second category of indicators related to new Industrial Organisation (IO) methods sought to measure competition directly rather than via proxies such as market shares and market structures. These indicators include the Lerner index and the H-statistic based on the Panzar-Rosse model (Panzar and Rosse, 1987).

The Lerner index measures a bank's ability to set its price over the marginal cost and provides a bank-specific measure of market power. By way of interpretation, a bank with Lerner index near zero has little market power, whereas a bank whose Lerner index is close to one is akin to a monopolist. The Lerner index presents multiple advantages over alternative metrics of competition. First, it is the only bank level and time-varying measure of market power in addition to market shares (Beck et al., 2013).However, while the Lerner index is a proxy for current and future profits deriving from pricing power, market shares also capture the implicit rent extracted from being too big to fail, and are thus subject to measurement error as measures of pricing power (Beck et al., 2013). Second, unlike the H-statistic, estimating the Lerner index does not require a banking system to be in long-run equilibrium (Schaeck and Cihák, 2012). Third, unlike market concentration and market shares, the Lerner index does not require specifying a geographic product market (Aghion et al., 2005), a particularly complex task given the extent of transnational banking operations. [12] As our main purpose is to examine the bank-firm level association between competition and access to credit, we follow recent literature (Maudos and de Guevara, 2007; Berger et al., 2009b; Beck et al., 2013; Anginer et al., 2014; Fungáčová et al., 2017) and use the Lerner index as our measure of competition.
Given the estimates of a bank's price and marginal cost, the Lerner index is calculated as :

$$Lerner_{b,t} = \frac{P_{b,t} - \hat{M}C_{b,t}}{P_{b,t}}$$

12. Admittedly, the estimation of the cost function still requires specifying the geographical scope of the market (Beck et al., 2013). Throughout the analysis we use a Lerner index based on a cost function estimated on a country by country basis, and in Section 1.4.1 we show that using a Lerner index based on a cost function estimated at the Euro Area level does not alter our results.

TABLE 1.1 – Correlation between measures of banking concentration and competition

	Lerner	Market share	HHI	CR5
Market shares	0.2436			
	(0.0000)			
HHI	0.6012	0.7781		
	(0.0000)	(0.0000)		
CR5	0.6225	0.6647	0.9811	
	(0.0000)	(0.0000)	(0.0000)	
-(H-statistic)	0.7197	-0.6994	-0.1060	0.0746
	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Notes : The table reports correlations between non-structural measures (the HHI index, the CR5 concentration ratio and market shares), the Panzar-Rosse H-statistic and the country average of the Lerner index previously estimated. All indicators are at the country-year level and are defined so that an increase in the metric corresponds to less competition (i.e. we take the negative of the H-statistic). P-values are reported in parentheses.

where b denotes banks, and t years, $P_{b,t}$ is the ratio of total operating income to total assets, while the estimate for banks' marginal cost ($\hat{MC}_{b,t}$) is derived from a translog cost function as explained in appendix A.1. We thus obtain a Lerner index for each bank and year, as a direct measure of bank market power for our main analysis. As Beck et al. (2013), in Table 1.1 we document that the Lerner index is positively and significantly correlated to other standard measures of inter-bank competition and market structure – banks' domestic market share by total assets, the Hirschmann-Herfindahl index, the CR5 concentration ratio (i.e. the market share of the largest five banks in each country by total assets), and the H-statistic – which further validates our choice of using it as measure of inter-bank competition.

1.3.2 Testable predictions

The discussion in Section 1.1 implies that higher market power may have two opposing effects on firms' credit conditions : a positive effect through the information channel and a negative effect through the market power channel. Regressing a measure of credit availability on a measure of bank market power would thus yield an estimate of the net effect of the two mechanisms, the dominant effect covering the other. Furthermore, if there are heterogeneities in the way bank competition affects corporate borrowers – that is, if the relative strength of the two mechanisms varies across firms and banks – forcing the relationship between bank market power and credit conditions to be homogeneous for all firms and banks would introduce a composition bias into our estimation (Bonaccorsi di Patti and Dell'Ariccia, 2004).

In order to effectively disentangle the two effects, we devise three testable predictions based on the information hypothesis which exploit the multidimensional structure of our data to assess how the relationship between bank market power and firms' credit conditions varies across firms and banks. The predictions are as follows :

1. Higher bank market power will be associated with higher credit availability and lower funding costs for borrowing firms

This prediction stems directly from the information hypothesis : banks with high market power (i.e. lower competitive pressure) have more incentives to invest in information acquisition and to build long-term credit relationships because they can better internalise the cost of these activities and because they face a lower risk of borrowers switching to another bank (Petersen and Rajan, 1994, 1995; Love and Martínez Pería, 2015). We therefore expect that firms borrowing from banks with high market power have better access to credit than firms borrowing from banks with low market power.

2. Higher bank market power will be relatively more beneficial (or less detrimental) to borrowing firms most exposed to informational asymmetries

For the information hypothesis, banks with high market power have more incentives to alleviate firms' asymmetric information issues by investing in monitoring projects and establishing value-enhancing credit relationships (Vives, 2001). Borrowers most exposed to information issues should hence benefit of better credit conditions in more concentrated banking markets (Petersen and Rajan, 1994, 1995; Bonaccorsi di Patti and Dell'Ariccia, 2004). Conversely, high inter-bank competition can hamper access to finance by reducing intermediaries' rents and decreasing their overall incentives to generate information and allay borrowers' agency problems (Marquez, 2002). We therefore expect the credit constraint of firms most exposed to information asymmetries – e.g. small, low-quality and opaque firms – to be lower when firms are served by banks with high market power.

3. Higher bank market power will be relatively more beneficial (or less detrimental) to firms borrowing from banks with a comparative advantage in relationship lending

The information hypothesis is centred upon the importance of lender-borrower relationships. In turn, relationship banking depends on the capacity of banks to glean, store and utilise soft, qualitative information on borrowers over repeated interactions (Rajan, 1992; Boot, 2000). With respect to these activities, not all banks are equal. While some banks will have a comparative advantage in using soft information to produce relationship loans thanks to their organisational structure, business model and/or intrinsic characteristics – e.g. small and local community banks – other banks may be specialised in taking lending decisions based on hard, quantitative information (Stein, 2002). By increasing the marginal rent of relationship-specific investments, low competition should particularly encourage banks with a comparative advantage in relationship lending to ease credit conditions (Boot and Thakor, 2000). We therefore expect firms served by banks with a comparative advantage in relationship lending to have relatively better access to credit when their reference banks also enjoy high market power.

1.3.3 Econometric models and identification

In this section we present three empirical models to test the three theoretical predictions introduced in Section 1.3.2. Model 1.1 estimates the average effect of bank market power on firms' credit conditions, while Models 1.2 and 1.3 test how the effect varies across firms and banks, respectively.

Testing how bank competition affects credit availability runs into identification issues. First, firms' credit conditions are affected by numerous factors unrelated to the state of inter-bank competition that need to be controlled for. However, most of them – business cycle, industry demand, factor endowments and prices – can be thought of as common to all firms within an industry at a given point in time. Additionally, as noted by Bonaccorsi di Patti and Dell'Ariccia (2004), firms within the same industry are likely to share a similar exposure to information problems intrinsic to the technology prevailing in that particular sector. Following Amiti and Weinstein (2011) and Berger et al. (2017), our identification strategy exploits the fact that within the same industry some firms borrow from lenders with relatively high market power, while others borrow from lenders with relatively low market power. We then use this within-industry-year variation to isolate how a firm's credit conditions relate to its reference bank's market power. Insofar industry-year fixed effects absorb industry supply-and-demand shocks shared by all firms within an industry at a given point in time, our strategy allows to identify how banks' market power affect their corporate customers' credit outcomes. In all models we hence introduce industry-year fixed effects to remove all unobservable heterogeneity in credit demand related to time-varying industry factors.

Second, using firms' credit balances as direct measures of credit availability is problematic because the amount of funds a firm borrows in any given year is jointly determined by supply and demand (Petersen and Rajan, 1994, 1995). To identify the effect of bank market power on credit supply we alternate four measures of access to credit at the firm level. First, *Short-term loans* and *Long-term loans* correspond to the (log of) short and long-term bank credit, end of year balances. Second, *Trade credit* corresponds to the (log of) end of year balances of short-term finance due to suppliers and obtained in concurrence with sales of goods and services. Finally, *Funding costs* corresponds to firms' shadow borrowing rate derived as financial expenses divided by total liabilities in line with Fungáčová et al. (2017) and Carbó-Valverde et al. (2009). In this setup, a shift in credit supply is identified if bank market power has a opposite effect on credit quantity (*Short-term loans* and *Long-term loans*) and credit price ($Funding\ costs_f$). Similarly, since trade credit is an imperfect and more expensive substitute to bank loans, reliance on trade credit within a particular sector should reflect the extent to which market power relaxes or restricts firms access to bank credit (Petersen and Rajan, 1994, 1995; Nilsen, 2002; Carbó-Valverde et al., 2009).[13] [14]

In Model 1.1, firm f's credit conditions are a function of its reference bank b's market power, a series of firm, bank and country level control variables and industry-year fixed effects. The model tests 1 and provides information on the Euro Area-wide impact of bank market power on access to credit. The model is specified as follows :

$$\textit{Access to credit}_{f,i,t} = \beta_1 \textit{Lerner}_{b,t-1} + \gamma_1 F_{f,i,t-1} + \gamma_2 B_{b,t-1} + \gamma_3 C_{f,b,t} + \alpha_{i,t} + \varepsilon_{f,i,t} \quad (1.1)$$

where f indicates firms, b banks, i industries and t years. As discussed, the regressand (*Access to credit*) is a firm level outcome variable corresponding to *Short-term loans*, *Long-term loans*, *Trade credit* and *Funding costs*. The main explanatory variable (*Lerner*) is banks' Lerner index as derived in section 1.3.1. Coefficient β_1 represents the net effect of bank market power on firms' credit conditions. For the information hypothesis, we expect β_1 to be positive when *Access to credit* is measured by *Short-term loans* and *Long-term loans* and negative when it is measured by *Trade credit* and *Funding costs*. In other words, firms related to banks with high market power should obtain more short and long-term credit, draw less trade credit and face lower funding costs.

Based on the arguments outlined in Section 1.3.2, we augment Model 1.1 to allow for heterogeneity across firms and test 2. In Model 1.2, firm f's access to credit is a function of its reference bank b's market power and of its interaction with a measure of firm f's financial constraint due to information asymmetries, alongside a set of firm, bank and country level control variables and fixed effects. The model is specified as :

$$\begin{aligned}\textit{Access to credit}_{f,i,t} = {} & \beta_1 \textit{Lerner}_{b,t-1} + \beta_2 \textit{Lerner} \times \textit{Financial constraint}_{f,i,t-1} \\ & + \gamma_1 F_{f,i,t-1} + \gamma_2 B_{b,t-1} + \gamma_3 C_{f,b,t} + \alpha_{i,t} + \varepsilon_{f,i,t} \quad (1.2)\end{aligned}$$

where we add the interaction between $\textit{Lerner}_b$ with $\textit{Financial constraint}_{f,i,t-1}$, a series of firm level variables that proxy (the inverse of) a firm's individual exposure to informational asymmetries, i.e. firm size, the level of cash flow, profitability and transparency. Based on the information hypothesis, higher bank market power should be relatively more beneficial

13. For identification we also assume that the market power of firms that supply trade credit is industry-specific and hence netted out by industry fixed effects. The assumption is borne out by the evidence that discount terms in trade credit contracts are typically set at the industry level (Petersen and Rajan, 1994).

14. Recent research cast doubts on the reliability of trade credit as proxy for financing constraint by suggesting that trade credit sends a positive signal to banks on the creditworthiness of potential borrowers : rather than a substitute, trade credit would then be a complement to bank lending (Giannetti et al., 2011; Agostino and Trivieri, 2014). However, since such signal should be especially valuable for relatively uninformed banks, we regard this specific concern to be less relevant in our analysis since we focus on banks that are already in a lending relationship and therefore unlikely to be uninformed on their corporate borrowers.

in terms of credit conditions for firms most exposed to informational asymmetries, i.e. small, illiquid, unprofitable and opaque firms. Therefore, we expect coefficient β_2 to be negative when *Access to credit* is measured by *Short-term loans* and *Long-term loans* and positive when it is measured by *Trade credit* and *Funding costs*.

Finally, to test for heterogeneity across banks (3), Model 1.3 specifies firm f's access to credit as a function of its reference bank b's market power and of its interaction with an indicator of whether bank b has a comparative advantage in relationship lending, and includes a set of firm, bank and country level control variables. The model is specified as :

$$\begin{aligned} Access\ to\ credit_{f,i,t} = \beta_1 Lerner_{b,t-1} + \beta_3 Lerner \times Relationship\ lender_b \\ + \gamma_1 F_{f,i,t-1} + \gamma_2 B_{b,t-1} + \gamma_3 C_{f,b,t} + \alpha_{i,t} + \varepsilon_{f,i,t} \quad (1.3) \end{aligned}$$

where we add the interaction between $Lerner_b$ with $Relationship\ lender_b$, a series of bank level dummies capturing whether a bank has a comparative advantage in relationship lending based on its size, business model and geographical position. For the information hypothesis, higher bank market should be relatively more beneficial (or less detrimental) to firms served by banks with a comparative advantage in relationship lending, i.e. small and local community banks. Therefore, we expect coefficient β_3 to be positive when $Access\ to\ credit_f$ is measured by *Short-term loans* and *Long-term loans* and negative when it is measured by *Trade credit* and *Funding costs*.

All models include the vectors F, B and C which contain firm, bank and country level control variables. Specifically, in vector F we include *Size* (the log of firm's total assets), since firms of different size have different financing patterns (Beck et al., 2008, 2013) ; *Cash flow* and *Profit margin* (the log of cash flow and the ratio of EBITDA to total assets, respectively) as observable measures of firm performance and quality (Carbó-Valverde et al., 2009) ; *Default risk* (operating profits over interest paid) ; and *Transparency* (tangible fixed assets over total assets), a measure for how easily a firm can be evaluated and monitored by a bank, and/or can post tangible collateral to obtain external financing (Bonaccorsi di Patti and Dell'Ariccia, 2004; Freixas and Rochet, 2008; Fungáčová et al., 2017). Vector B contains *Size* (the log of total assets), as banks of different size have different lending policies (Gambacorta, 2005) ; *RoA* (the return on assets), which captures any linkages between bank performance and credit supply (Carbó-Valverde et al., 2009) ; *Risk* (the log of the Z-score), measuring the distance from insolvency (Beck et al., 2013) ; and *Leverage* (Equity capital over total assets) which controls for bank capitalization. Finally, vector C contains *GDP growth* (the annual growth rate of real GDP) and *Inflation* (the annual change in HCIP) to account for cyclical and country-specific determinants of credit outcomes (Gambacorta, 2003) ; and *Spread* (the difference between the yield on a country's 10-year government bond and the yield on the 10-year German's Bund) to capture the cross-country divergence in funding conditions that arose during the Euro Area sovereign debt crisis between 2010 and 2012 (Albertazzi et al., 2014). As in Beck et al. (2013) all firm and bank level variables enter the model with a lag to mitigate endogeneity concerns related to reverse causality, while country variables are contemporaneous to the dependent variable. All firm and bank level variables are winsorised at 1% and 99% levels to minimise the influence of outliers.[15] Industry-year fixed effects ($\alpha_{i,t}$) are included to absorb all time-varying industry-specific shocks. As in De Marco (2019) we use 4-digits North American Industry Classification System (NAICS) codes to identify 280 industrial sectors. Finally, $\varepsilon_{f,i,t}$ represents the idiosyncratic error term.

1.4 Results

This section presents the main results. We first focus on the overall effect of bank market power on firms' access to credit and estimate Model 1.1. Subsequently, we analyse how this relationship varies across firms and banks by estimating Models 1.2 and 1.3. In all estimations we add industry-year fixed effects and cluster standard errors at the bank level.

1.4.1 The average effect of bank market power on access to credit

We first estimate Model 1.1 to test 1 : for the information hypothesis, firms related to banks with higher bank market power should have better access to credit. The test therefore rests on the sign of β_1.

In Table 1.2 we report results across four panels, each containing a different measure of firms' access to credit. Across specifications, findings reject the information hypothesis : *Lerner* is negatively related to short and long-term credit and positively related to trade credit and funding costs. Within the same industry and in the same year, firms served by banks with high market power borrow less at all maturities, draw more trade credit and face higher funding costs than firms served by banks with low market power. This result is robust across specifications. In the second column of each panel we add firm level variables to control for balance sheet characteristics that may explain variation in credit conditions. For analogous reasons, in the third column of each panel we add bank balance sheet variables. In the fourth column of each panel we use a Lerner index obtained from estimating the marginal cost through a cost function specified at the Euro Area level rather than at the country level as discussed in section 1.3.1.

The effect of bank market power is economically significant : for the full specification (column 3 of each panel), estimates indicate that firms borrowing from banks with high market power (75 percentile of *Lerner*) obtain 22% and 24% less short and long-term credit, respectively, draw 6% more trade credit and pay 11% higher funding costs than firms borrowing from banks with low market power (25 percentile of *Lerner*). These results are supportive of the market power hypothesis, whereby low bank competition is associated

15. Results are qualitatively and quantitatively robust if we do not winsorise. The complete list of variables is reported in Table A.3 alongside descriptive statistics and data sources.

to tighter credit conditions. Furthermore, the finding that high bank market power has opposite effects on the quantity and price of credit suggests that low bank competition is associated with restrictions in credit supply rather than in credit demand.

1.4.2 The effect of bank market power on access to credit across firms

In this section we estimate Model 1.2 to test 2 : for the information hypothesis, higher bank market power will be relatively more beneficial (or less detrimental) to borrowing firms most exposed to informational asymmetries. This test therefore hinges on estimates of β_2 as formalized in Model 1.2. More specifically, across specifications the interacted variable – *Financial constraint* – corresponds to four measures of firm level exposure to agency problems : *Size*, *Cash-flow*, *Profit margin* and *Transparency*.

TABLE 1.2 – The average effect of bank market power on access to credit

	Panel I				Panel II				Panel III				Panel IV			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Dep. variable	Short-term loans$_{f,t}$				Long-term loans$_{f,t}$				Trade Credit$_{f,t}$				Funding costs $_{f,t}$			
Lerner$_{b,t-1}$	-1.907***	-1.373***	-1.362***	-0.876**	-2.300***	-1.807***	-1.496***	-1.598***	0.390***	0.362***	0.383**	0.366**	0.488***	0.450***	0.685***	0.460***
	(0.253)	(0.271)	(0.423)	(0.375)	(0.238)	(0.241)	(0.383)	(0.316)	(0.125)	(0.127)	(0.188)	(0.167)	(0.100)	(0.096)	(0.164)	(0.097)
Size$_{f,t-1}$	1.026***	0.999***	0.995***	1.025***	0.910***	0.925***	0.921***	0.941***	0.885***	0.752***	0.754***	0.747***	0.010	0.037***	0.033***	0.030***
	(0.027)	(0.053)	(0.052)	(0.055)	(0.031)	(0.031)	(0.031)	(0.031)	(0.013)	(0.032)	(0.032)	(0.033)	(0.008)	(0.013)	(0.012)	(0.012)
Cash flow$_{f,t-1}$		0.028	0.032	0.036		-0.045*	-0.045*	-0.033		0.178***	0.178***	0.176***		-0.025**	-0.024**	-0.026**
		(0.047)	(0.046)	(0.046)		(0.024)	(0.024)	(0.026)		(0.029)	(0.029)	(0.029)		(0.012)	(0.011)	(0.012)
Profit margin$_{f,t-1}$		-1.013**	-1.057***	-1.003**		0.112	0.099	0.010		-3.259***	-3.257***	-3.246***		0.069	0.063	0.073
		(0.412)	(0.388)	(0.427)		(0.251)	(0.250)	(0.251)		(0.300)	(0.301)	(0.297)		(0.177)	(0.181)	(0.187)
Default risk$_{f,t-1}$		-0.451***	-0.452***	-0.467***		-0.221***	-0.224***	-0.234***		-0.037**	-0.037**	-0.035**		-0.047***	-0.047***	-0.045***
		(0.053)	(0.052)	(0.051)		(0.039)	(0.039)	(0.038)		(0.015)	(0.015)	(0.015)		(0.009)	(0.009)	(0.008)
Transparency$_{f,t-1}$		0.925***	0.927***	1.061***		1.915***	1.893***	2.038***		-0.912***	-0.909***	-0.937***		-0.236***	-0.242***	-0.268***
		(0.220)	(0.219)	(0.231)		(0.184)	(0.183)	(0.197)		(0.144)	(0.143)	(0.142)		(0.046)	(0.045)	(0.051)
Size$_{b,t-1}$			-0.078*				0.080*				-0.016				-0.014	
			(0.047)				(0.043)				(0.019)				(0.013)	
RoA$_{b,t-1}$			2.756				-11.439				-0.978				-7.770**	
			(10.669)				(7.921)				(4.750)				(3.747)	
Risk$_{b,t-1}$			0.126				-1.244				1.660				-0.052	
			(1.722)				(0.868)				(1.054)				(0.315)	
Leverage$_{b,t-1}$			-1.213				1.709***				-0.130				0.403	
			(0.960)				(0.617)				(0.382)				(0.315)	
Inflation$_{fb,t}$	42.835***	44.841***	47.752***	53.896***	39.099***	38.520***	30.614***	50.838***	-2.567	5.612	5.988	2.944	-10.431***	-8.760***	-10.237***	-12.565***
	(11.537)	(9.704)	(11.417)	(10.448)	(8.777)	(7.923)	(6.504)	(10.652)	(5.034)	(5.039)	(5.117)	(5.757)	(3.358)	(3.351)	(3.439)	(3.956)
GDP growth$_{fb,t}$	24.319**	19.678*	20.656**	38.812***	16.121**	8.802	11.140*	35.167***	-24.489***	-20.469***	-19.230***	-25.350***	4.147	4.713	6.836**	-1.415
	(10.648)	(10.101)	(9.874)	(9.289)	(7.126)	(6.331)	(5.938)	(8.037)	(4.432)	(4.243)	(4.138)	(4.090)	(3.074)	(2.987)	(2.855)	(3.877)
Spread$_{fb,t}$	36.965***	39.627***	43.589***	53.139***	20.780***	18.923***	15.608***	33.896***	-2.089	7.247***	6.601***	4.093*	-1.224	-1.698	-1.763	-5.368**
	(5.704)	(5.536)	(7.727)	(5.435)	(4.458)	(4.335)	(4.104)	(4.550)	(2.782)	(2.548)	(2.452)	(2.378)	(1.502)	(1.587)	(1.830)	(2.138)
Industry×Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	6,912	6,912	6,912	6,912	6,761	6,761	6,761	6,761	8,466	8,466	8,466	8,466	7,681	7,681	7,681	7,681
Adjusted R-squared	0.443	0.479	0.480	0.474	0.554	0.592	0.594	0.584	0.566	0.599	0.599	0.599	0.032	0.039	0.040	0.036

Notes : Results are based on Model 1.1 estimated with industry-year fixed effects over 2010-2016. The dependent variables are the log of short-term loans (Panel I), the log of long-term loans (Panel II), the log of trade credit (Panel III) and funding costs (Panel IV) defined as financial expenses over total liabilities. $Lerner_{b,t-1}$ is banks' Lerner index as defined in Section 1.3.1 and included with one-year lag. For columns 1-3 in each panel, *Lerner* is computed as described in Appendix A.1, where the marginal cost is estimated with separate regressions for each country. For column 4 in each panel, *Lerner* is computed as described in Appendix A.1, where the marginal cost is estimated in a single Euro Area-wide regression. The variables $Size_{f,t-1}$ (log of total assets), $Cash\ flow_{f,t-1}$ (log of cash flow), $Profit\ margin_{f,t-1}$ (EBITDA/total assets), $Default\ risk_{f,t-1}$ (interest coverage ratio) and $Transparency_{f,t-1}$ (fixed tangible assets/total assets) are one-year-lagged firm controls. The variables $Size_{b,t-1}$ (log of total assets), $RoA_{b,t-1}$ (Return on Assets), $Risk_{b,t-1}$ (log of Z-scores), $Leverage_{b,t-1}$ (common equity/total assets) are one-year-lagged bank controls. The variables $Inflation_{fb,t}$ (HCIP inflation), $GDP\ growth_{fb,t}$ (growth rate of real GDP) and $Spread_{fb,t}$ (Sovereign yield spread) are contemporaneous country variables. Standard errors in parentheses are clustered at the bank level. ***/**/* indicate significance at the 1%/5%/10% level.

First, we look at firm size, as measured by the log of total assets, since small firms are widely recognised to suffer of significant information asymmetries. [16] Models of equilibrium credit rationing imply that smaller firms are particularly vulnerable to adverse selection and moral hazard because they are informationally opaque (Stiglitz and Weiss, 1981). Furthermore, information asymmetries are thought to be stronger for small firms due to their restricted credit history, short track record and lower ability to provide collateral. As a result, small firms typically do not have access to public capital market and are dependent on financial institutions for external finance (Berger and Udell, 2002). Conversely, large firms usually benefit from internal capital market and face less financing constraints (Carbó-Valverde et al., 2009; Andrieu et al., 2018). We therefore expect to find that smaller firms obtain less credit, on average. Furthermore, according to the information hypothesis, small firms should have better access to credit in more concentrated credit markets where banks' incentive to create long-term lending relationships is stronger (Petersen and Rajan, 1995).

Results contradict this view. In Table 1.3, the interaction term in the first column of the first two panels implies that within the same industry-year small firms served by banks with high market power obtain less short- and long-term bank credit than larger firms. The effect is statistically and economically sizable : the reduction in short and long-term credit associated with a one-standard-deviation increase in bank market power (i.e. 0.16, moving from the 25 to the 75 percentile of *Lerner*) is, respectively, 27% and 56% larger for small (25 percentile of *Size*) than large firms (75 percentile). [17] Conversely, there is no significant evidence that smaller firms related to banks with high market power draw more or less trade credit and face higher or lower funding costs than larger firms. In line with evidence provided by Beck et al. (2004) and Bonaccorsi Di Patti and Gobbi (2007), these findings suggest that high bank market power worsens small firms' credit conditions over and above the fact that they are more credit constrained to begin with.

Second, according to the information hypothesis, banks should lend more to lower quality firms in more concentrated markets. Using firm's *Cash flow* and *Profit margin* to capture firms' observable creditworthiness (Carbó-Valverde et al., 2009), we find evidence against this theoretical prediction. Estimates in columns 2 suggest that, after controlling for cash flow, illiquid firms related to banks with high market power obtain significantly less short and long-term credit and draw more trade credit. Similarly, high market power is significantly associated to a more marked reliance on trade credit for unprofitable firms over and above the fact that unprofitable firms draw more trade credit on average. Instead,

16. Results are qualitatively unchanged if we take the European commission definition of small and medium-sized enterprises and use a dummy for SMEs that takes values 1 if a firm has (i) 250 or less employees or (ii) operating revenues up to €50 million and total assets up to €43 million and 0 otherwise, as in Ryan et al. (2014).

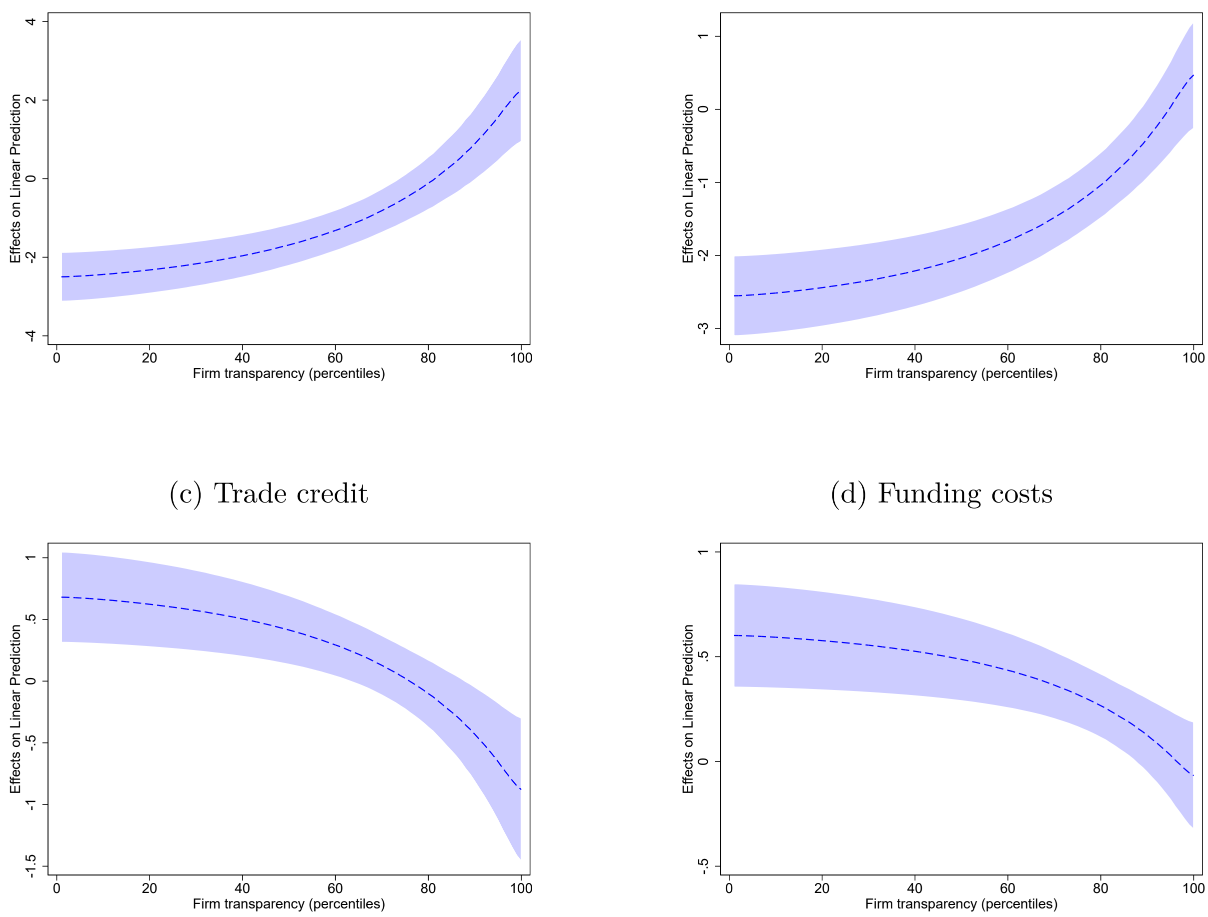
17. Specifically, the reduction in *Short-term loans* associated with a one-standard-deviation increase in *Lerner* evaluated at the 25 and 75 percentiles of *Size* is 33% and 26%, respectively, while the reduction in *Long-term loans* associated with a one-standard-deviation increase in *Lerner* evaluated at the same percentiles of *Size* is 47% and 30%, respectively.

we find no indication that low quality firms served by banks with high market power face funding costs that differ systematically from those faced by the average firm.

Third, information issues are typically more severe for opaque borrowers, e.g. firms whose evaluation and monitoring by banks is particularly difficult. Within a particular sector, adverse selection and moral hazard should be less of a problem for activities involving a large share of tangible fixed assets than for activities chiefly employing human capital whose quality is unobservable ex-ante and costly to monitor ex-post. Furthermore, a large share of fixed assets mitigates agency problems since it can be posted as collateral against borrowing (Freixas and Rochet, 2008; Bonaccorsi di Patti and Dell'Ariccia, 2004). Following Bonaccorsi di Patti and Dell'Ariccia (2004) and Fungáčová et al. (2017) we use the ratio of physical assets to total assets as an indicator of transparency in order to test if, as implied by the information hypothesis, opaque firms benefit of higher credit availability when served by banks with higher market power. Findings presented in column 4 of each panel strongly reject this claim. As apparent in Figure 1.1, not only the adverse impact of market power on bank and trade credit borrowed abates with firms' transparency, but the effect is reversed for highly transparent firms. In other words, there are large heterogeneities in the way market power affect credit conditions across firms with different degrees of opaqueness. Specifically, the reduction in short and long-term credit associated with a one-standard-deviation increase in bank market power (i.e. 0.16, moving from the 25 to the 75 percentile of *Lerner*) is, respectively, five and two times larger for opaque firms (25 percentile of *Transparent*) than transparent firms (75 percentile of *Transparent*).

FIGURE 1.1 – The effect of bank market power on access to credit across firms' transparency

(a) Short-term loans (b) Long-term loans (c) Trade credit (d) Funding costs



Notes : estimated marginal effect of banks' Lerner index on measures of firms' credit conditions as a function of firms' degree of transparency, based on estimates reported in Table 1.3, columns 4 of Panels I,II,III,IV.

TABLE 1.3 – The effect of bank market power on access to credit across firms

	Panel I				Panel II				Panel III				Panel IV			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Dep. variable	Short-term loans$_{f,t}$				Long-term loans$_{f,t}$				Trade Credit$_{f,t}$				Funding costs $_{f,t}$			
Lerner$_{b,t-1}$	-1.730***	-1.170***	-1.366***	-2.548***	-2.136***	-1.084***	-1.559***	-2.214***	0.349*	0.290	0.515**	0.720***	0.605***	0.683***	0.631***	0.845***
	(0.469)	(0.431)	(0.463)	(0.358)	(0.401)	(0.404)	(0.396)	(0.427)	(0.189)	(0.210)	(0.203)	(0.231)	(0.141)	(0.189)	(0.128)	(0.186)
Lerner$_{b,t-1}$	0.224*				0.417***				0.021				0.048			
×Size$_{f,t-1}$	(0.128)				(0.128)				(0.066)				(0.035)			
Lerner$_{b,t-1}$		0.171*				0.352***				-0.083*				-0.003		
×Cash flow$_{f,t-1}$		(0.103)				(0.107)				(0.044)				(0.035)		
Lerner$_{b,t-1}$			0.107				1.410				-2.682**				1.093	
×Profit margin$_{f,t-1}$			(1.934)				(1.281)				(1.118)				(1.075)	
Lerner$_{b,t-1}$				4.981***				2.984***				-1.533***				-0.706***
×Transparency$_{f,t-1}$				(0.786)				(0.494)				(0.416)				(0.207)
Size$_{f,t-1}$	0.900***	0.992***	0.995***	0.991***	0.753***	0.914***	0.921***	0.920***	0.745***	0.755***	0.754***	0.754***	0.013	0.033***	0.033***	0.033***
	(0.063)	(0.052)	(0.053)	(0.052)	(0.080)	(0.032)	(0.031)	(0.031)	(0.044)	(0.032)	(0.032)	(0.032)	(0.014)	(0.011)	(0.012)	(0.012)
Cash flow$_{f,t-1}$	0.032	-0.036	0.032	0.030	-0.042*	-0.175***	-0.045*	-0.046**	0.179***	0.212***	0.179***	0.181***	-0.023**	-0.023	-0.024**	-0.023**
	(0.046)	(0.068)	(0.047)	(0.047)	(0.023)	(0.050)	(0.024)	(0.022)	(0.029)	(0.038)	(0.029)	(0.029)	(0.011)	(0.021)	(0.012)	(0.011)
Profit margin$_{f,t-1}$	-1.065***	-1.064***	-1.098	-1.068***	0.032	0.033	-0.451	0.125	-3.259***	-3.248***	-2.187***	-3.260***	0.057	0.063	-0.363	0.060
	(0.380)	(0.382)	(0.889)	(0.375)	(0.250)	(0.243)	(0.558)	(0.248)	(0.301)	(0.299)	(0.612)	(0.299)	(0.178)	(0.179)	(0.336)	(0.178)
Default risk$_{f,t-1}$	-0.452***	-0.456***	-0.453***	-0.434***	-0.224***	-0.233***	-0.226***	-0.215***	-0.037**	-0.035**	-0.034**	-0.041***	-0.047***	-0.047***	-0.049***	-0.049***
	(0.052)	(0.053)	(0.052)	(0.051)	(0.039)	(0.040)	(0.039)	(0.038)	(0.015)	(0.015)	(0.015)	(0.015)	(0.009)	(0.009)	(0.009)	(0.009)
Transparency$_{f,t-1}$	0.924***	0.928***	0.927***	-0.899**	1.891***	1.897***	1.895***	0.822***	-0.909***	-0.907***	-0.912***	-0.349	-0.243***	-0.242***	-0.240***	0.011
	(0.222)	(0.222)	(0.219)	(0.349)	(0.185)	(0.186)	(0.184)	(0.243)	(0.144)	(0.142)	(0.141)	(0.227)	(0.046)	(0.046)	(0.045)	(0.072)
Size$_{b,t-1}$	-0.075	-0.075	-0.077*	-0.073	0.078*	0.079*	0.080*	0.074*	-0.016	-0.016	-0.016	-0.016	-0.014	-0.014	-0.014	-0.014
	(0.047)	(0.047)	(0.047)	(0.045)	(0.042)	(0.042)	(0.043)	(0.041)	(0.019)	(0.019)	(0.019)	(0.020)	(0.013)	(0.013)	(0.013)	(0.013)
RoA$_{b,t-1}$	2.543	2.465	2.754	3.467	-11.330	-11.393	-11.463	-11.397	-0.979	-0.949	-1.108	-1.034	-7.729**	-7.772**	-7.709**	-7.860**
	(10.617)	(10.648)	(10.669)	(10.127)	(7.512)	(7.592)	(7.953)	(7.543)	(4.735)	(4.812)	(4.703)	(4.875)	(3.795)	(3.728)	(3.671)	(3.661)
Risk$_{b,t-1}$	0.319	0.268	0.125	0.564	-0.905	-0.977	-1.253	-1.009	1.675	1.605	1.703	1.552	-0.020	-0.054	-0.069	-0.089
	(1.728)	(1.740)	(1.717)	(1.638)	(0.870)	(0.877)	(0.869)	(0.861)	(1.048)	(1.066)	(1.055)	(1.073)	(0.320)	(0.321)	(0.312)	(0.317)
Leverage$_{b,t-1}$	-1.152	-1.131	-1.213	-1.287	1.745***	1.791***	1.717***	1.622***	-0.126	-0.159	-0.128	-0.102	0.406	0.403	0.402	0.424
	(0.959)	(0.972)	(0.961)	(0.912)	(0.583)	(0.588)	(0.617)	(0.588)	(0.385)	(0.388)	(0.378)	(0.389)	(0.321)	(0.319)	(0.312)	(0.311)
GDP growth$_{bf,t}$	19.947**	20.219**	20.646**	15.411	8.942	9.596	11.029*	8.131	-19.305***	-18.988***	-18.968***	-17.915***	6.619**	6.847**	6.714**	7.522***
	(10.003)	(10.025)	(9.928)	(10.023)	(5.647)	(5.920)	(5.962)	(6.006)	(4.134)	(4.157)	(4.132)	(4.280)	(2.889)	(2.877)	(2.877)	(2.871)
Inflation$_{bf,t}$	47.076***	47.552***	47.762***	44.785***	29.419***	30.646***	30.543***	29.416***	5.946	5.980	5.796	6.815	-10.343***	-10.236***	-10.114***	-9.787***
	(11.312)	(11.433)	(11.375)	(11.547)	(6.483)	(6.596)	(6.458)	(6.541)	(5.113)	(5.183)	(5.161)	(5.137)	(3.474)	(3.441)	(3.387)	(3.427)
Spread$_{bf,t}$	40.895***	41.049***	43.575***	38.660***	12.064***	11.968***	15.453***	13.431***	6.363**	7.756***	6.814***	7.866***	-2.218	-1.733	-1.862	-1.277
	(7.857)	(8.325)	(7.881)	(7.408)	(4.107)	(4.068)	(4.086)	(4.087)	(2.689)	(2.465)	(2.454)	(2.542)	(1.963)	(1.970)	(1.861)	(1.872)
Industry×Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	6,912	6,912	6,912	6,912	6,761	6,761	6,761	6,761	8,466	8,466	8,466	8,466	7,681	7,681	7,681	7,681
Adjusted R-squared	0.480	0.480	0.479	0.486	0.596	0.596	0.594	0.597	0.599	0.600	0.600	0.601	0.040	0.040	0.041	0.041

Notes : Estimates are based on Model 1.2 estimated with industry-year fixed effects over 2010-2016. The dependent variables are the log of short-term loans (Panel I), the log of long-term loans (Panel II), the log of trade credit (Panel III) and funding costs (Panel IV) defined as financial expenses over total liabilities. *Lerner*$_{b,t-1}$ is banks' Lerner index as defined in 1.3.1 an included with one-year lag. The variables *Size*$_{f,t-1}$ (log of total assets), *Cash flow*$_{f,t-1}$ (log of cash flow), *Profit margin*$_{f,t-1}$ (EBITDA/total assets), *Default risk*$_{f,t-1}$ (interest coverage ratio) and *Transparency*$_{f,t-1}$ (fixed tangible assets/total assets) are one-year-lagged firm controls. The variables *Size*$_{b,t-1}$ (log of total assets), *RoA*$_{b,t-1}$ (Return on Assets), *Risk*$_{b,t-1}$ (log of Z-scores), *Leverage*$_{b,t-1}$ (common equity/total assets) are one-year-lagged bank controls. The variables *Inflation*$_{fb,t}$ (HCIP inflation), *GDP growth*$_{fb,t}$ (growth rate of real GDP) and *Spread*$_{fb,t}$ (Sovereign yield spread) are contemporaneous country variables. Standard errors in parentheses are clustered at the bank level. ***/**/* indicate significance at the 1%/5%/10% level.

By the same token, the increase in trade credit and funding costs associated with a one-standard-deviation increase in bank market power is, respectively, 9 and 2 times larger for opaque vis-à-vis transparent firms. [18] These results suggest that higher bank market power aggravates the credit constraint of opaque firms over and above their being more constrained to begin with.

Overall, this set of results rejects the information hypothesis in favour of the market power hypothesis. Higher bank market power appears to be especially detrimental for credit availability precisely where the information hypothesis predicts it should be most beneficial. Indeed, the credit constraint of firms most exposed to information asymmetries is more binding for those served by banks with high market power. Conversely, high bank market power appears to matter less – and possibly to be even beneficial – for the credit availability of higher quality firms that are least exposed to information asymmetries.

1.4.3 The effect of bank market power on firms' access to credit across banks

In this section, we test 3, whereby higher bank market power should be relatively more beneficial (or less detrimental) to firms borrowing from banks with a comparative advantage in relationship lending. The test depends on estimates of β_3 as per Model 1.3. Across specifications, the interacted variable (*Relationship lender*) corresponds to three bank-specific characteristics measuring a lender's putative comparative advantage in relationship lending : *Small*, *Coop/Savings* and *Local*.

First, access to credit should be easier for firms related to small banks. Indeed, small banks are seen to have the ability to easily transmit soft information on borrowers given their reduced layers of management and simple organisational structure. By contrast, large and hierarchical banks find it more difficult to manage such information and tend to make lending decision based on hard, quantitative information instead. Indeed, for smallest banks the agency problem between management and loan officers – the latter being the depository of the most valuable soft information on borrowers – is typically resolved with the president of the bank making or reviewing most of the business loans. In contrast, larger and more complex banks usually require more layers of management that may hinder the production of information-driven loans (Stein, 2002). In this sense, small banks are likely to have a comparative advantage vis-à-vis large banks in relationship lending (Berger and Udell, 2002; Stein, 2002; Berger et al., 2005; Liberti and Mian, 2009; Canales and Nanda, 2012; Berger et al., 2017). For these reasons, we expect firms served by small banks to be less

18. Specifically, the reduction in *Short-term loans* associated with a one-standard-deviation increase in *Lerner* evaluated at the 25 and 75 percentiles of *Transparent* is 36% and 8%, respectively, while the reduction in *Long-term credit* associated with a one-standard-deviation increase in *Lerner* evaluated at the same percentiles of *Size* is 38% and 20%, respectively. In the same way, the increase in *Trade credit* associated with a one-standard-deviation increase in *Lerner* evaluated at the same percentiles of *Size* is 9% and 1%, respectively ; finally, the increase in *Funding costs* associated with a one-standard-deviation increase in *Lerner* evaluated at the same percentiles of *Size* is 9% and 5%, respectively.

credit constrained, on average. Moreover, for the information hypothesis we expect that, by increasing the marginal rent from relationship lending, low inter-bank competition should encourage relationship-specific investments and in turn increase small banks' incentives to supply relationship loans (Boot and Thakor, 2000).

We test for this hypothesis by interacting *Lerner* with *Small*, an indicator variable that takes value 1 if a bank's average size lies in the bottom decile of the distribution – which in our sample corresponds to a size cut-off for banks with total assets worth € 300 million – and 0 otherwise. Estimates reported in the first column of the first three panels of Table 1.4 support this hypothesis. [19] The coefficient on the interaction term indicates that the negative association between market power and credit conditions is significantly weaker for firms that borrow from small banks as compared to those that borrow from larger banks. Specifically, among firms borrowing from banks with high market power, those served by small banks obtain more short and long-term credit and draw less trade credit than firms served by larger banks. This result uncovers important heterogeneities in the effect of market power on firms' access to credit across banks : a one-standard-deviation increase in bank market power (i.e. 0.16, moving from the 25 to the 75 percentile of *Lerner*) is associated to a 27% drop in short and long-term credit for firms served by medium-large banks as opposed to a positive but not statistically significant effect for firms served by small banks. By the same token, a one-standard-deviation increase bank market power implies a 7% increase in trade credit for firms served by large banks as opposed to a non-statistically significant corresponding effect for firms served by small banks. These results are partly consistent with the *information hypothesis* : insofar low competition fosters the establishment of lending relationships, our results indicate that firms borrowing from small banks with high market are less credit constrained than firms borrowing from medium-large banks with high market power. Moreover, since we control for bank size, this result indicates that higher bank market power is associated with a smaller reduction (increase) in bank (trade) credit for firms associated to small banks over and above the fact that smaller banks provide more traditional lending, on average (Berger and Udell, 1995; Berger et al., 1995). In this sense, our findings are in line with empirical evidence on relationship lending and small banks (Berger et al., 2005; Berger and Black, 2011; Berger et al., 2017) and with the finding that mergers and acquisitions involving small banks tend to increase small business lending (Peek and Rosengren, 1998; Strahan and Weston, 1998). On the other hand, panel 4 provides no evidence on the presence of distributional effects of market power across bank size for firms' funding costs, indicating that higher market power is associated to higher funding costs regardless of the size of the bank a firm is borrowing from. This finding too is line with Petersen and Rajan (1994) and Berger et al. (2017), fitting the notion that adjustments in credit volume are more likely outcomes of

19. We use an indicator variable rather than a continuous variable because of large multicollinearity arising from interacting two bank level continuous variables, i.e. *Lerner* and *Size*. Results are qualitatively similar if we use a continuous indicator for bank size instead, but in that case the magnitude of coefficient estimates is much inflated by multicollinearity.

lending relationships than adjustments in price.[20]

Second, among firms borrowing from banks with high market power, we expect access to credit to be easier for firms that borrow from local community banks since the latter have stronger incentives to engage in credit relationships than commercial non-local banks. There are various reasons for this. First, community banks are seen to be particularly able to provide credit to firms having idiosyncratic credit needs and risks related to the prospects of the local economy (Avery and Samolyk, 2004). As a result, local community banks tend to develop more enduring and stable credit relationships with corporate borrowers than commercial banks. Second, their local nature gives community banks a competitive edge in screening and monitoring borrowers, and thus in managing asymmetric information problems typically associated with small business lending (Angelini et al., 1998). This may be because agents operating within the same community share various types of relationships and in so doing acquire soft information that would otherwise be available to outsiders only at a cost. Accordingly, a bank operating within a small community may exploit this informational advantage in its credit activities. Third, local community banks may apply "social sanctions" to borrowing firms which are typically not available to commercial banks (Banerjee et al., 1994; Besley and Coate, 1995).[21]

To capture the extent to which a bank is a local community bank, we use two measures. First, we look at cooperative and savings banks. As opposed to commercial banks, European savings and cooperative banks have an overwhelmingly regional and local presence, and are typically expected to support local business and entrepreneurs (De Santis and Surico, 2013; Bülbül et al., 2013). In addition, the ownership structure of cooperatives may confer them a comparative advantage in dealing with asymmetric information problems, since a bank owned and/or managed by community members can easily utilise inside information in its lending activity (Angelini et al., 1998). Second, we look at banks that are located in the same city as their corporate customers, as these banks are likely to be geographically close to their corporate customers and rooted in the same local economy. Indeed, geographical distance from borrowers is an important determinant of the availability and pricing of bank loans, either because the vicinity of lenders to borrowers dilutes inter-bank competition (Lederer and Hurter, 1986) or because monitoring costs increase with lender-borrower distance (Sussman and Zeira, 1995). We therefore test for this hypothesis by cross-interacting *Lerner* with *Coop/Savings*, an indicator that takes value 1 if a bank is either a cooperative or a savings bank and 0 otherwise, and with *Local*, a dummy taking value 1 if bank and firm are located in the same city and 0 otherwise.

20. Petersen and Rajan (1994) note that if a firm is credit rationed in the sense of Stiglitz and Weiss (1981), a firm's marginal return on investment would be higher than the price of credit, so that firms would demand more but not necessarily cheaper credit.

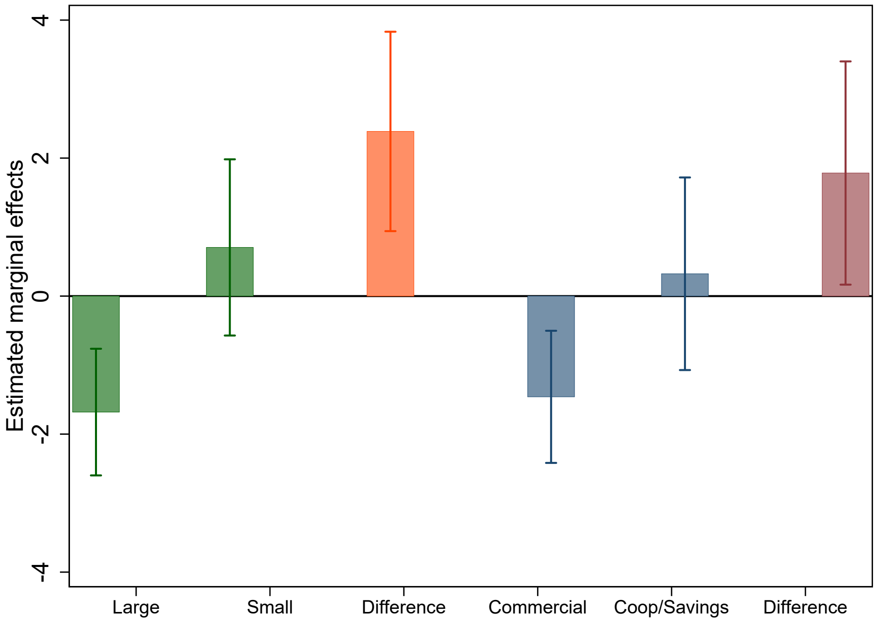
21. In the context of group lending social sanctions can take various forms. For instance, a community lender may stop future cooperation with a community borrower, which can be particularly damaging if there exist other forms of exchange between the two, for instance involving productive activities. Alternatively, a social sanction may constitute the interruption of reciprocal help during hard times (Besley and Coate, 1995).

TABLE 1.4 – The effect of bank market power on access to credit across banks

	Panel I				Panel II				Panel III				Panel IV			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Dep. variable	Short-term loans$_{f,t}$				Long-term loans$_{f,t}$				Trade Credit$_{f,t}$				Funding costs$_{f,t}$			
Lerner$_{b,t-1}$	-1.681***	-1.669***	-1.533***	-1.536***	-1.670***	-1.904***	-1.897***	-1.908***	0.482**	0.421**	0.295	0.423*	0.658***	0.668***	0.692***	0.719***
	(0.468)	(0.531)	(0.528)	(0.527)	(0.421)	(0.501)	(0.449)	(0.521)	(0.191)	(0.205)	(0.211)	(0.222)	(0.155)	(0.186)	(0.172)	(0.186)
Lerner$_{b,t-1}$ ×Small$_b$	2.386***	1.996***	1.924***	1.839**	2.121***	1.929***	1.953***	1.902***	-0.951*	-0.994*	-0.617*	-1.023**	0.253	0.271	0.278	0.264
	(0.733)	(0.745)	(0.728)	(0.733)	(0.658)	(0.663)	(0.398)	(0.661)	(0.517)	(0.511)	(0.328)	(0.519)	(0.245)	(0.246)	(0.202)	(0.238)
Lerner$_{b,t-1}$ ×Savings/Coop$_b$		1.418*	1.693**	1.293		1.313***	1.308***	1.450***		0.276	0.162	0.318		-0.090	-0.059	-0.175
		(0.798)	(0.828)	(0.892)		(0.403)	(0.428)	(0.445)		(0.272)	(0.269)	(0.316)		(0.197)	(0.206)	(0.214)
Lerner$_{b,t-1}$ ×Local$_{fb}$			-1.899***	-1.926***			0.063	0.671			-0.054	0.296			-0.272	-0.661**
			(0.531)	(0.636)			(0.400)	(0.538)			(0.221)	(0.213)			(0.178)	(0.331)
Lerner$_{b,t-1}$ ×Savings/Coop$_b$				1.915*				-0.910				-0.340				0.731
×Local$_{fb}$				(1.067)				(0.749)				(0.515)				(0.448)
Size$_{f,t-1}$	0.990***	0.976***	0.974***	0.971***	0.926***	0.922***	0.922***	0.922***	0.755***	0.754***	0.755***	0.753***	0.032***	0.033***	0.033***	0.032***
	(0.052)	(0.052)	(0.051)	(0.050)	(0.030)	(0.030)	(0.030)	(0.030)	(0.032)	(0.033)	(0.033)	(0.033)	(0.012)	(0.012)	(0.012)	(0.012)
Cash flow$_{f,t-1}$	0.035	0.036	0.037	0.039	-0.047**	-0.048**	-0.048**	-0.047**	0.178***	0.178***	0.178***	0.178***	-0.023**	-0.024**	-0.023**	-0.024**
	(0.046)	(0.046)	(0.045)	(0.045)	(0.023)	(0.023)	(0.023)	(0.024)	(0.029)	(0.029)	(0.029)	(0.029)	(0.011)	(0.012)	(0.011)	(0.012)
Profit margin$_{f,t-1}$	-1.214***	-1.197***	-1.203***	-1.243***	0.074	0.103	0.097	0.082	-3.233***	-3.231***	-3.244***	-3.240***	0.049	0.049	0.044	0.049
	(0.373)	(0.369)	(0.375)	(0.372)	(0.243)	(0.242)	(0.246)	(0.243)	(0.299)	(0.299)	(0.301)	(0.298)	(0.184)	(0.184)	(0.181)	(0.185)
Default risk$_{f,t-1}$	-0.450***	-0.447***	-0.445***	-0.444***	-0.224***	-0.224***	-0.224***	-0.224***	-0.037**	-0.037**	-0.038**	-0.037**	-0.047***	-0.047***	-0.047***	-0.047***
	(0.052)	(0.052)	(0.051)	(0.051)	(0.039)	(0.039)	(0.039)	(0.039)	(0.015)	(0.015)	(0.015)	(0.015)	(0.009)	(0.009)	(0.009)	(0.009)
Transparency$_{f,t-1}$	0.842***	0.796***	0.787***	0.772***	1.879***	1.858***	1.859***	1.855***	-0.886***	-0.891***	-0.894***	-0.894***	-0.250***	-0.247***	-0.248***	-0.247***
	(0.204)	(0.198)	(0.196)	(0.197)	(0.181)	(0.179)	(0.179)	(0.180)	(0.144)	(0.145)	(0.145)	(0.144)	(0.043)	(0.043)	(0.044)	(0.043)
Size$_{b,t-1}$	-0.039	-0.040	-0.050	-0.044	0.087**	0.087**	0.086*	0.081*	-0.026	-0.024	-0.021	-0.026	-0.011	-0.011	-0.013	-0.010
	(0.050)	(0.047)	(0.044)	(0.044)	(0.041)	(0.043)	(0.045)	(0.045)	(0.018)	(0.018)	(0.019)	(0.020)	(0.011)	(0.011)	(0.012)	(0.011)
Leverage$_{b,t-1}$	-3.654***	-2.647*	-2.836**	-2.866**	-0.491	0.095		0.081	0.827	0.939		0.942	0.158	0.109		0.056
	(1.338)	(1.392)	(1.386)	(1.400)	(0.999)	(1.020)		(1.002)	(0.656)	(0.638)		(0.636)	(0.384)	(0.372)		(0.365)
RoA$_{b,t-1}$	8.958	4.358	6.577	7.918	-8.814	-11.655	-11.248*	-11.979	-2.746	-3.062	2.006	-3.094	-7.260**	-7.067*	-6.289**	-6.378*
	(11.118)	(11.382)	(11.472)	(11.722)	(8.408)	(8.600)	(5.885)	(8.281)	(4.669)	(4.628)	(4.275)	(4.620)	(3.593)	(3.600)	(2.791)	(3.501)
Risk$_{b,t-1}$	-0.001	0.000	-0.000	-0.000	-0.001**	-0.001	-0.001*	-0.001	0.001**	0.001**	0.001	0.001**	-0.000	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Inflation$_{bf,t}$	42.133***	34.361***	34.195***	34.456***	29.753***	26.170***	26.760***	26.427***	7.827	7.000	9.148*	6.860	-10.996***	-10.576***	-10.396***	-10.342***
	(11.482)	(9.739)	(9.712)	(9.631)	(6.376)	(6.154)	(6.624)	(6.347)	(5.369)	(5.545)	(4.874)	(5.603)	(3.638)	(3.579)	(3.427)	(3.525)
GDP growth$_{bf,t}$	20.987*	13.493	13.519	14.249	10.391	3.313	3.311	3.457	-19.331***	-20.677***	-20.404***	-20.390***	6.913**	7.394**	7.592**	7.513**
	(11.176)	(13.601)	(13.500)	(13.587)	(6.635)	(7.730)	(7.766)	(7.765)	(4.263)	(4.418)	(4.343)	(4.466)	(2.935)	(3.088)	(3.090)	(3.051)
Spread$_{bf,t}$	43.364***	36.225***	38.278***	39.528***	16.589***	10.391**	11.177*	10.986**	6.529**	5.184*	7.344**	5.559*	-1.841	-1.405	-0.603	-0.590
	(7.295)	(7.301)	(7.174)	(7.052)	(3.947)	(4.812)	(5.723)	(5.378)	(2.521)	(2.705)	(2.863)	(3.260)	(1.849)	(2.067)	(1.917)	(2.069)
Industry ×Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Savings/Coop FE		✓	✓	✓		✓	✓	✓		✓	✓	✓		✓	✓	✓
Local FE			✓	✓			✓	✓			✓	✓			✓	✓
Savins/Coop FE × Local FE				✓				✓				✓				✓
Observations	6,912	6,912	6,912	6,912	6,761	6,761	6,761	6,761	8,466	8,466	8,466	8,466	7,681	7,681	7,681	7,681
Adjusted R-squared	0.482	0.483	0.485	0.485	0.595	0.596	0.596	0.596	0.600	0.600	0.600	0.600	0.040	0.040	0.041	0.041

Notes : Estimates are based on Model 1.3 estimated with industry-year fixed effects over 2010-2016. The dependent variables are the log of short-term loans (Panel I), the log of long-term loans (Panel II), the log of trade credit (Panel III) and funding costs (Panel IV) defined as financial expenses over total liabilities. *Lerner*$_{b,t-1}$ is banks' Lerner index as defined in 1.3.1 an included with one-year lag. The variable *Small*$_b$ is a dummy variable indicating whether a bank is in the 1 decile by size (total assets). The variable *Savings/Coop*$_b$ indicates whether a banks is either a cooperative or a savings bank. The variable *Local*$_{fb}$ indicates whether a bank-firm pair is located in the same city. The variables *Size*$_{f,t-1}$ (log of total assets), *Cash flow*$_{f,t-1}$ (log of cash flow), *Profit margin*$_{f,t-1}$ (EBITDA/total assets), *Default risk*$_{f,t-1}$ (interest coverage ratio) and *Transparency*$_{f,t-1}$ (fixed tangible assets/total assets) are one-year-lagged firm controls. The variables *Size*$_{b,t-1}$ (log of total assets), *RoA*$_{b,t-1}$ (Return on Assets), *Risk*$_{b,t-1}$ (log of Z-scores), *Leverage*$_{b,t-1}$ (common equity/total assets) are one-year-lagged bank controls. The variables *Inflation*$_{fb,t}$ (HCIP inflation), *GDP growth*$_{fb,t}$ (growth rate of real GDP) and *Spread*$_{fb,t}$ (Sovereign yield spread) are contemporaneous country variables. The model are estimated including *Savings/Coop*$_b$ and *Local*$_{fb}$ fixed effects as indicated. Standard errors in parentheses are clustered at the bank level. ***/**/* indicate significance at the 1%/5%/10% level.

FIGURE 1.2 – The effect of bank market power on access to credit across banks



Notes : Estimated marginal effect of banks' Lerner index on firms' short-term credit for small vs large banks and cooperative/savings vs commercial banks, based on estimates reported in 1.4, columns 1-4 of panel I.

Results reported in Table 1.4 provide some evidence consistent with this view. Estimates in columns 2 and 6 indicate that the negative effect of high market power on bank short and long-term credit is attenuated for firms served by cooperative or savings banks. Specifically, a one standard deviation increase in banks' Lerner index is associated to a 27% and 30% drop in short and long-term credit for firms related to commercial banks, and to a not statistically significant *increase* in short and long-term credit for firms related to cooperative or savings banks. In the same vein, while the negative effect of high market power on short-term loans is amplified if firm and bank are in the same city, the coefficient changes sign – implying an attenuation– if that bank is a cooperative or a savings bank. Importantly, since we control for *Savings/Coop*, *Local* and their interaction, this result indicates that higher bank market power is associated with a smaller reduction in short-term credit for firms served by local savings and cooperative banks over and above any systematic differences in lending activities by local cooperative and savings banks (Angelini et al., 1998). These findings are broadly in line with studies reporting that a large market presence of community banks is associated with more small business lending (Berger et al., 2014) and that community bank mergers are associated with higher loan growth and a greater market share of small business loans funded by local community banks (Avery and Samolyk, 2004). On the other hand, results in table 1.4 show no evidence of corresponding differential effects in terms of long-term credit, trade credit or funding costs.

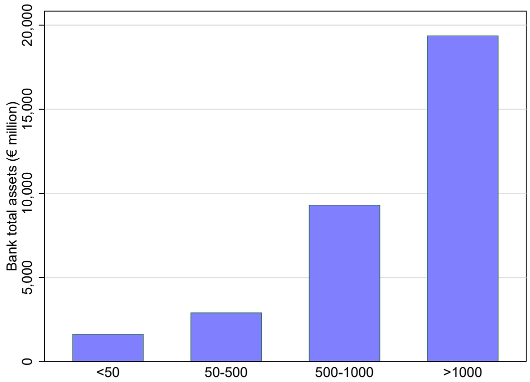
1.4.4 Discussion : market power or information ?

The findings presented in previous sections show that the impact of bank competition on firms' access to credit is markedly heterogeneous. On the one hand, high bank market power implies lower credit availability, more reliance on trade credit and higher borrowing costs for customer firms, particularly for small and opaque firms. On the other hand, the reduction in credit availability associated with high bank market power is attenuated for firms that borrow from small and local community banks. On balance, we reject the information hypothesis in favour of the market power hypothesis – that is, we consider that our evidence indicates that low competitive pressure for banks is related to worse credit conditions for their customer firms. We come to this conclusion based on two considerations. First, the negative effect of bank market power on firm credit availability is especially detrimental precisely where the information hypothesis predicts it should be most beneficial — that is, for small and opaque firms (Bonaccorsi di Patti and Dell'Ariccia, 2004). At the same time, bank market power is at best neutral for the borrowing conditions of firms linked to banks for which the information hypothesis should apply more closely — i.e. small and local community banks (Boot, 2000). We thus consider this latter result as only partly supportive of the information hypothesis which instead predicts low competition to have an unequivocally positive effect on firms' borrowing conditions.

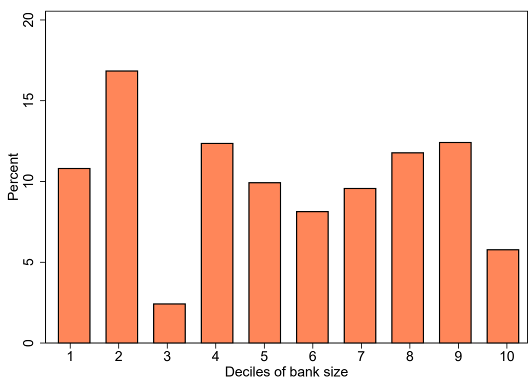
Second, most firms in our sample are SMEs served by banks with no clear interest in relationship lending — that is, medium-large, commercial and non-local banks. Indeed, in our sample a bank's number of lending relationships increases with its size (Figure 1.3a). For instance, banks with less than € 1 billion worth of total assets entertain on average less than 50 relationships with firms, whereas a medium sized bank with total assets worth 10 billion has up to 1000 relationships. This is particularly important considering that in our sample more than 90% of firms declare to be related to a single bank. In other words, larger banks account for a larger share of firms in our sample. Figure 1.3b shows that small banks in the first decile of the distribution – for which we find evidence consistent with the information hypothesis – serve only 11% of firms in our sample, the remaining firms being served by medium sized and large banks.

Crucially, in our sample this is also true for SMEs (see Figure A.1 in Appendix A.5), which, alongside opaque firms, have been shown to be most adversely affected by their bank's degree of market power. The same argument can be made for local community banks. In our sample, only 12% of firms are served by what we defined as local community banks – i.e. cooperative or savings banks located in the same city as the firm. As a result, even if we had underestimated the relevance of the information hypothesis, the information production effect would still be dominated by the market power effect. In fact, this is exactly what we observe in Table 1.2, where results indicate that the overall effect of bank market power on firms' access to credit is clearly negative, implying that the market

FIGURE 1.3 – Compositional effects



(a) Bank size and number of firm relationships



(b) Percentage of firms associated to banks of different size.

power effect outweighs the information production effect across the board. Therefore, even if relationship lenders mitigate the adverse effect of market power on their corporate customers, the balance of evidence indicate that high bank market power has an unambiguously adverse effect on firms' credit conditions because a large majority of firms are SMEs served by banks with no clear incentive to engage in relationship lending.

The limited size of our final sample may cast doubt on the external validity of this interpretation. Specifically, while in our sample a relatively low number of firms are served by small banks, this may be peculiar to our matched database. To mitigate this concern, we return to our original sample of bank-firm relationships for the Euro Area, a much larger database comprising 1623 banks and 620.825 firms for a total of 721.276 bank-firm unique relationships. In particular, we look at the fraction of firms associated to banks of different size and see how many of them are associated to small banks. In this larger sample, only 42.908 firm (6.9%) are linked to a bank that is small by our definition (i.e. with total assets equal or less than 300 million). In this regard, Figure A.2 shows that only a small fraction of firms are related to small banks. Finally, we look at firms that report a single reference bank (528.760, i.e. 85,2% of the sample). Among those, only 6.3% are related to small banks, with the distribution of single-bank firms by bank size being almost identical to that of the full sample (Figure A.3).

Conclusion

In this paper we investigated how bank competition affects firms' credit availability using a database of bank-firm relationships for the Euro Area. Results indicate that high bank market power is associated with worse credit conditions for borrowing firms. Within the same industry and year, firms that borrow from banks with high market power obtain less bank credit (both short and long-term), rely more on trade credit and face higher funding costs than firms that borrow from banks with low market power. Looking at the cross-section of firms, we find the effect of bank market power on credit availability to be especially detrimental precisely where the information hypothesis predicts it should be most beneficial. For a given level of bank market power, opaque firms receive less short and long-term credit, draw more trade credit and face higher funding costs than transparent firms. In the cross-section of banks, for a given level of market power firms borrowing from small and local community banks obtain more credit than firms borrowing from larger and non-local commercial banks, in line with the notion that low competition improves credit availability for firms related to banks with a competitive advantage in forming long-term lending relationships. While this particular finding is partly consistent with the information hypothesis, its significant must be nuanced. Indeed, the predominance of SMEs served by medium-large banks in our sample determines that the overall effect of bank market power on credit conditions is unequivocally adverse for most firms. We therefore consider our results to support the market power hypothesis, whereby lower inter-bank competition worsens credit conditions of corporate borrowers.

These findings have direct implications for competition policy. The current interest in cross-country banking consolidation in the EU may significantly increase the market power of individual banking groups and lower the level of competition in the banking sector. In this respect, our evidence cautions that these developments may result in overall lower credit availability and higher funding costs, especially for financially constrained borrowers such as opaque and small firms. Moreover, while consolidation between small banks could lead to better credit conditions, the recent interest in European banking consolidation has been mostly confined to large lenders (Arnold et al., 2018). From a policy perspective, our results therefore suggest that the benefits of bank consolidation such as scale efficiencies and financial stability should be weighed against the potential negative consequences for firms' access to credit and the costs in terms of economic growth and employment given the critical role of SMEs in European economies (Berger et al., 2017). In this respect, further analysis may find it profitable to trace the wider ramifications of bank market power, for instance in terms of firms' investment, employment and profitability.

A Appendix Chapter I

A.1 Estimating the Lerner index

The Lerner index is defined as the ratio of the difference between price of output and marginal cost to the price. The price of output is the average price of bank output computed as the ratio of total income to total assets. The marginal cost is obtained by estimating a translogarithmic cost function with one output (total asset), and three proxies for input prices (labor, borrowing and capital). As in Demirguc-Kunt and Peria (2010), we estimate the following model :

$$\ln(TC)_{b,t} = \alpha_0 + \alpha_1 y_{b,t} + \frac{1}{2}\alpha_2(\ln y_{b,t})^2 + \sum_{j=1}^{3}\beta_j \ln w_{b,t,j} + \sum_{j=1}^{3}\sum_{k=1}^{3}\beta_{j,k}\ln w_{b,t,j} \times \ln w_{b,t,k}$$
$$+ \frac{1}{2}\sum_{j=1}^{3}\gamma_j \ln w_{b,t,j} \times \ln y_{b,t} + Trend_t(\delta_1 + \delta_2 Trend_t + \delta_3 \ln y_{b,t} + \sum_{j=1}^{3}\delta_4 \ln w_{b,t,j}) + \epsilon_{b,t} \quad \text{(A.1)}$$

where b stands for banks, t for years and j for input prices. In model A.1, TC denotes total costs (sum of total interest paid and operating costs), y total banking assets, w_1 labor price (staff expenses divided by total assets), w_2 the price of physical capital (non-interest expenses divided by total assets) and w_3 the price of borrowed funds (total interest paid divided by customer and short term funding).[1] Model (2) is estimated on a sample of 3650 Euro Area banks extracted from Orbis Bank Focus covering the period 2010-2016. The estimation is carried out country by country with bank-fixed effects. The estimated coefficients are employed to derive the marginal cost (MC) :

$$\widehat{MC_{b,t}} = \frac{TC_{b,t}}{y_{b,t}}\left(\hat{\alpha_1} + \hat{\alpha_2}\ln y_{b,t} + \frac{1}{2}\sum_{j=1}^{3}\hat{\gamma_j}\ln w_{b,t,j} + \hat{\delta_3} Trend_t\right) \quad \text{(A.2)}$$

Finally, the bank-specific Lerner index is obtained as :

$$Lerner_{b,t} = \frac{P_{b,t} - \widehat{MC_{b,t}}}{P_{b,t}} \quad \text{(A.3)}$$

1. To minimise the incidence of outliers, all variables are winsorised at 1%.

A.2 Estimating the H-statistic

A large number of studies measured bank competition with the H-statistic (Panzar and Rosse, 1987), which captures the elasticity of banks revenues relative to input prices. The H-statistic takes values between 0 and 1. By way of interpretation, when the H-statistic takes the value of 1, the market is under perfect competition, when it takes the value of 0 the market is under a monopoly and between 0 and 1 the system operates under monopolistic competition. Indeed, under perfect competition an increase in input prices raises both marginal costs and total revenues by the same amount, and hence the H-statistic equals 1. Under a monopoly, an increase in input prices results in a rise in marginal costs, a fall in output and a decline in revenues, leading to a H-statistic less than or equal to 0. Following Demirguc-Kunt and Peria (2010) we estimate the following model :

$$\ln P_{b,t} = \beta_1 \ln w_{1,b,t} + \beta_2 \ln w_{2,b,t} + \beta_3 \ln w_{3,b,t} + \gamma lnZ_{b,t} + \alpha_i + \delta_t + \varepsilon_{b,t} \quad \text{(A.4)}$$

where b denote banks and t denotes years. As for the Lerner index, w_1 w_2 and w_3 denote the input prices of deposits, labor and capital, respectively. Z is a vector of controls that includes the ratio of equity over total assets, net loans over total assets and the natural logarithm of total assets. α_1 and δ denote bank and year fixed effects, respectively.

The H-statistic is then calculated as :

$$H = \hat{\beta}_1 + \hat{\beta}_2 + \hat{\beta}_3 \quad \text{(A.5)}$$

A.3 The relation between firms and reference banks

Firms' credit balances may be an invalid proxy for the unobserved share of borrowing from the reference bank. To test for the validity of this approximation, we collapse bank credit across firms for each bank, so to create a bank level variable that collects all bank borrowing by firms connected to that particular bank as in Amiti and Weinstein (2011). While this measure is spurious as banks (firms) likely lend (borrow) to other firms (from other banks) not covered in our database, unconditional correlations between bank and firm variables are high : firms' aggregate borrowing moves closely with the total lending, total assets, leverage and stock of non-performing loans (NPL) of the bank reported as their reference bank (first column of Table A.1). This finding suggests there exist interdependencies between firms and reference banks that may reflect credit relations.

TABLE A.1 – Correlation between aggregate firm borrowing within a bank and bank's balance sheet

	ln Agg. firm borrowing$_{b,t}$	ln bank loans$_{b,t}$	ln bank total assets$_{b,t}$	Bank leverage$_{b,t}$
ln bank loans$_{b,t}$	0.3887 (0.0000)			
ln bank total assets$_{b,t}$	0.3543 (0.0000)	0.9877 (0.0000)		
Bank leverage$_{b,t}$	0.314 (0.0000)	-0.3083 (0.0000)	-0.3252 (0.0000)	
ln bank NPL$_{b,t}$	0.192 (0.0000)	0.8185 (0.0000)	0.8014 (0.0000)	-0.1482 (0.0000)

Notes : The table reports pair-wise correlations between a bank's selected balance sheet variables and the aggregate borrowing of all firms linked to that bank. P-values are reported in parentheses.

Yet, firm aggregate borrowing and bank total lending may co-move due to common cyclical trends. To tease these out, we regress firm total borrowing on bank total lending conditional on macroeconomic indicators and year fixed effects by estimating the following bank level model :

$$Agg.\ firm\ borrowing_{b,t} = \beta_1 Loans_{b,t} + \beta_2 total\ assets_{b,t} + \beta_3 Leverage_{b,t} + \beta_4 NPL_{b,t} + \gamma C_{bt} + \alpha_t + \epsilon_{bt} \quad (A.6)$$

where b denotes banks and t years. The dependent variable (*Agg. firm borrowing*) is the log aggregate borrowing of all firms linked to a particular bank and is regressed on four bank balance sheet variables of that bank : *Loans* (the log of a bank's total loans), *Total assets* (the log of a bank's total assets), *Leverage* (common equity/total assets) and *NPL* (the log of a bank's stock of non-performing loans). In vector C we include country level controls (Real GDP growth, inflation and sovereign spread) and year fixed effects to absorb cyclical factors.

Estimates of model A.6 are reported in Table A.2. Regression analysis confirms that firm aggregate borrowing by bank is correlated with bank total loans even when controlling for cyclical factors. Elasticities are positive and both statistically and economically significant, which we take as a further indication of the existence of credit relationships between banks and firms.

TABLE A.2 – Relation between aggregate firm borrowing and banks' balance sheets

	(1)	(2)	(3)	(4)
Variables		Agg. firm borrowing$_{b,t}$		
Loans$_{b,t}$	77.53***			
	(0.711)			
Total assets$_{b,t}$		59.65***		
		(0.778)		
Leverage$_{b,t}$			1,530***	
			(12.98)	
NPL$_{b,t}$				69.90***
				(-1.013)
GDP growth$_{b,t}$	-13,307***	-55,917***	-55,527***	-59,691***
	(180.3)	(196.7)	(191.6)	(213.3)
Inflation$_{b,t}$	163.4***	56.44***	8.177***	47.52***
	-3.195	(-3.130)	(-2.960)	(-3.430)
Spread$_{b,t}$	-15,372***	-39,649***	-44,189***	-42,698***
	(106.4)	(116.0)	(108.5)	(125.1)
Observations	278,439	171,53	171,516	145,507
R-squared	0.182	0.568	0.587	0.523
Year FE	✓	✓	✓	✓

Notes : Estimates are based on Model A.6 estimated with year fixed effects over 2010-2016. The dependent variable (*Agg. firm borrowing*) is the log aggregate borrowing of all firms linked to a particular bank. Dependent variables include : *Loans* (the log of a bank's total loans) ; *total assets* (the log of a bank's total assets) ; *Leverage* (common equity/total assets) and *NPL* (the log of a bank's stock of non-performing loans) ; *Inflation* (HCIP inflation) ; *GDP growth* (growth rate of real GDP) ; and *Spread* (Sovereign yield spread). Standard errors are reported in parentheses, and ***/**/* indicate significant at the 1%/5%/10% level.

A.4 Tables

Table A.3 – Variable list and descriptive statistics

Name	Source	Description	Obs.	Mean	Sd	Min	Max
Bank variables							
$Lerner_b$	Orbis Bank Focus	Banks' Lerner index[1]	130,867	0.329	0.153	-0.068	0.729
$Lerner_b$	Orbis Bank Focus	Banks' Lerner index[2]	171,100	0.304	0.123	-0.145	0.543
$Size_b$	Orbis Bank Focus	Log of total banking assets	173,620	7.837	1.752	4.112	11.827
RoA_b	Orbis Bank Focus	Return on Assets	173,287	0.007	0.007	-0.008	0.039
$Risk_b$	Orbis Bank Focus	Log of Z scores[3]	172,175	7.317	0.036	7.161	7.347
Leverage	Orbis Bank Focus	Common equity/total assets	173,606	0.089	0.096	0.020	0.709
Firm variables							
$Long\text{-}term\ loans_f$	Amadeus	Log of long-term loans	203,299	-1.752	2.071	-8.034	2.968
$Short\text{-}term\ loans_f$	Amadeus	Log of short-term loans	102,457	-2.781	2.542	-10.178	2.680
$Trade\ credit_f$	Amadeus	Log of trade credit	176,015	-2.803	2.278	-9.323	2.163
$Funding\ costs_f$	Amadeus	Financial expenses/total liabilities	104,908	0.227	0.754	0.000	6.147
$Size_f$	Amadeus	Log of total assets	335.308	-0.667	1.921	-5.408	3.874
$Cash\ flow_f$	Amadeus	Log of cash flow	122,985	-3.067	2.049	-7.886	1.910
$Profit\ margin_f$	Amadeus	EBITDA/total assets[4]	155,841	0.010	0.179	-0.732	0.651
$Transparency_f$	Amadeus	Tangible physical assets/total assets	289,229	0.268	0.268	0.000	0.974
$Default\ risk_f$	Amadeus	Interest coverage rate (operating profits/interest paid)	106,558	0.372	1.150	-0.680	7.084
Country variables							
Inflation	Eurostat	HCIP Inflation index, annual change	335,656	0.0141	0.011	-0.016	0.042
GDP growth	Eurostat	annual growth rate of real GDP	335,656	0.011	0.019	-0.061	0.228
Spread	European Central Bank	Yield differential between a country's 10-year sovereign bond and 10-year German Bund	333,444	0.016	0.023	0.000	0.091

Notes : for each variable used in the analysis the table provides a summary description, the data source and descriptive statistics including mean, standard deviation, min and max. All bank and firm level variables are winsorised at 1%.

[1] Lerner index computed as described in appendix A.1, where the marginal cost is estimated with separate regressions for each country.

[2] Lerner index computed as described in appendix A.1, where the marginal cost is estimated with a single Euro Area-wide regression.

[3] As in Beck et al. (2013), Z-scores are computed as $(RoA_{bt} + Leverage_{bt})/\sigma(RoA)_{bt}$ where RoA is a bank's return on assets, *Leverage* is equity over total assets and $\sigma(RoA)$ is the standard deviation of return on assets.

[4] EBITDA corresponds to earnings before interest, taxes, depreciation, and amortisation.

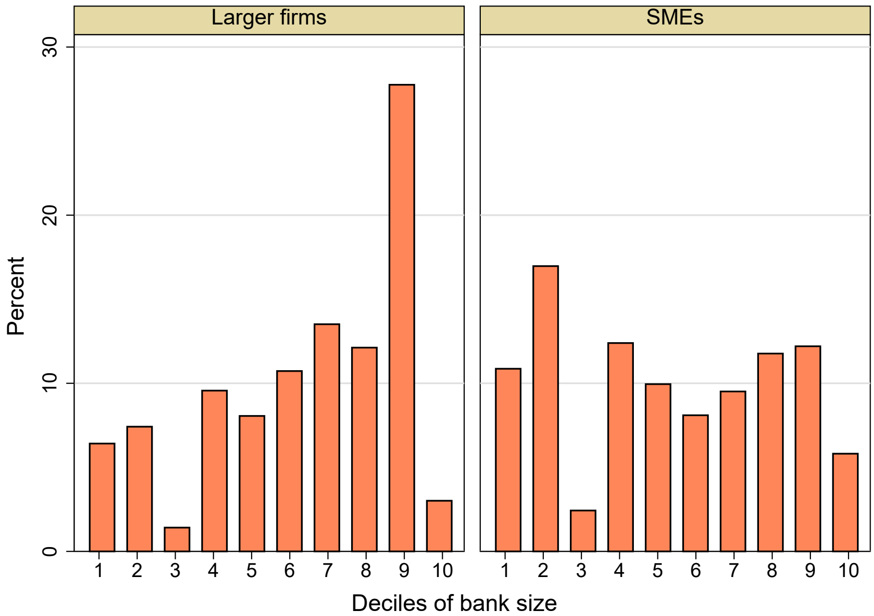
TABLE A.4 – Geographical coverage

Country	N of firms	N of banks
Austria	2638	130
Cyprus	303	4
France	3599	34
Germany	26039	629
Ireland	1	1
Latvia	39	1
Malta	15	2
Netherlands	2	1
Portugal	10647	73
Slovenia	14996	4
Spain	744	22
Total	59023	901

Notes : the table reports the number of firms and banks in the sample located in a particular country in the Euro Area.

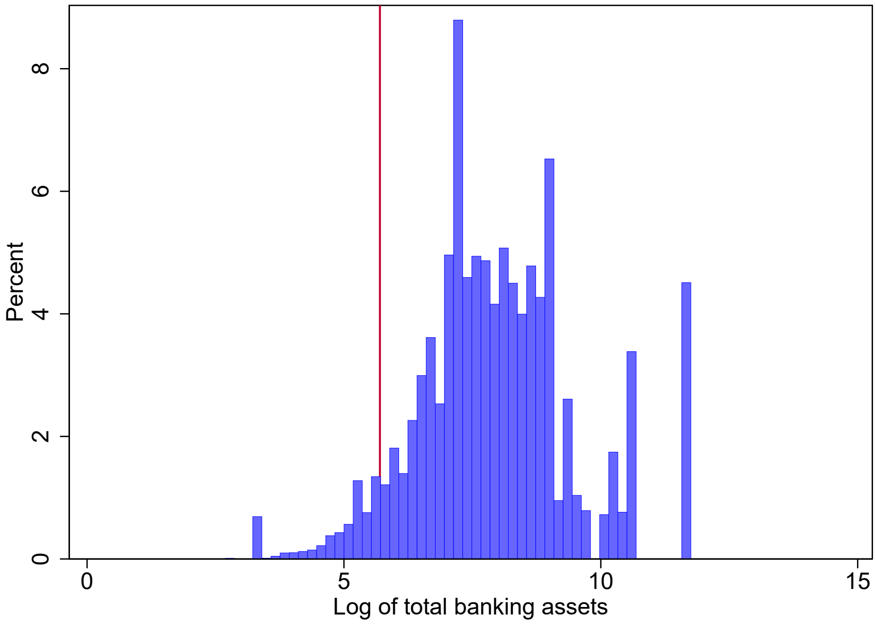
A.5 Figures

Figure A.1 – Fraction of firms associated to banks by size : SMEs vs other firms



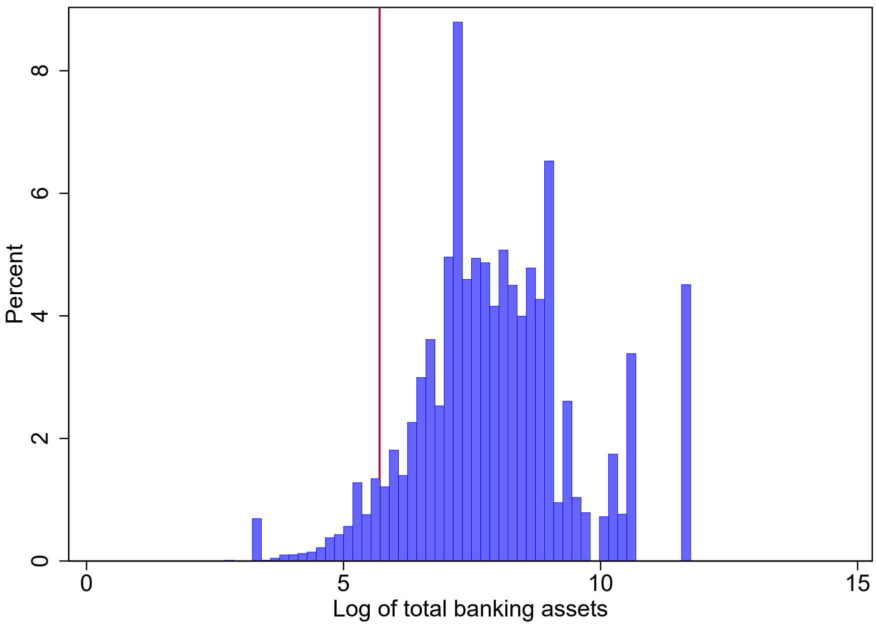
Notes : the figure reports the histogram of the average size of firms' reference banks (10 deciles of banks by mean log total assets) for SMEs (right-hand side panel) and for larger firms (left-hand side panel). Averages are computed over 2010-2016.

FIGURE A.2 – Fraction of firms associated to banks by bank size : original sample



Notes : the figure reports the histogram of the average size of firms' reference banks (mean log total assets). Contrary to all other figures where not indicated, data for this figure refer to the original sample containing 751.276 bank-firm relationships. Averages are computed over 2010-2016. The vertical red line corresponds to the log-equivalent of 300 Million, our threshold to define a bank as small as discussed in Section 1.4.3.

Figure A.3 – Fraction of single-bank firms associated to banks by bank size : original sample



Notes : the figure reports the histogram of the average size of the reference bank of firms reporting a single lender (mean log total assets). Contrary to all other figures where not indicated, data for this figure refer to the original sample containing 751.276 bank-firm relationships. Averages are computed over 2010-2016. The vertical red line corresponds to the log-equivalent of 300 Million, our threshold to define a bank as small as discussed in Section 1.4.3.

2 Chapter II: On the desirability of banking competition

2.1 Introduction

Banking competition became a key research field after the global financial crisis (GFC). Political and economic policies following the crisis, the banking unions and regulations especially, transformed the structure of the banking market. The desirable bank market structure emerged as a central question and, to our knowledge, has no theoretical answer from a dynamic stochastic general equilibrium (DSGE) perspective. This paper aims to find an optimal structure of the banking market which ensures better financial stability and improves households' welfare.

The concentration of the banking market is assumed to lead to greater financial stability making the economy less sensitive to the impact of financial shocks (Keeley, 1990; Allen and Gale, 2004; Beck et al., 2006, 2013). This assumption is in line with the traditional *competition-fragility view* arguing that higher competition leads to lower profit margins and encourages bank risk-taking. Australia and Canada are examples of countries where regulation on bank competition appears to have preserved financial stability during and after the GFC. Their regulation prohibits mergers between the largest banks and maintains an oligopolistic and highly concentrated [1] banking market structure [2]. Arguments linking financial stability and market concentration are also advanced in the debate about banking consolidation across the European Union (EU) where some policy makers welcome cross-border banking consolidation either as a vector of financial integration or as a way to reduce excess capacity (Nuoy, 2017).

This paper assesses and compares the most desirable and stable banking market structures under perfect (PC), monopolistic (MC), Cournot (CC), and Bertrand (BC) competition in a nonlinear DSGE framework.

Despite the empirical and theoretical pieces of evidence of imperfect banking competition, numerous DSGE models neglect the role of intermediaries by assuming PC (Kiyotaki and Moore, 1997; Bernanke et al., 1999; Iacoviello, 2005). Such framework prevents to correctly assess the impact of shocks originating from the financial sector. Besides, banks have no market power and cannot influence private banks' interest rate setting. As the GFC revealed, private banks play a central role in the business cycle and potentially have a significant impact on social welfare. Consequently, the banking sector cannot be restricted to a simple amplifier of the transmission mechanisms. Although the banking literature has significantly grown since the GFC (Iacoviello, 2015; Brunnermeier and Sannikov, 2014; Angeloni and Faia, 2013; Kiley and Sim, 2017; Kollmann et al., 2011; Gerali et al., 2010; Meh and Moran, 2010), the critical characteristics of the banking sector are still missing. Some of these models use the banking sector, but this feature remains only technical (Iacoviello, 2015). Others are only designed to consider shocks from the financial sector without

1. Five of the largest banks in these two countries alone hold more than 80 percent of the market shares of loans and deposits.

2. The optimal number of banks with strong market power is arbitrarily set by policy makers at four for Australia and five for Canada.

allowing for bank market power. By considering monopolistic banking competition and introducing the idea that the markups of the banks depend on their market power, Gerali et al. (2010) marks a turning point in this literature. Market power becomes an essential determinant of the interest rate-setting behavior (Gerali et al., 2010; Darracq Pariès et al., 2011; Brzoza-Brzezina et al., 2013).

Although monopolistic competition confers a specific market power to banks, it does not allow to take into account some characteristics of the banking sector such as homogeneous loans and deposits, strategic interactions, or barriers to entry. Moreover, MC is based on the unrealistic assumption that agents demand a composite bundle of many loans and deposit contracts. Consequently, oligopolistic competition should be more appropriate to capture a larger part of banking market characteristics.

Our paper contributes to the literature through several dimensions. First, we provide a theoretical framework to facilitate the introduction of oligopolistic competition in banking to existing DSGE models. This allows to consider more realistic assumptions such as barriers to entry (Broecker, 1990) and homogenous loans (Angeloni et al., 2003). Second, to our knowledge, this is the first paper to compare different banking market structures : a model without any financial intermediaries–equivalent to PC–, a model with monopolistic banking competition (MC) and models with oligopolistic (CC and BC) banking competition. Third, oligopolistic frameworks allow to consider the number of banks (exogenous parameter) in the determination of interest margins, while other bank competition structures do not allow this. Consequently, we analyse the impact of various levels of bank number on the business cycle under CC and BC. [3]

Our results show that taking into account the structure of the banking market in the transmission of economic and financial shocks is essential. We find that an oligopolistic competition with a limited number of banks mitigates the transmission of financial shocks, and ensures more financial stability. This result confirms the *competition-fragility view*. In terms of social welfare, we find that an oligopolistic structure with a limited number of banks is more desirable compared to MC or a large number of banks. Our results support arguments in favour of the banking union in Europe and, also justify regulations on banking sector leading to maintain oligopolistic and concentrated banking structures.

The remainder of the paper is organised as follows. The model under PC is presented in Section 2.3, and the imperfect competition models are presented in Section 2.4. Section 2.5 presents the calibration and empirical exercises, Section 2.7 the simulation results, Section 2.9 the concluding remarks, and the Appendix provides additional results.

3. Because the theoretical framework of the oligopoly accounts for the number of banks present in the market, the latter can be endogenised, and the barrier to entry assumption becomes plausible.

2.2 The model

Our baseline model (PC) contains four types of agents : patient and impatient households, entrepreneurs, and a central bank. Households supply labor, purchase goods for consumption and accumulate housing. Entrepreneurs produce a homogeneous intermediate good using productive capital and labor supplied by households. Agents lend and borrow directly from the market without intermediaries. Patient households (Section 2.3.1) discount less heavily the future than other agents, which guides their loaning and borrowing behaviours. Consequently, they lend on the financial market while impatient households (Section 2.3.2) and entrepreneurs (Section 2.3.3) borrow. Financial frictions are modelled through the use of collateral constraints : agents wishing to borrow on the market must hold a proportionate share of their loans in the form of collateral, as in Iacoviello (2005) and Gerali et al. (2010). We consider the stock of housing as collateral for impatient households and the stock of capital for entrepreneurs. We then introduce capital producers (Section 2.3.5) as a modelling device to consider varying prices of capital, essential to determine the entrepreneurs' collateral value. We also consider the nominal rigidities essential to match empirical data (Smets and Wouters, 2003, 2007) by adding retailers (Section 2.3.4) who buy intermediate goods from entrepreneurs in a competitive market, differentiate them at no cost, and resell them in a monopolistic market. Price rigidities are assumed to follow a Calvo (1983) adjustment at the retail level. A monetary policy rule is assumed to close the model (Section 2.3.6).
We then consider imperfect competition on the banking sector (Section 2.4). We assume a segmented retail sector with both loan and deposit branchs (Gerali et al., 2010). Retail banks operate alternatively in a regime of monopolistic, Cournot and Bertrand competition. In order to introduce bank capital as an internal source of funding for banks, we assume that bankers are the sole owners of the bank, such that the entire profit is used by bankers to consume and accumulate bank capital.

2.3 Perfect competition

In order to construct an identical framework consistent across our model specifications, we write interest rates specific to each financial instrument, and the central money transfer equation. However, in the baseline model, we assume that : Assumption 1, the interest rate of deposits (R^d) and loans (R^{b_i} and R^{b_e}) are equal to the monetary policy rate [4] (R) ; and Assumption 2, the seigniorage transfers from the central bank J_{cb} are equal to 0. Those assumptions will be released in imperfect competition frameworks.

4. $R^d = R^{b_i} = R^{b_e} = R$.

2.3.1 Patient households

Patient households p work, consume and accumulate housing to maximise their utility according to the following objective function

$$\mathbb{E}_0 \sum_{k=0}^{\infty} \beta_p^k \left(\epsilon_t^z \ln\left(c_{p,t+k}\right) + j \ln\left(h_{p,t+k}\right) - \frac{l_{p,t+k}^{1+\varphi}}{1+\varphi} \right) \tag{2.1}$$

where $c_{p,t}$ denotes the current consumption, $h_{p,t}$ housing services, and $l_{p,t}$ worked hours of patient households. j is the housing weight in the household's preferences and φ is the disutility of labor. β_p is the patient households' discount factor and ϵ_t^z is a preference shock that affects consumption detailed in Section 2.3.8.

Patient households maximise their utility function (Eq. 2.1) with respect to their following budget constraint

$$c_{p,t} + q_{h,t}\left(h_{p,t} - h_{p,t-1}\right) + d_t = \frac{1+R_{t-1}^d}{\pi_t} d_{t-1} + w_{p,t} l_{p,t} + J_{r,t} + J_{cb,t} \tag{2.2}$$

where $q_{h,t} = Q_{h,t}/\pi_t$ is the real housing price, [5] π_t the gross inflation rate, d_t the amount of deposit remunerated at the nominal rate R_t^d, $w_{p,t} = W_{p,t}/\pi_t$ the patient households' real wage. Lump-sum transfers contain both dividend from retailers $J_{r,t}$ and seigniorage transfer from the central bank $J_{cb,t}$.

The optimality conditions of the patient households' maximisation of their utility (Eq. 2.1) subject to their budget constraint (Eq. 2.2) are detailed in the Appendix A.1.1.

2.3.2 Impatient households

Impatient households i work, consume and accumulate housing to maximise their utility according to the following objective function

$$\mathbb{E}_0 \sum_{k=0}^{\infty} \beta_i^k \left(\epsilon_t^z \ln\left(c_{i,t+k}\right) + j \ln\left(h_{i,t+k}\right) - \frac{l_{i,t+k}^{\varphi+1}}{\varphi+1} \right) \tag{2.3}$$

where $c_{i,t}$ denotes the current consumption,$h_{i,t}$ housing services and $l_{i,t}$ worked hours of impatient households. β_i is the impatient households' discount factor. The only difference between the two types of households ties to their degree of impatience : impatient households discount the future more heavily than patient ones which implies that β_i is smaller than β_p (Iacoviello, 2005; Gerali et al., 2010). ϵ_t^z is the same preference shock than for patient households.

Impatient household decisions occur according to their following budget constraint

$$c_{i,t} + q_{h,t}\left(h_{i,t} - h_{i,t-1}\right) + \frac{1+R_{t-1}^{b_i}}{\pi_t} b_{i,t-1} = b_{i,t} + w_{i,t} l_{i,t} + J_{cb,t} \tag{2.4}$$

5. $Q_{h,t}$ is the nominal housing price.

where $b_{i,t}$ denotes impatient households' loans, $R_t^{b_i}$ the nominal interest rate on loans, $w_{i,t}$ the impatient households' real wage, and $J_{cb,t}$ the lump-sum transfer obtained from the central bank.

In our model, financial frictions come from the collateral constraint (Kiyotaki and Moore, 1997; Iacoviello, 2005; Gerali et al., 2010). This constraint forces borrowers to own part of their borrowings in the form of mobilisable assets. For impatient households, this constraint is based on the amount of their real estate. It implies that if the borrower fails to pay his debt, the lender can take possession of its assets by paying a proportional transaction cost equal to $(1 - m_{i,t})\, \mathbb{E}_t \left[q_{h,t+1} h_{i,t} \pi_{t+1}\right]$. In this context, impatient households can borrow $b_{i,t}$ up to a limit equal to $m_{i,t} \mathbb{E}_t \left[q_{h,t+1} h_{i,t} \pi_{t+1} / \left(1 + R_t^{b_i}\right)\right]$. We can write the following collateral constraint

$$\left(1 + R_t^{b_i}\right) b_{i,t} \leq m_{i,t} \mathbb{E}_t \left[q_{h,t+1} h_{i,t} \pi_{t+1}\right] \tag{2.5}$$

where $m_{i,t}$ is the loan-to-value (LTV) ratio detailed in Section 2.3.8. A positive shock on $m_{i,t}$ is interpreted as a collateral constraint tightening. This allows analysing the impact of a credit rationing scenario on the economy.

The optimality conditions of the impatient households' maximisation of their utility (Eq. 2.3) subject to their budget (Eq. 2.4) and collateral (Eq. 2.5) constraints are detailed in Appendix A.1.2.

2.3.3 Entrepreneurs

Entrepreneurs produce intermediate goods according to the following Cobb and Douglas (1928) production function

$$y_t = A_t k_{e,t-1}^{\alpha} l_{p,t}^{\mu(1-\alpha)} l_{i,t}^{(1-\mu)(1-\alpha)} \tag{2.6}$$

where y_t represents intermediate goods, and $k_{e,t}$ the productive capital. α is the share of capital in the production function and μ the share of patient households' labor. A_t is a technology shock detailed in Section 2.3.8.

Entrepreneurs e maximise their utility, which depends only on consumption, according to the following objective function

$$\mathbb{E}_0 \sum_{k=0}^{\infty} \beta_e^k \ln\left(c_{e,t+k}\right) \tag{2.7}$$

where $c_{e,t}$ denotes entrepreneurs' consumption, and β_e the entrepreneurs' discount factor. As for impatient households, entrepreneurs are assumed to be borrowers and therefore, to discount the future more heavily than lenders such as the discount factor β_e should be lower than the one of patient households ($\beta_e < \beta_p$).

Entrepreneurs' decisions occur according to the following budget constraint

$$c_{e,t} + \frac{1+R^{b_e}_{t-1}}{\pi_t} b_{e,t-1} + w_{p,t} l_{p,t} + w_{i,t} l_{i,t} + q_{ke,t} k_{e,t} = \frac{y_t}{x_t} + b_{e,t} + q_{ke,t}\left(1-\delta_{ke}\right) k_{e,t-1} + \tau_{e,t} \quad (2.8)$$

where $b_{e,t}$ denotes entrepreneurs' loans, $R^{b_e}_t$ the nominal interest rate on loans, $q_{ke,t}$ the real price of capital, δ_{ke} the capital depreciation rate, x_t the markup of final over intermediate goods and $\tau_{e,t}$ the lump-sum transfers from the central bank.

As for impatient households, we assume that the entrepreneurs' collateral value constrains the borrowing amount they can borrow, which is given by their holdings of physical capital. The entrepreneur collateral constraint follows

$$\left(1+R^{b_e}_t\right) b_{e,t} \leq \mathbb{E}_t\left[m_{e,t} q_{ke,t+1}\left(1-\delta_{ke}\right) k_{e,t} \pi_{t+1}\right] \quad (2.9)$$

where $m_{e,t}$ is the entrepreneurs' LTV detailed in Section 2.3.8.

Finally, the optimality conditions of the entrepreneurs' maximisation of their utility (Eq. 2.7) subject to their budget constraint (Eq. 2.8), collateral constraint (Eq. 2.9) and production function (Eq. 2.6) are detailed in Appendix A.1.3.

2.3.4 Retail sector

Following Bernanke et al. (1999) and Iacoviello (2005), we assume that goods produced by entrepreneurs can not be immediately consumed. They are first sold to retailers, at wholesale prices $P_{w,t}$, and retailers differentiate them into final goods at no cost. Retailers then sell final goods to consumers at market prices P_t. Under this assumption, $x_t = P_t/P_{w,t}$ denotes the markup of final over intermediate goods.

Retailers z bundle the intermediate goods y_t according to the following CES technology

$$y_t = \left[\int_0^1 y_t\left(z\right)^{\frac{\epsilon_t-1}{\epsilon_t}} dz\right]^{\frac{\epsilon_t}{\epsilon_t-1}} \quad (2.10)$$

where ϵ_t is the elasticity of substitution between intermediate goods detailed in Section 2.3.8.

Given the aggregate output index (Eq. 3.20), the price index P_t is

$$P_t = \left[\int_0^1 P_t\left(z\right)^{1-\epsilon_t} dz\right]^{\frac{1}{1-\epsilon_t}} \quad (2.11)$$

so that each retailer faces an individual demand curve such as

$$y_t\left(z\right) = \left(\frac{P_t\left(z\right)}{P_t}\right)^{-\epsilon_t} y_t \quad (2.12)$$

Following Galí (2015), we introduce price rigidities through a Calvo (1983) adjustment where each retailer resets their prices only with probability $1-\theta$. Consequently, at each period, a fraction θ of retailers keep their prices unchanged, leading to interpret θ as a natural index of price stickiness. In this context, $P_t^*(z)$ denotes the reset price and the corresponding individual demand $y_t^*(z)$ is given by

$$y_t^*(z) = \left(\frac{P_t^*(z)}{P_t}\right)^{-\epsilon_t} y_t \tag{2.13}$$

The aggregate price dynamics is

$$1 = \theta \pi_t^{\epsilon_t - 1} + (1-\theta)\left(\pi_t^*\right)^{(1-\epsilon_t)} \tag{2.14}$$

where π_t^* is the gross inflation rate in period t set by firms reoptimising their price.

A retailer reoptimising in period t will choose his price P_t^* that maximises the current market value of its profit given by

$$\mathbb{E}_t \sum_{k=0}^{\infty} \theta^k \Lambda_{t,k}^p \left[\frac{P_t^* - P_{t+k}^w}{P_{t+k}} y_{t+k}^*(z)\right] \tag{2.15}$$

where $\Lambda_{t,k}^p = \beta_p U_{c,t+k}/U_{c,t}$ is the stochastic discount factor, taking the demand curve (Eq. 2.13) and the wholesale price P_t^w as given.

The optimality condition associated with the retailers' problem is [6]

$$\sum_{k=0}^{\infty} \theta^k \mathbb{E}_t \left[\Lambda_{t,k}^p \left(\frac{P_t^*}{P_{t+k}} - \frac{\epsilon_t}{\epsilon_t - 1}\frac{1}{x_{t+k}}\right) y_{t+k}^*(z)\right] = 0 \tag{2.16}$$

where $\epsilon/(\epsilon-1)$ is the natural (frictionless) markup.

In our model, a positive shock on ϵ_t leads to a decrease in the optimal value of markups, which can be interpreted as a negative price markup shock.

2.3.5 Capital goods producers

At the beginning of each period, capital producers buy an amount i_t of final goods and the stock of old undepreciated capital $(1-\delta_{ke})\, k_{e,t-1}$ from entrepreneurs. [7]

The amount of capital good produced is

$$k_{e,t} = (1-\delta_{ke})k_{e,t-1} + \left[1 - \frac{\kappa_i}{2}\left(\frac{\epsilon_t^{qk} i_t}{i_{t-1}} - 1\right)^2\right] i_t \tag{2.17}$$

where κ_i is the adjustment cost of a change in investment and ϵ_t^{qk} is a shock to the efficiency of investment detailed in Section 2.3.8.

The new capital is then sold to entrepreneurs at the nominal market price of capital Q_k. We assume a perfectly competitive capital market such as the capital good producers' profit maximisation delivers a dynamic equation similar to Smets and Wouters (2003, 2007) for the real price of capital. The optimality condition is detailed in Appendix A.1.4.

6. See Appendix A.2 for more details.

7. We assume that old capital can be converted one to one into new capital and that the transformation of the final good is subject to quadratic adjustment costs.

2.3.6 Monetary policy

The model is closed with the following standard monetary policy reaction function *à la* Taylor (1993)

$$1 + R_t = (1 + R_{t-1})^{\rho_R} \left(\overline{\pi}^{\rho_\pi} \left(\frac{y_t}{y_{t-1}} \right)^{\rho_y} \left(1 + \overline{R}\right) \right)^{1-\rho_R} (1 + \varepsilon_{r,t}) \tag{2.18}$$

where ρ_π and ρ_y reflect the central bank policy weights on inflation and the output gap, respectively. The parameter $\rho_R \in]0;1[$ captures the degree of interest rate smoothing, $\varepsilon_{r,t}$ exogenous fluctuations in the nominal interest rate, and $\overline{\pi}$ the steady-state inflation rate.

We assume that the central bank transfers its profits received from seigniorage to all agents. According to Assumption 2, they are assumed to be 0 in the benchmark model. Otherwise, they are equal to

$$J_{cb,t} = (1 + R_t)\, m_t \tag{2.19}$$

where J_{cb} are seigniorage transfers and m_t are funds obtained by banks in the monetary market.

2.3.7 Aggregation

Equilibrium in the good market is

$$y_t = c_{p,t} + c_{i,t} + c_{e,t} + i_t \tag{2.20}$$

and the equilibrium in the housing market is

$$h_{p,t} + h_{i,t} = 1 \tag{2.21}$$

The aggregate labor is

$$l_t = l_{p,t} + l_{i,t} \tag{2.22}$$

and the aggregate wage is

$$w_t = w_{p,t} + w_{i,t} \tag{2.23}$$

2.3.8 Stochastic structure

The structural shocks are assumed to follow an AR(1) functional form such as

$$X_t = (1 - \rho_X)\, \overline{X} + \rho_X X_{t-1} + \eta_t^X \tag{2.24}$$

where $X_t \in \left\{ \epsilon_t^z, A_{e,t}, m_{i,t}, m_{e,t}, \epsilon_t, \epsilon_t^{qk} \right\}$, $\overline{X}$ is the steady-state value of X_t, $\rho_X \in [0,1[$ is the first-order autoregressive parameter of the shock X_t, and the innovation η_t^X is an *i.i.d* normal error term with zero mean and standard deviation σ_X.

2.4 Imperfect competition

In this section, we introduce financial intermediaries and present three types of imperfect competition in the banking sector : MC (Section 2.4.3), CC (Section 2.4.4), and BC (Section 2.4.5).

This sector completes the benchmark model (Section 2.3) from which we relax Assumption 1 and Assumption 2. [8]

2.4.1 Bank's activity

The same banking activity is assumed over the different competition types to simplify comparison - a simple intermediation function whereby the bank collects deposits from patient households and grants credits to impatient households and entrepreneurs. We assume that each bank j gets funds from the monetary market, deposits, and bank equity. The intermediation activity is then captured by a loan production function taking account of all balance sheet items.

This function is given by

$$b_{e,t}(j) + b_{i,t}(j) = k_{b,t-1}^{\chi_b}(j)\left(m_t(j) + d_t(j)\right)^{1-\chi_b} \tag{2.25}$$

where $b_{e,t}$ and $b_{i,t}$ are respectively loans to entrepreneurs and to impatient households, $k_{b,t}$ is the bank capital and m_t the funds obtained from the monetary market. χ_b is the share of capital in the production function of loans.

The resulting marginal cost is [9]

$$mc_{b,t}(j) = \frac{R_t^{1-\chi_b} R_{kb,t}^{\chi_b}}{(1-\chi_b)^{1-\chi_b}\,\chi_b^{-\chi_b}} \tag{2.26}$$

where $R_{kb,t}$ is the rental rate of capital.

The optimal input ratio for the bank is given by [10]

$$\frac{m_t(j) + d_t(j)}{k_{b,t}(j)} = \frac{R_{kb,t}}{R_t}\frac{1-\chi_b}{\chi_b} \tag{2.27}$$

and the profit equation $j_{b,t}$ for the banking activity is

$$j_{b,t}(j) = \left(\begin{array}{c} R_t^{b_e}(j)\, b_{e,t}(j) + R_t^{b_i}(j)\, b_{i,t}(j) - \\ mc_{b,t}(j)\left(b_{e,t}(j) + b_{i,t}(j)\right) + \left(R_t - R_t^d(j)\right) d_t(j) \end{array}\right) / \pi_{t+1} \tag{2.28}$$

where the income consists of interests earned on loans and money markets. Costs related to banking activity are composed of marginal costs of loan production and interests paid on deposits.

8. We now assume that $R^d \neq R^{b_i} \neq R^{be} \neq R^b$ and $J_{cb} = (1+R)m \neq 0$.

9. See Appendix A.3 for more details.

10. The optimal input ratio is obtain such as the slope of the isoquant and is equal to the slope of isocost line : $MP_{m+d}/MP_{k_b} = P_{m+d}/P_{k_b}$, where MP is the marginal product and P is the cost.

2.4.2 Bankers

Bankers b consume and accumulate capital.[11] They are assumed to be the sole owners of the bank j and maximise their utility following an objective function of the form

$$\mathbb{E}_0 \sum_{k=0}^{\infty} \beta_b^k \ln c_{b,t+k} \tag{2.29}$$

where $c_{b,t}$ is bankers' consumption and β_b the static discount factor. We assume that bankers discount the future like patient households ($\beta_b = \beta_p$).

Bankers decisions behave according to the following budget constraint

$$c_{b,t} + k_{b,t} = (1 + R_{kb,t-1} - \delta_{kb})k_{b,t-1} + j_{b,t}(j) \tag{2.30}$$

where $k_{b,t}$ is the bank capital, $j_{b,t}(j)$ the profit payment received by bankers from bank activity (Eq. 3.37), $R_{kb,t-1}$ the bank capital's rental rate, and δ_{kb} the bank capital depreciation rate.

Bankers maximise their utility function (Eq. 2.29) subjects to the budget constraint (Eq. 3.44) leading to the following first order condition

$$\frac{1}{c_{b,t}} = \beta_b \mathbb{E}_t \left[\frac{1}{c_{b,t+1}} (1 + R_{kb,t} - \delta_{kb}) \right] \tag{2.31}$$

2.4.3 Monopolistic competition

We introduce MC at the banking level by considering the demand for loans and deposits aggregated through a CES aggregator (Gerali et al., 2010). We assume MC in the borrowing and lending markets where we differentiate retail loan and deposit banks.

2.4.3.1 Retail deposit branch

Each bank j chooses its rate of deposit $R_t^d(j)$ which maximises its profit

$$\mathbb{E}_t \sum_{t=0}^{\infty} \Lambda_{t,t+k}^b \left[\left(R_t - R_t^d(j) \right) d_t(j) \right] \tag{2.32}$$

where $\Lambda_{t,t+k}^b = \beta_b U'_{c,t+k}/U'_{c,t}$ is the stochastic discount factor of bankers who are the sole owners of the banks.

The retail deposit bank is constrained by the deposit demand of patient households

$$d_t(j) = \left(\frac{R_t^d(j)}{R_t^d} \right)^{-\varsigma_{d,t}} d_t \tag{2.33}$$

11. Bank capital can be considered as an internal source of funds for banking activity as bankers are the sole owners of the banks.

where $R_t^d(j)$ is the bank's deposit rate, R_t^d is the economy-wide deposit rate, $d_t(j)$ is the demand for these bank deposits, and d_t is the economy-wide demand for deposits. $\varsigma_{d,t}$ is the exogenous elasticity of substitution of deposits detailed in Section 2.4.6.

After imposing a symmetric equilibrium, the first order condition becomes

$$R_t^d = R_t \frac{\varsigma_{d,t}}{\varsigma_{d,t} - 1} \tag{2.34}$$

2.4.3.2 Retail loan branch

The loan branch grants loans to impatient households and entrepreneurs. The retail loan bank chooses the interest rates $R_t^{b_k}(j)$ maximising the profit

$$\mathbb{E}_t \sum_{t=0}^{\infty} \Lambda_{t,t+k}^b \left[\sum_{k=e,i} R_t^{b_k}(j)\, b_{k,t}(j) - mc_{b,t}(j) \left(\sum_{k=e,i} b_{k,t}(j) \right) \right] \tag{2.35}$$

where b_k denotes loans to impatient households ($b_{i,t}$) and entrepreneurs ($b_{e,t}$), and $R_t^{b_k}$ the rate on loans to impatient households ($R_t^{b_i}$) and entrepreneurs ($R_t^{b_e}$).

Retail loan banks are constrained by the loan demand of impatient households and entrepreneurs

$$b_{k,t}(j) = \left(\frac{R_t^{b_k}(j)}{R_t^{b_k}} \right)^{-\varsigma_{bk,t}} b_{k,t} \tag{2.36}$$

where $R_t^{b_k}(j)$ is the bank's loan rate, $R_t^{b_k}$ the economy-wide loan rate, $b_{k,t}(j)$ the demand for bank j loans, and $b_{k,t}$ the economy-wide demand for deposits. $\varsigma_{b,k,t}$ is the exogenous elasticity of substitution of loans detailed in Section 2.4.6.

After imposing a symmetric equilibrium, the first order condition associated with the bank problem for impatient households' and entrepreneurs' loan rate is

$$R_t^{b_{ki}} = mc_{b,t} \frac{\varsigma_{b_k,t}}{\varsigma_{b_k,t} - 1} \tag{2.37}$$

2.4.4 Cournot oligopoly

We analyse competition in quantity (CC) which requires the inverse demand function for deposits and loans. Starting from the aggregated demand function, we write the inverse demand function as in Colciago and Etro (2010).

The retail activity is also divided between two types of banks, retail deposit, and retail loan branch. As banks compete on quantities, each bank j chooses the amount of deposit or the amount of loans, taking as given the production of all banks and the inverse function of demand.

As we are interested in analysing the impact of a change in the number of banks operating in the market on the economy, and especially on the household's welfare, the number of banks N is exogenous.

2.4.4.1 Retail deposit branch

Each bank j chooses its amount of deposit $d_t(j)$ which maximizes its equation of profit

$$\mathbb{E}_t \sum_{t=0}^{\infty} \Lambda^b_{t,t+k} \left[R_t - R^d_t(j)\right] d_t(j) \tag{2.38}$$

taking as given deposits of all other banks and under the inverse demand function [12]

$$R^d_t(j) = \frac{d_t(j)^{\frac{-1}{\varsigma_{d,t}}} EXP_{d,t}}{\sum_{i=1}^{N_t} d_t(i)^{\frac{\varsigma_{d,t}-1}{\varsigma_{d,t}}}} \tag{2.39}$$

where $EXP_{d,t} = R^d_t d_t$ is the deposits' function of expenses.

The first order conditions associated with the retail deposit branch under CC is

$$\left(\frac{\varsigma_{d,t}-1}{\varsigma_{d,t}}\right) \frac{d_t(j)^{\frac{-1}{\varsigma_{d,t}}} EXP_{d,t}}{\sum_{i=1}^{N_t} d_t(i)^{\frac{\varsigma_{d,t}-1}{\varsigma_{d,t}}}} - \left(\frac{\varsigma_{d,t}-1}{\varsigma_{d,t}}\right) \frac{d_t(j)^{\frac{\varsigma_{d,t}-2}{\varsigma_{d,t}}} EXP_{d,t}}{\left(\sum_{j=i}^{N_t} d_t(i)^{\frac{\varsigma_{d,t}-1}{\varsigma_{d,t}}}\right)^2} = R_t \tag{2.40}$$

In each period, N banks compete on quantities, choosing their individual supply $d_t(j)$ that maximises profits taking the supply of all other banks as given. For all banks $j = 1, 2, ..., N$, Eq. 2.40 can be simplified by imposing a symmetric equilibrium which leads to the symmetric individual deposit supply

$$d_t = \frac{(\varsigma_{d,t}-1)(N-1) EXP_{d,t}}{R_t \varsigma_{d,t} N^2} \tag{2.41}$$

Because $R^d_t = EXP_{d,t}/d_t$, R^d_t can be expressed as

$$R^d_t = R_t \frac{N^2}{(N-1)} \frac{\varsigma_{d,t}}{\varsigma_{d,t}-1} \tag{2.42}$$

which is associated with the deposit equilibrium markup

$$\mu_{d,t} = \frac{\varsigma_{d,t} N^2}{(\varsigma_{d,t}-1)(N-1)} \tag{2.43}$$

Finally, the deposit markup depends on the time-varying inter-temporal elasticity of substitution of deposits, and the number of active banks in the market.

12. See Appendix A.5 for more details.

2.4.4.2 Retail loan branch

Each bank j chooses its amount of loans $b_{k,t}(j)$ which maximizes its equation of profit

$$\mathbb{E}_t \sum_{t=0}^{\infty} \Lambda^b_{t,t+k} \left[\sum_{k=i,e} R_t^{b_k}(j)\, b_{k,t}(j) - mc_{b,t}(j) \left(\sum_{k=i,e} b_{k,t} \right) \right] \tag{2.44}$$

taking as given the loans of all other banks and under the inverse demand function [13]

$$R_t^{b_k}(j) = \frac{b_{k,t}(j)^{\frac{-1}{\varsigma_{b_{k,t}}}} EXP_{bk,t}}{\sum_{i=1}^{N_t} b_{k,t}(i)^{\frac{\varsigma_{b_{k,t}}-1}{\varsigma_{b_{k,t}}}}} \tag{2.45}$$

where $EXP_{bk,t} = R_t^{b_k} b_{k,t}$ is the loans' function of expenses.

The first order condition associated with the loan retail bank under CC is

$$\left(\frac{\varsigma_{b_{k,t}}-1}{\varsigma_{b_{k,t}}}\right) \frac{b_{k,t}(j)^{\frac{-1}{\varsigma_{b_{k,t}}}} EXP_{bk,t}}{\sum_{i=1}^{N_t} b_{k:t}(i)^{\frac{\varsigma_{b_{k,t}}-1}{\varsigma_{b_{k,t}}}}} - \left(\frac{\varsigma_{b_{k,t}}-1}{\varsigma_{b_{k,t}}}\right) \frac{b_{k,t}(j)^{\frac{\varsigma_{b_{k,t}}-2}{\varsigma_{b_{k,t}}}} EXP_{bk,t}}{\left(\sum_{j=i}^{N_t} b_{k,t}(i)^{\frac{\varsigma_{b_{k,t}}-1}{\varsigma_{b_{k,t}}}}\right)^2} = mc_{b,t} \tag{2.46}$$

At each period, N banks compete on quantities, choosing their individual supply $b_{k,t}(j)$ that maximise profits taking the supply of all other banks as given. For all banks $j = 1, 2, ..., N$, Eq. 2.46 can be simplified by imposing a symmetric equilibrium.

This generates the symmetric individual loan supply

$$b_{k,t} = \frac{\left(\varsigma_{b_{k,t}}-1\right)(N-1)\, EXP_{bk,t}}{mc_{b,t}\varsigma_{b_{k,t}} N^2} \tag{2.47}$$

as $R_t^{b_k} = EXP_{bk,t}/b_{k,t}$, we can write the expression of $R_t^{b_k}$ such as

$$R_t^{b_k} = mc_{b,t} \frac{N^2}{(N-1)} \frac{\varsigma_{b_{k,t}}}{\varsigma_{b_{k,t}}-1} \tag{2.48}$$

which is associated with the loan equilibrium markup

$$\mu_{bk,t} = \frac{\varsigma_{b_{k,t}} N^2}{\left(\varsigma_{b_{k,t}}-1\right)(N-1)} \tag{2.49}$$

Finally, the loan markup depends on the time-varying inter-temporal elasticity of substitution of loans, and the number of active banks in the market.

13. See Appendix A.5 for more details.

2.4.5 Bertrand oligopoly

Similarly to the firm competition in Faia (2012), we introduce BC for banks. We now consider that banks compete by choosing their loan rate. Each bank j chooses the rate that maximises profits taking as given the rate of the other banks i.

2.4.5.1 Retail deposit branch

Each bank j chooses its rate of deposit $R_t^d(j)$ which maximises its profit

$$\mathbb{E}_t \sum_{t=0}^{\infty} \Lambda_{t,t+k}^b \left[R_t - R_t^d(j)\right] d_t(j) \tag{2.50}$$

taking as given the deposit rate of all banks and under the direct demand function with strategic interactions [14]

$$d_t(j) = \frac{R_t^d(j)^{-\varsigma_{d,t}}}{\sum_{i=1}^N R_t^d(i)^{-(\varsigma_{d,t}-1)}} EXP_{d,t} \tag{2.51}$$

The first order condition associated with the deposit retail bank under BC is

$$\begin{aligned} & R_t EXP_{d,t} \left(\frac{-\varsigma_{d,t} R_t^d(j)^{-\varsigma_{d,t}-1}}{\sum_{i=1}^N R_t^d(i)^{-(\varsigma_{d,t}-1)}} + \frac{(\varsigma_{d,t}-1) R_t^d(j)^{-2\varsigma_{d,t}}}{\left[\sum_{i=1}^N R_t^d(i)^{-(\varsigma_{d,t}-1)}\right]^2} \right) \\ = \; & EXP_{d,t} \left(\frac{(1-\varsigma_{d,t}) R_t^d(j)^{-\varsigma_{d,t}}}{\sum_{i=1}^N R_t^d(i)^{-(\varsigma_{d,t}-1)}} + \frac{(\varsigma_{d,t}-1) R_t^d(j)^{1-2\varsigma_{d,t}}}{\left[\sum_{i=1}^N R_t^d(i)^{-(\varsigma_{d,t}-1)}\right]^2} \right) \end{aligned} \tag{2.52}$$

In each period, N banks compete on prices, choosing their individual deposit rate $R_t^d(j)$ that maximises profits taking the rate of all the other banks as given. For all banks $j = 1, 2, ..., N$, Eq. 2.52 can be simplified by imposing a symmetric equilibrium, leading to the individual deposit rate

$$R_t^d = R_t \frac{(\varsigma_{d,t}(1-N) - 1)}{(1-\varsigma_{d,t})(N-1)} \tag{2.53}$$

which is associated with the following deposit equilibrium markup

$$\mu_{d,t} = \frac{(\varsigma_{d,t}(1-N) - 1)}{(1-\varsigma_{d,t})(N-1)} \tag{2.54}$$

14. See appendix A.6 for more details.

2.4.5.2 Retail loan branch

Each bank j chooses its rate of loans $R_t^{b_k}(j)$ which maximises its equation of profit

$$\mathbb{E}_t \sum_{t=0}^{\infty} \Lambda_{t,t+k}^{b} \left[\sum_{k=i,e} R_t^{b_k}(j)\, b_{k,t}(j) - mc_{b,t}(j) \left(\sum_{k=i,e} b_{k,t} \right) \right] \tag{2.55}$$

taking as given the loan rate of all banks and under the direct demand function with strategic interactions [15]

$$b_{k,t}(j) = \frac{R_t^{b_k}(j)^{-\varsigma_{b_{k,t}}}}{\sum_{i=1}^{N} R_t^{b_k}(i)^{-\left(\varsigma_{b_{k,t}}-1\right)}} EXP_{bk,t} \tag{2.56}$$

The first order condition associated with the loan retail bank in Bertrand oligopoly is

$$\begin{aligned} & EXP_{bk,t} \left(\frac{\left(1-\varsigma_{b_{k,t}}\right) R_t^{b_k}(j)^{-\varsigma_{b_{k,t}}}}{\sum_{i=1}^{N} R_t^{b_k}(i)^{-\left(\varsigma_{b_{k,t}}-1\right)}} + \frac{\left(\varsigma_{b_{k,t}}-1\right) R_t^{b_k}(j)^{1-2\varsigma_{b_{k,t}}}}{\left[\sum_{i=1}^{N} R_t^{b_k}(i)^{-\left(\varsigma_{b_{k,t}}-1\right)}\right]^2} \right) \\ = \; & mc_{b,t} EXP_{bk,t} \left(\frac{-\varsigma_{b_{k,t}} R_t^{b_k}(j)^{-\varsigma_{b_{k,t}}-1}}{\sum_{i=1}^{N} R_t^{b_k}(i)^{-\left(\varsigma_{b_{k,t}}-1\right)}} + \frac{\left(\varsigma_{b_{k,t}}-1\right) R_t^{b_k}(j)^{-2\varsigma_{b_{k,t}}}}{\left[\sum_{i=1}^{N} R_t^{b_k}(i)^{-\left(\varsigma_{b_{k,t}}-1\right)}\right]^2} \right) \end{aligned} \tag{2.57}$$

In each period, N banks compete on prices, choosing their individual loan rates $R_t^{b_k}(j)$ that maximise profits taking the rates of all other banks as given. For all banks $j = 1, 2, ..., N$, Eq. 2.57 can be simplified by imposing a symmetric equilibrium. This generates the symmetric individual loan rate

$$R_t^{b_k} = mc_{b,t} \frac{\left(\varsigma_{b_{k,t}}(1-N)-1\right)}{\left(1-\varsigma_{b_{k,t}}\right)(N-1)} \tag{2.58}$$

which is associated with the following equilibrium markup

$$\mu_{d,t} = \frac{\left(\varsigma_{b_{k,t}}(1-N)-1\right)}{\left(1-\varsigma_{b_{k,t}}\right)(N-1)} \tag{2.59}$$

15. See appendix A.6 for more details.

2.4.6 Stochastic structure

The structural shocks to the banking sector are assumed to follow a first-order autoregressive functional form such as

$$X_t = (1-\rho_X)\,\overline{X} + \rho_X X_{t-1} + \eta_t^X \tag{2.60}$$

where $X_t \in \left\{\varsigma_{d,t}, \varsigma_{b_{k,t}}\right\}$, $\overline{X}$ is the steady-state value of X_t, $\rho_X \in [0,1[$ is the first-order autoregressive parameter of the shock X_t and the innovation η_t^X is an $i.i.d$ normal error term with zero mean and standard deviation σ_X.

2.5 Calibration

Our parameters are calibrated according to the literature and historical steady-state ratios for the US. [16] We calibrate $\beta_p = 0.994$ to obtain a deposit rate close to 2 percent. The discount factor of impatient households and entrepreneurs, respectively β_i and β_e are calibrated to 0.975 to ensure the binding of the collateral constraint in the steady-state. [17] The banker discount factor β_b is assumed to be equal to that of the patient households as in Hollander and Liu (2016). The relative weight of housing in the utility function j is calibrated to 0.2, which is close to the calculated ratio of US residential investment to GDP. The labor disutility is $\varphi = 1$ in line with the value of Galí (2008). The capital share in the production function α is 0.25, a value commonly used in the literature, the depreciation rate of capital δ_k is 0.025 as in Brzoza-Brzezina et al. (2013) and the share of patient households μ is calibrated to 0.8 in line with the evidence of Iacoviello and Neri (2010). The steady-state price markup $\overline{\epsilon}$ is calibrated to 6, leading to a price markup of 20%, a common value in the literature (Galí, 2008). The patient households LTV ratio $\overline{m_{i,t}}$ is 0.7 in line with the US share of housing loans to GDP and Iacoviello (2005). The entrepreneurs' value $\overline{m_{e,t}}$ is 0.35 reflecting the evidence that entrepreneurs can less easily collateralise their loans than impatient households.

For the banking parameters, only few papers estimate the value for the US in the literature. The elasticity of substitution for deposit $\overline{\varsigma_d}$ is -1.47 calculated as the average monthly spread between deposit rate [18] and the effective federal fund rate (monetary policy

16. We calibrate our model from quarterly US data. We make this choice because of the accessibility of the data, their quality, and the length of the sample. This choice scarcely impacts the calibration of our parameters. As demonstrated by Smets and Wouters (2005), the aggregated macroeconomic variables behaviour in the Eurozone was similar to what observed in the US. This leads to a lack of significant differences in the estimated parameters between these two monetary areas.

17. In the steady-state, the borrowing constraints are binding if and only if the Lagrange multipliers (λ_i and λ_e) are greater than 0. As $\lambda_i = \frac{1}{c_i}(\beta_p - \beta_i)$ and $\lambda_e = \frac{1}{c_e}(\beta_p - \beta_e)$, they are greater than zero if and only if $\beta_p > \beta_i$ and $\beta_p > \beta_e$. Satisfying these constraints implies that borrowers always prefer to borrow rather than favour precautionary savings.

18. The deposit rate is the National Rate on Non-Jumbo Deposits obtained from FRED database.

rate). The elasticity of substitution for impatient households $\overline{\varsigma_{bi}}$ and entrepreneurs $\overline{\varsigma_{be}}$ loans are calibrated to respectively 3.3 and 2.7 reflecting the average monthly spread between loan rate to impatient households and firms and monetary policy rate, respectively. According to the recent US commercial banks' balance sheet condition we calibrate the bank capital share in the production function χ_b to 0.09 and the bank capital depreciation rate δ_{kb} is calibrated to 0.1. As banks are assumed to be symmetric in our model, the number of banks is a proxy for bank concentration. In what follows, we calibrate the number of banks N equal to 2, 5, and 50 alternatively in order to consider different scenarios of concentration of the banking market.

Parameter	**Description**	**Calibration**
β_p	Patient households' static discount factor	0.994
β_i	Impatient households' static discount factor	0.975
β_e	Entrepreneurs' static discount factor	0.975
β_b	Bankers' static discount factor	0.994
φ	Disutility of labor	1
j	Relative utility weight of housing	0.2
α	Capital share in the production function	0.25
μ	Labor income share of patient households	0.8
δ_k	Depreciation rate of physical capital	0.025
$\overline{\epsilon}$	Steady-state price markup	6
θ	Price stickiness Calvo (1983) parameter	0.7
χ_b	Bank capital share in the loan production function	0.09
δ_{kb}	Bank capital depreciation rate	0.1
$\overline{\varsigma_d}$	Steady-state elasticity of substitution of deposits	-1.47
$\overline{\varsigma_{bi}}$	Steady-state elasticity of substitution of impatient loans	3.3
$\overline{\varsigma_{be}}$	Steady-state elasticity of substitution of entrepreneur loans	2.7
$\overline{m_{i,t}}$	Steady-state LTV ratio of impatient households	0.7
$\overline{m_{e,t}}$	Steady-state LTV ratio of impatient entrepreneurs	0.35
ϕ_π	Weight on inflation in the monetary policy rule	2
ϕ_Y	Weight on output gap in the monetary policy rule	0.3
ρ_R	Interest rate smoothing	0.75
$\overline{\pi}$	Steady-state gross inflation rate	1

TABLE 2.1 – Definition of estimated models' parameters.

Table 2.2 presents the steady-state ratios for each competition type from the calibration presented in Table 2.1. We compare these theoretical steady-state ratios with the historical ones [19] and with the theoretical values obtained by Gerali et al. (2010). We find that all our specifications give results close to Gerali et al. (2010).

SS ratio	PC	MC	CC	BC	CC	BC	1976-2018	Gerali's value
Nb. of banks			N=2	N=2	N=50	N=50		
c/y	0.88	0.89	0.90	0.89	0.90	0.90	0.95	0.87
k/y	4.76	4.08	4.03	4.57	4.08	4.09	2.46	4.40
i/y	0.12	0.10	0.10	0.11	0.10	0.10	0.29	0.11
b/y	2.99	1.98	1.93	2.61	1.98	2.00	0.86	1.90

TABLE 2.2 – Matching of steady-state ratio with economic data

Table 2.3 compares theoretical financial steady-state ratios with the historical US data. We first compare to the empirical values of the full sample, spanning from 1976 to 2018, second, we compare to the period 2008-2018 in order to analyse only the period after the GFC and third, we compare to the period 2003-2007 allowing to analyse a short period sample characterised by the absence of specific risk. We find results in line with the evolution of concentration in the American banking sector captured by the evolution of the 5-bank asset concentration ratio. Fig.2.1 highlights two waves of concentration, the first one in 2004 and the second one in 2008. Consequently the five largest banks held 31.1% of total bank assets in 2003, and this amount increased to around 50% after the GFC. In line with this empirical evidence that the US banking market tends to be more concentrated after the GFC, the comparison of theoretical values with the full sample reveals that the BC type with 50 banks fits better the observed steady-state ratios. However, for the period after the GFC, the BC with two banks is closer to historical values.

SS ratio	PC	MC	CC	BC	CC	BC	1976-2018	2008-2018	2003-2007
Nb. of banks			N=2	N=2	N=50	N=50			
b_h/b	0.46	0.32	0.31	0.41	0.32	0.32	0.5	0.5	0.52
b_e/b	0.54	0.68	0.69	0.59	0.68	0.68	0.5	0.5	0.48
$400 \times R$	2.41	4.07	2.03	2.41	3.99	4.01	5.00	0.64	2.98
$400 \times R^{b_h}$		9.75	10.38	4.23	9.77	9.57	7.74	4.22	5.86
$400 \times R^{b_e}$		10.80	11.50	4.23	10.82	10.58	8.33	4.60	6.29

TABLE 2.3 – Matching of steady-state ratio with financial data

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19. See Appendix A.8 for more details about the data.

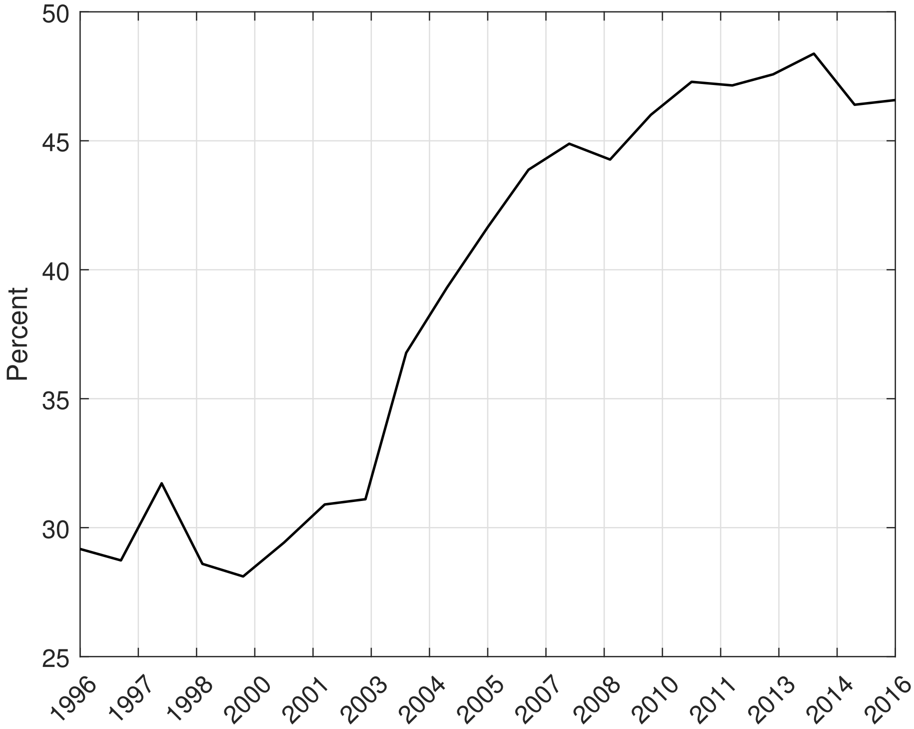

FIGURE 2.1 – Source : 5-Bank Asset Concentration for the US, Federal Reserve bank of St. Louis

2.6 Moment matching

We compare our different banking structures to US empirical data over the period 1976 to 2018. We find that oligopolistic competition models better match historical data first moments (Table 2.4). In particular, the CC model is the closest to the empirical data.

	MC	CC	BC	CC	BC	Empirical value
Nb. of banks		N=2	N=2	N=50	N=50	
Inflation	1	1	1	1	1	0.77
Housing price	1.14	1.20	1.11	1.14	1.14	1.13
Monetary policy rate	1.38	1.05	1.07	1.34	1.34	1.25
Entrepreneurs loan rate	2.37	1.62	1.20	2.23	2.28	1.93
Impatient households loan rate	2.14	1.62	1.20	2.02	2.06	2.08
Deposits	0.39	0.59	0.29	0.40	0.39	0.56
Output	0.11	0.14	0.06	0.11	0.11	0.39
Investment	0.51	0.67	0.34	0.51	0.50	0.45
Wage	0.13	0.17	0.09	0.13	0.12	0.32
Entrepreneurs loans	0.49	0.64	0.34	0.49	0.48	0.59
Impatient households loans	0.17	0.41	0.23	0.19	0.18	0.72
Capital	0.51	0.67	0.34	0.51	0.50	0.39

TABLE 2.4 – Matching of different competition type to the main empirical variables

2.7 Simulation

Simulations are obtained by solving the model in nonlinear, computed with an analytical steady-state, and solved in the second order of simulation. We assume a number of banks equal to 5 in order to be close to the reality of most industrialised countries.

We restrict our analysis to four mains shocks composed of two economic shocks (positive productivity and negative monetary policy shocks) and two financial shocks (positive impatient households and entrepreneurs' loans markup shocks). For all of them, the unconditional welfare is impacted, and the magnitude of its response depends on banking competition. In order to capture this difference, we compare the impulse response functions under all competition types (MC, CC, and BC) focusing on welfare variations.

We write the unconditional welfare for each household (patient and impatient), and we aggregate it to obtain the welfare of all households in our economy. We write the unconditional welfare of patient households ($Welfare_{p,t}$) and impatient households ($Welfare_{i,t}$), such as

$$Welfare_{p,t} = U_p + \beta_p Welfare_{p,t+1} \tag{2.61}$$

$$Welfare_{i,t} = U_i + \beta_i Welfare_{i,t+1} \tag{2.62}$$

where U_p and U_i are respectively the patient and impatient households' utility functions (given by eq.2.1 and eq.2.3).

We aggregate the unconditional welfare for all households according to a weighted average between patient (μ) and impatient ($1-\mu$) households' welfares such as

$$Welfare_t = \mu Welfare_{p,t} + (1-\mu)\, Welfare_{i,t} \tag{2.63}$$

where $\mu = 0.8$

2.7.1 Productivity shock

The unconditional welfare is positively impacted after a 1% positive productivity shock whatever the type of competition. However, the amplification mechanism changes through each competition scenario. As we can see in Fig. 2.2, a one percent productivity shock leads to an increase in the unconditional welfare of almost 1.5 percent in PC while it increases the unconditional welfare at more than 3 percent in MC. The change in unconditional welfare in the oligopolistic competition framework is between the other two types of competition. In particular, the rise of the unconditional welfare after a positive productivity shock in CC and BC is between 1.5 and 3 percent.

Fig. 2.3 compares the IRFs of the MC model with those of oligopolistic competition. [20] The transmission mechanism of a productivity shock to welfare is very standard. After this shock, firms are more productive and increase their production. Extra-profit earned are rebated to patient households which get more consumption, leisure and, finally, welfare. Also, impatient households enjoy higher wages allowing them to expand their consumption and thereby to increase their unconditional welfare. Moreover, inflation decreases leading the monetary authority to decrease the policy rate. This is transmitted to retail rates allowing impatient households and entrepreneurs to enjoy better loans conditions. The level of loans is higher and so on the level of investment and impatient households' housing demand. This plays as an amplification effect on the unconditional welfare of impatient households.

However, competition type plays an important role in this transmission mechanism as it impacts the response of retail loan rates after a change in the monetary policy rate. As the policy rate impacts positively the level of marginal cost of producing loans, a decrease in the policy rate is translated into a decrease in marginal cost. The marginal cost of producing loans is positively related to each equation of interest rate setting dynamics (Eq. 2.37, Eq. 2.48 and Eq. 2.58) leading to a decrease in retail loan rates whatever the competition framework. However, in oligopolistic competition the negative response of borrowing

20. After a productivity shock, the IRFs under PC and MC are close to Gerali et al. (2010), see Appendix A.7.1 for more details. Indeed, we find that the response of consumption is attenuated under MC while the response of investment is amplified. We also find that the responses of the variables are more persistent under MC than under PC.

interest rates is attenuated, dampening the positive response of loans and investment. In fact, under oligopolistic competition, banks act by taking into account the behaviour of other banks. [21] In order to maintain their market shares, oligopolistic banks reduce their loans rates (BC) or increasing the amount of loans granted (CC), so that they maintain their margins. Finally, in oligopolistic competition frameworks, rates and bank profit fall less than in MC and loans and investment increase less, resulting in the same response of unconditional welfare. [22]

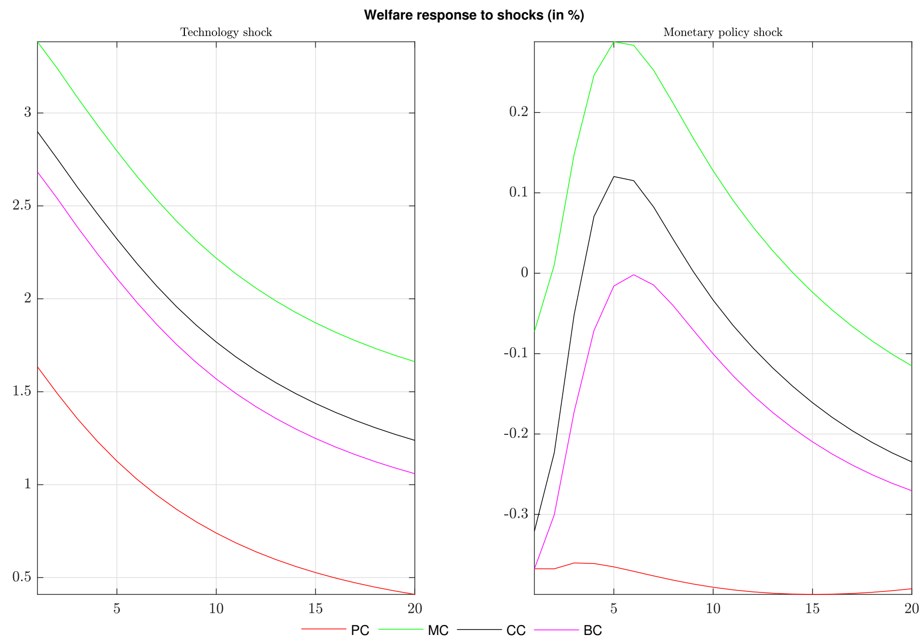

FIGURE 2.2 – Unconditional welfare response after a positive productivity shock and a negative monetary policy shock

21. The equilibrium we find is a Nash equilibrium since we do not assume any cooperation between the banks.
22. More details about the partial adjustment in MC are provided in Appendix A.7.2.

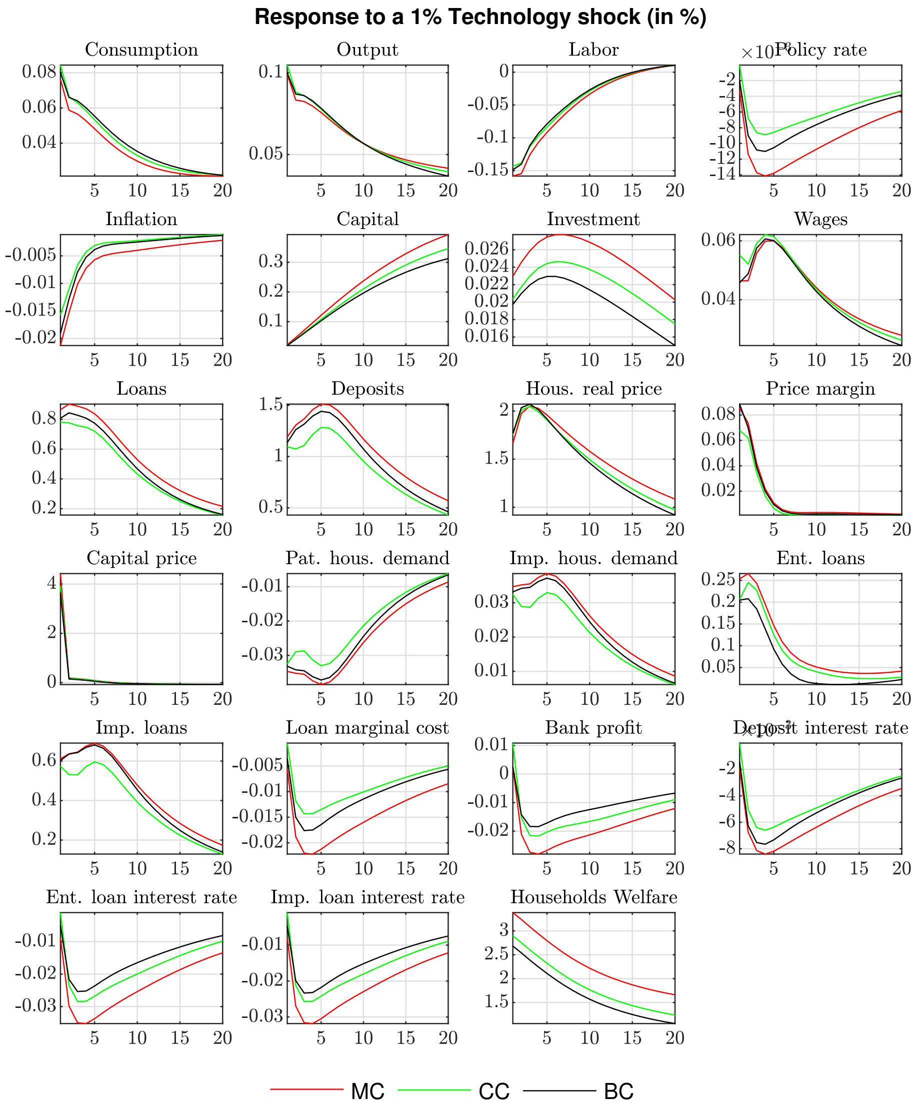

FIGURE 2.3 – Response to a 1% technology shock

2.7.2 Monetary policy shock

Unconditional welfare is negatively impacted after a 1% monetary policy shock. The transmission mechanism changes through each competition scenario. A one percent monetary policy shock leads to a decrease in the unconditional welfare of more than 0.3 percent under PC while it increases by almost 0.05 percent under MC (Fig.2.2). Unconditional welfare variations are impacted by the oligopolistic competition, as it lies between the other two types of competition. Especially, the change of unconditional welfare after a monetary policy shock is somewhere between 0.05 and -0.3 percent under CC and BC.
Monetary policy is transmitted to the economy through three main effects mentionned by Gerali et al. (2010) and detailed in Figure 2.4 : the real rate effect, the financial accelerator effect and the nominal debt effect. Over those three channels, the welfare of households is negatively impacted.
The increase of monetary policy rate leads to an increase in real rates as the prices in the economy are assumed to be sticky. Facing higher rates, households decide to postpone their consumption, thus decrasing the welfare.
Moreover, the nominal debt effect works through the decrease in prices. In turn, this leads to a rise in the real cost of current debt and pushes borrowers to deleverage, cut loan demand and so, investment and impatient households' housing demand. As a result, this tends to decrease the unconditional welfare of impatient households.
Finally, the financial accelerator effect works through the value of collateral. The increase in rate reduces the collateral value, pushing banks to cut the amount of loans granted. The cut in the amount of loans supplied reduces investment, and also the impatient households' housing demand, hence further attenuating the response of the welfare.
While unconditional welfare response is generally negative after a monetary policy shock, the magnitude of the change depends on the type of competition. Indeed, monetary policy shock affects the interest rate setting dynamics of retail loan banks. As the market share of banks (ϵ^{bk}) are taking as given, oligopolistic banks choose a higher interest rate than in MC to generate a positive profit. The greater the number of banks (N) in the market, the more the oligopolistic competition would be close to the MC case where banks have a negligible impact on each other and where free entry into the market would smooth out profits.
In other words, for N and ϵ^{bk} given, a change in R leads to a change in R^{b_k} such that, $R^{b_k}_{mc} < R^{b_k}_{cc} < R^{b_k}_{bc}$. We finally get the same structure for loans and welfare responses.

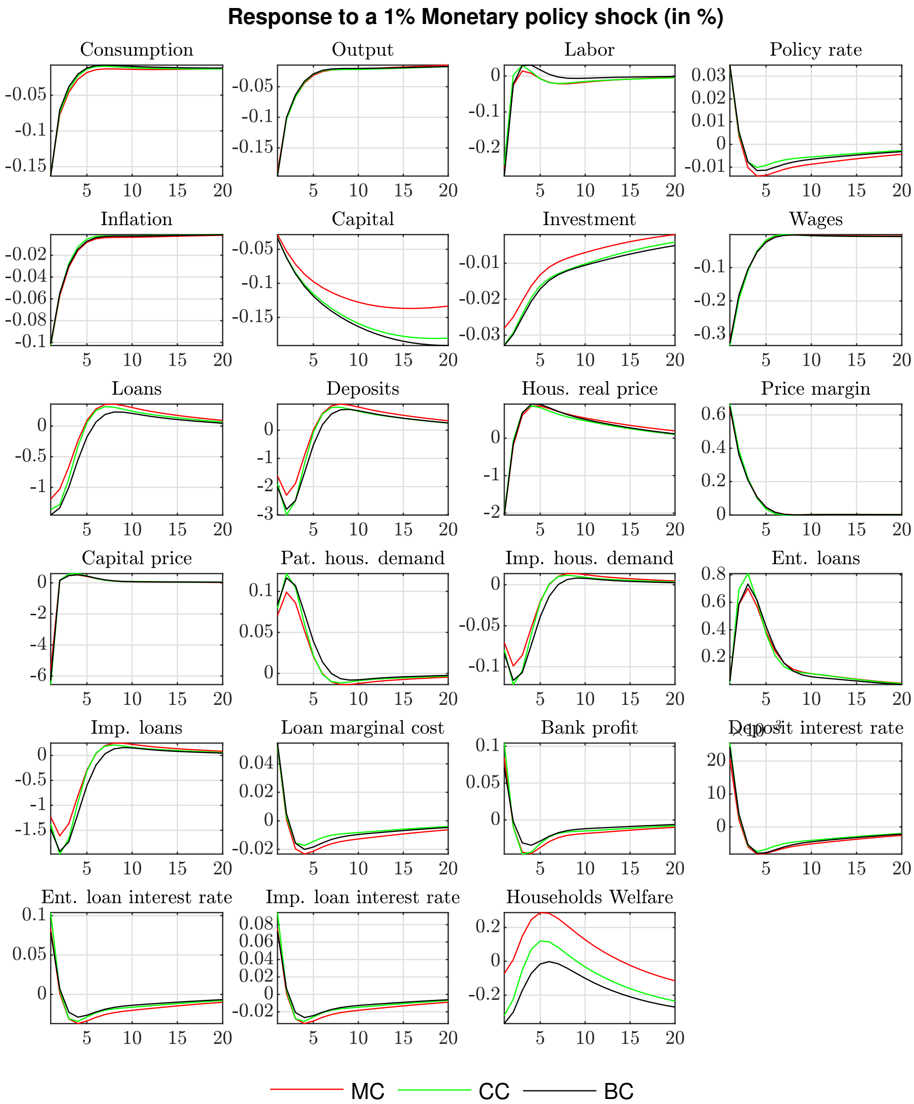

FIGURE 2.4 – Response to a 1% positive monetary policy shock

2.7.3 Financial shocks

Among financial shocks, we investigate loan markup shocks for impatient households and entrepreneurs. They are related to credit crunch scenarios. According to the literature, a positive loan markup shock leads to an increase in the related loan rate involving a decrease in the amount of loans. We analyse a shock on impatient households' loan rate and a shock on entrepreneurs' loan rate. In both cases, we note a decline in the unconditional welfare.

The transmission mechanism of loan markup shocks affects welfare. The increase in loan rate to impatient households reduces their demand for housing and therefore decreases the unconditional welfare in aggregate terms (Fig. 2.5). A loan markup shock for entrepreneurs lowers investment (Fig. 2.6). The fall in investment corresponds to a fall in aggregate demand, leading to a fall in output and then contribute to lower the unconditional welfare of the aggregate households.

However, the magnitude of this decline depends on the structure of the banking market. Those shocks affect the interest rate setting dynamics through a change in the market power of banks. Because of strategic interactions present in the oligopolistic structure, banks increase their interest rates but less than in MC in order to maintain their market share leading to the same dynamic for welfare. Fig. 2.5 and Fig. 2.6 show that the change in the unconditional welfare in the case of impatient households' loan markup shock is greater in the case of MC–a decrease of 0.015%–than in the case of oligopolistic competition–a decrease of between 0.01% and 0.15% under CC and BC, respectively. After an entrepreneurs' loan markup shock, we get the same result. Specifically, the change in the unconditional welfare is around 0.035% under MC while it is 0.03 under CC and 0.02% under BC.

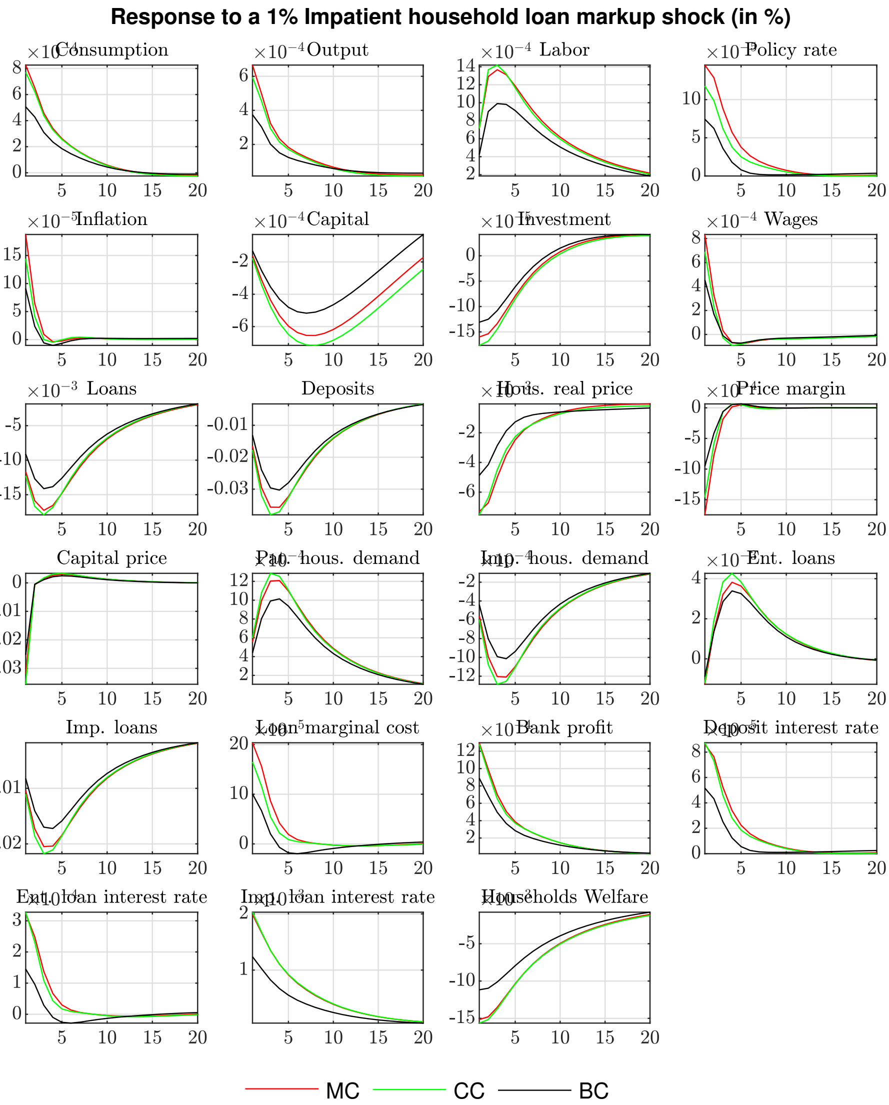

FIGURE 2.5 – Response to a 1% impatient households' loans markup shock

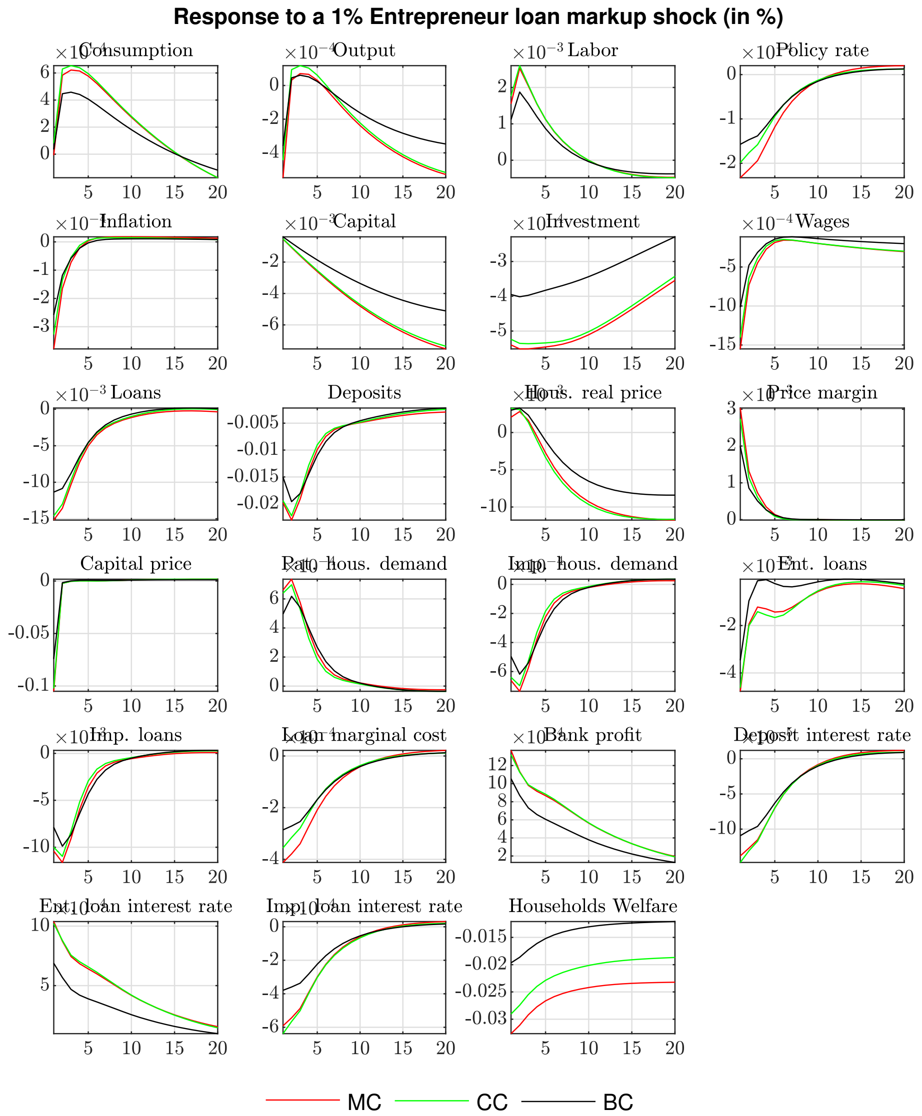

FIGURE 2.6 – Response to a 1% entrepreneurs' loans markup shock

2.7.4 Variance decomposition

The forecast error variance decomposition indicates what proportion of error, of each variable, is due to each exogenous shock. This analysis allows evaluating the role of economic shocks, financial shocks, and monetary policy shock in economic fluctuations under different bank competition scenarios. Results of our theoretical variance decomposition are simulated at a second-order and provide results in line with the literature. Notably, our models relate the main characteristics of variance decomposition : the productivity shock explains more than 40 percent of the variations in output and the price markup shock explains about 60 percent of the variations of inflation. Beyond these findings contributing to validate our models, we analyse the variance decomposition of financial shocks. We build a block, "financial shocks", allowing us to take into account simultaneously the impact of all financial shocks (LTV shocks and loan markup shocks). We compare the contribution of financial shocks over different banking market structure, covering both competition type and the number of banks on the market.

2.7.4.1 Financial shocks under different bank competition

Our model allows to compare different types of banking competition (Table 2.5). Thus, we find that financial shocks account for 6.96 percent of output, 21.3 percent of interest rate and 5.15 percent of inflation under MC while under CC with 50 banks, financial shocks explain 6.7 percent of output, 20.7 percent of the interest rate and 4.8 percent of inflation. Under BC with 50 banks, financial shocks explain 6.3 percent of the output, 19.8 percent of the interest rate and 4.6 percent of inflation. This reveals that financial shocks have less impact on the main variables of the economy when the banking market is in oligopolistic competition. On the other hand, in line with previous results, financial shocks are responsible for a larger share of unconditional welfare variations in MC than in oligopolistic competition (20.1 percent under MC against 19.8 percent under CC and 18.8 in BC).

2.7.4.2 Financial shocks under different number of banks

The impact of the number of banks in the market in terms of financial shocks' variance decomposition is also part of our analysis. As banks are assumed to be symmetric, the number of banks inversely relates to market concentration. In particular, we find that when the market is highly concentrated (5 banks), the impact of financial shocks on key macroeconomic variables decreases. In particular, we find that in the five-bank CC model, financial shocks account for 5.3 percent of output variations, 15.7 percent of the monetary policy rate and 2.3 percent of inflation. In the BC five-bank model, financial shocks account for 2.1 percent of output variations, 8.2 percent of the monetary policy rate and 1.5 percent of the inflation rate. The impact on the unconditional welfare is also attenuated. Financial shocks explain 18.1 percent and 8.3 percent of the welfare variations under five-banks CC and BC, respectively.

Finally, the results of our theoretical variance decomposition show that financial shocks account for a smaller share of the variable's error variance in an oligopolistic and concentrated market. These results confirm the *competition-fragility view* (Keeley, 1990; Berger et al., 2009a) suggesting that a competitive environment on the banking sector would lead to a decrease in intermediation margins which will pushes the banks to increase their risk-taking, a potential source of financial instability. Thus, in line with this argument, we find that the impact of financial shocks would be mitigated in a concentrated market. Besides, oligopolistic banks set interest rates or choose the amount of loans granted, which maximise their profit, taking into account the behaviour of other banks. Following a financial shock, banks choose an interest rate / the amount of loan supplied, which limits the risk of losing market shares. Thus, the presence of strategic interactions in the CC and BC models restricts banks' risk-taking and thus, the transmission mechanism of financial shocks.

	Economic shocks	Financial shocks	Monetary policy shock
MC			
y	81.37	6.96	1.61
R	73.78	21.29	2.6
π	84.38	5.15	8.91
$welfare$	74.07	20.01	0.04
CC N=5			
y	83.47	5.28	1.83
R	76.98	15.68	3.42
π	87.2	2.28	10.35
$welfare$	75.87	18.05	0.12
BC N=5			
y	87.61	2.05	2.06
R	89.63	8.17	3.51
π	87.2	1.51	9.5
$welfare$	85.34	8.29	0.22
CC N=50			
y	81.7	6.71	1.64
R	74.04	20.71	2.68
π	84.58	4.81	9.04
$welfare$	74.36	19.81	0.05
BC N=50			
y	82.14	6.27	1.66
R	74.87	19.83	2.69
π	84.76	4.64	8.99
$welfare$	75.27	18.76	0.05

TABLE 2.5 – Variance decomposition of the main economic data

2.7.5 Bank concentration

This section allows to determine the number of banks that maximises the unconditional welfare of households and the most desirable level of bank competition. We first compare Bertrand's oligopoly with Cournot's oligopoly and find that whatever the number of banks on the market, Bertrand's oligopoly is always preferred to Cournot's oligopoly (Fig. 2.7). Second, we find that higher market concentration corresponds to higher unconditional welfare. In each competition type (CC and BC), the welfare responds to the number of banks with a hump shape curve where the highest level of welfare correspond to a number of banks equal to 2 (Fig. 2.7).
To complete the analysis, we compare the unconditional welfare value under each bank market structure (Table 2.6) and we obtain that Bertrand competition with two banks is more desirable than other types of competition.

	PC	MC	CC	BC	CC	BC
Nb. of banks			N=2	N=2	N=50	N=50
Welfare	−126.79	−126.83	−126.6	−124.3	−126.84	−126.78

TABLE 2.6 – Theoretical welfare simulations under each competition.

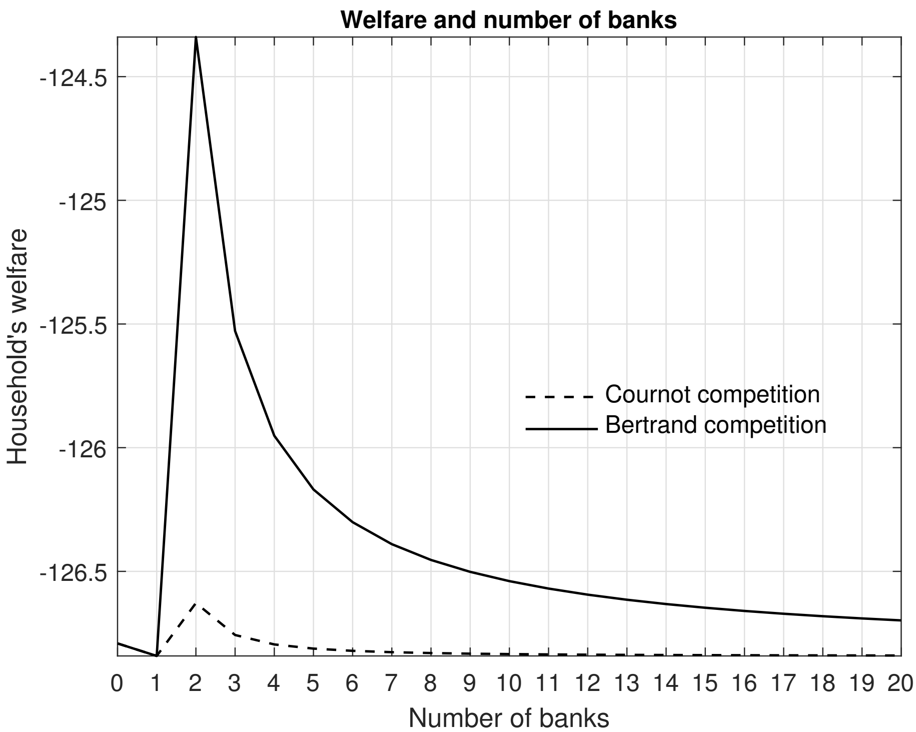

FIGURE 2.7 – Theoretical household welfare

This analysis highlights two findings. The first is that strategic interactions between banks improve welfare. Second, we show that welfare does not necessarily improve with the number of banks. The explanation comes from our loan production function acting as a bank liquidity constraint. With more banks in competition, each bank receives a smaller share of aggregate deposits, strengthening their liquidity constraint and leading to a decline in the supply of credit [23]. Under these conditions, investment and production decline, also leading to a decline in employment and, ultimately, in the welfare of households.

2.8 Interpretation and policy implications

This paper reveals two main results. First, more concentration in the banking market is beneficial to financial stability and social welfare. Indeed, in a concentrated environment, banks' margins increase, limiting bank risk-taking incentives and contributing to financial stability. This result is in line with the *competition fragility view*. On the other hand, a concentrated banking environment allows banks to capture a larger share of deposits, and thus increase their balance sheet liabilities and their ability to grant new loans. The increase in the amount of credits supplied leads to an increase in investment, production, and welfare.

Second, strategic interactions between banks are beneficial to financial stability and social welfare. Indeed, in presence of strategic interactions, banks act by taking into account the behaviour of other banks. In a Cournot competition framework, these behaviour favour the amount of loans granted while in a Bertrand competition framework, this lowers the level of the interest rate. A negative financial shock will, therefore, be mitigated in oligopoly thus safeguarding financial stability. It will also improve the welfare, the latter being positively correlated to the amount of loans granted.

These results are related to the debate on banking competition. Indeed, while some are in favour of more competition in the banking sector arguing for greater availability of credits, policymakers must take into account possible negative implications on financial stability and welfare. This evidence supports arguments in favour of the Banking Union in Europe, and also competitive policies conducted by the Canadian and Australian authorities.

23. It is true that increasing the number of banks increases the aggregate amount of deposits. However, banks will be more likely to face a binding liquidity constraint as long as the decline in deposits received by individual banks dominates the growth in the aggregate deposit.

2.9 Conclusion

In this paper, we investigate how bank competition affects financial stability and social welfare. To assess this impact, we use a nonlinear DSGE model with financial frictions, and assume alternatives types of competition in the banking sector. Our findings hold that oligopolistic competition and higher concentration are more desirable for agents and are a source of financial stability.

Our paper provides two sets of results. First, we compare different banking structures, allowing us to weigh the advantages of oligopolistic competition against other types of competition presented by the literature (CP and CM). Second, our oligopolistic framework allows us to take account of the number of banks in the market and therefore, to evaluate the impact of bank concentration.

Our first set of results is in favour of the *competition fragility view*, arguing that a more competitive market reduces bank margins and bank risk-taking, which finally fosters financial stability. Specifically, we find that financial shocks are attenuated when the banking market is in oligopoly. This result is validated by the analysis of variance decomposition which reveals that financial shocks that appear in a context of an oligopolistic structure with a low number of the banks, explain less error variance of main variables than the same shocks in monopolistic competition.

Our second set of results present evidence in line with a higher level of welfare when the banking market is more concentrated. The positive relationship between concentration and welfare comes from the fact that banks finance their loans with deposit. A concentrated banking environment allows banks to capture a larger share of deposits, and thus increase their balance sheet liabilities and their ability to grant new loans. The increase in the quantity of credits supplied leads to an increase in investment, production, and eventually, welfare.

These findings have a direct implication for policy. First, they confirm the importance of considerations related to financial stability in the debate about the banking union in the EU. Second, they support the Canadian and Australian policy consisting of lowering competition in the banking sector.

A Appendix Chapter II

A.1 Optimization problem

The agents' optimisation problems and their solutions are presented below.

A.1.1 Patient households

$$\epsilon_t^z \frac{1}{c_{p,t}} = \beta_p \mathbb{E}_t \left[\frac{1+R_t^d}{\pi_{t+1}} \epsilon_{t+1}^z \frac{1}{c_{p,t+1}} \right] \tag{A.1}$$

$$\frac{j}{h_{p,t}} = q_{h,t} \epsilon_t^z \frac{1}{c_{p,t}} - \beta_p \mathbb{E}_t \left[q_{h,t+1} \epsilon_{t+1}^z \frac{1}{c_{p,t+1}} \right] \tag{A.2}$$

$$l_{p,t}^{\varphi} = w_{p,t} \epsilon_t^z \frac{1}{c_{p,t}} \tag{A.3}$$

A.1.2 Impatient households

$$\epsilon_t^z \frac{1}{c_{i,t}} = \beta_i \mathbb{E}_t \left[\frac{1+R_t^{b_i}}{\pi_{t+1}} \epsilon_{t+1}^z \frac{1}{c_{i,t+1}} \right] + \lambda_{i,t} \left(1 + R_t^{b_i} \right) \tag{A.4}$$

$$\frac{j}{h_{i,t}} = q_{h,t} \epsilon_t^z \frac{1}{c_{i,t}} - \beta_i \mathbb{E}_t \left[q_{h,t+1} \epsilon_{t+1}^z \frac{1}{c_{i,t+1}} + \lambda_{i,t} m_{i,t} q_{h,t+1} \pi_{t+1} \right] \tag{A.5}$$

$$l_{i,t}^{\varphi} = w_{i,t} \epsilon_t^z \frac{1}{c_{i,t}} \tag{A.6}$$

A.1.3 Entrepreneurs

$$\frac{1}{c_{e,t}} = \beta_e \mathbb{E}_t \left[\frac{1+R_t^{b_e}}{\pi_{t+1}} \frac{1}{c_{e,t+1}} \right] + \lambda_{e,t} \left(1 + R_t^{b_e} \right) \tag{A.7}$$

$$\frac{1}{c_{e,t}}q_{ke,t} = \beta_e \mathbb{E}_t \left[\frac{1}{c_{e,t+1}} \left(\alpha \frac{y_{t+1}}{x_{t+1}k_{e,t}} + q_{ke,t+1}\left(1-\delta_{ke}\right) \right) + \lambda_{e,t} m_{e,t} q_{ke,t+1} \pi_{t+1} \left(1-\delta_{ke}\right) \right] \tag{A.8}$$

$$w_{p,t} = \frac{\mu\left(1-\alpha\right)}{l_{p,t}} \frac{y_t}{x_t} \tag{A.9}$$

$$w_{i,t} = \frac{\left(1-\mu\right)\left(1-\alpha\right)}{l_{i,t}} \frac{y_t}{x_t} \tag{A.10}$$

A.1.4 Capital good producers

$$\begin{aligned} 1 \quad = \quad & q_{k,t} \left(1 - \frac{\kappa_i}{2} \left(\frac{\epsilon_t^{qk} i_t}{i_{t-1}} - 1 \right)^2 \right) - \kappa_i \left(\frac{\epsilon_t^{qk} i_t}{i_{t-1}} - 1 \right) \left(\frac{\epsilon_t^{qk} i_t}{i_{t-1}} \right) \\ & + \beta_e \left(\frac{c_{e,t}}{c_{e,t+1}} \right) q_{k,t+1} \kappa_i \left(\frac{\epsilon_{t+1}^{qk} i_{t+1}}{i_t} - 1 \right) \left(\frac{\epsilon_{t+1}^{qk} i_{t+1}}{i_t} \right)^2 \end{aligned} \tag{A.11}$$

A.2 Recursive pricing

The pricing FOC is given by

$$\sum_{k=0}^{\infty} \theta^k \mathbb{E}_t \left[\Lambda_{t,k} \left(\frac{P_t^*}{P_{t+k}} - \frac{\epsilon}{\epsilon-1} \frac{1}{x_{t+k}} \right) y_{t+k}^* (z) \right] = 0 \tag{A.12}$$

where $X_{t+k} = \frac{P_t}{P_t^w}$.denotes the markup of final over intermediate goods. Using the demand function, this is

$$\sum_{k=0}^{\infty} \theta^k \mathbb{E}_t \left[\Lambda_{t,k} \frac{1}{P_{t+k}} \left(\frac{P_t^* (z)}{P_{t+k}} \right)^{-\epsilon} y_{t+k} \left(P_t^* - \frac{\epsilon}{\epsilon-1} \frac{P_{t+k}}{x_{t+k}} \right) \right] = 0 \tag{A.13}$$

or by dividing by P_t

$$\sum_{k=0}^{\infty} \theta^k \mathbb{E}_t \left[\Lambda_{t,k} \left(\frac{P_t}{P_{t+k}} \right)^{-\epsilon} \left(\frac{P_t^* (z)}{P_t} \right)^{-\epsilon} y_{t+k} \frac{P_t}{P_{t+k}} \left(\frac{P_t^*}{P_t} - \frac{\epsilon}{\epsilon-1} \frac{P_{t+k}}{P_t} \frac{1}{x_{t+k}} \right) \right] = 0 \tag{A.14}$$

Now plug in for the stochastic discount factor

$$\sum_{k=0}^{\infty} \theta^k \mathbb{E}_t \left[\beta^p \frac{\epsilon_{t+k}^z c_{p,t}}{\epsilon_t^z c_{p,t+k}} \left(\frac{P_t}{P_{t+k}} \right)^{1-\epsilon} \left(\frac{P_t^* (z)}{P_t} \right)^{-\epsilon} y_{t+k} \left(\frac{P_t^*}{P_t} - \frac{\epsilon}{\epsilon-1} \frac{P_{t+k}}{P_t} \frac{1}{x_{t+k}} \right) \right] = 0 \tag{A.15}$$

Multiply by $c_{p,t}^{-\sigma}$

$$\sum_{k=0}^{\infty} \theta^k \mathbb{E}_t \left[\beta^p \epsilon_{t+k}^z \frac{1}{c_{p,t+k}} \left(\frac{P_t}{P_{t+k}} \right)^{1-\epsilon} \left(\frac{P_t^* (z)}{P_t} \right)^{-\epsilon} y_{t+k} \left(\frac{P_t^*}{P_t} - \frac{\epsilon}{\epsilon-1} \frac{P_{t+k}}{P_t} \frac{1}{x_{t+k}} \right) \right] = 0 \tag{A.16}$$

Using

$$\pi_t^* = \left(\frac{P_t^* (z)}{P_t} \right) \tag{A.17}$$

We can write

$$\sum_{k=0}^{\infty} \theta^k \mathbb{E}_t \left[\beta^p \epsilon_{t+k}^z \frac{1}{c_{p,t+k}} \left(\frac{P_t}{P_{t+k}} \right)^{1-\epsilon} (\pi_t^*)^{-\epsilon} y_{t+k} \left(\pi_t^* - \frac{\epsilon}{\epsilon-1} \left(\frac{P_t}{P_{t+k}} \right)^{-1} \frac{1}{x_{t+k}} \right) \right] = 0 \tag{A.18}$$

which is equivalent to

$$\begin{gathered} \textstyle\sum_{k=0}^{\infty} \theta^k \mathbb{E}_t \left[\beta^p \epsilon_{t+k}^z \frac{1}{c_{p,t+k}} \left(\frac{P_t}{P_{t+k}} \right)^{1-\epsilon} (\pi_t^*)^{1-\epsilon} y_{t+k} \right] = \\ \textstyle\sum_{k=0}^{\infty} \theta^k \mathbb{E}_t \left[\beta^p \epsilon_{t+k}^z \frac{1}{c_{p,t+k}} \left(\frac{P_t}{P_{t+k}} \right)^{-\epsilon} (\pi_t^*)^{-\epsilon} y_{t+k} \frac{\epsilon}{\epsilon-1} \frac{1}{x_{t+k}} \right] \end{gathered} \tag{A.19}$$

where we bring π_t^* to the left

$$\begin{array}{c}\sum_{k=0}^{\infty}\theta^k \mathbb{E}_t\left[\beta^p \epsilon_{t+k}^z \frac{1}{c_{p,t+k}}\left(\frac{P_t}{P_{t+k}}\right)^{1-\epsilon}\left(\pi_t^*\right) y_{t+k}\right] = \\ \frac{\epsilon}{\epsilon-1}\sum_{k=0}^{\infty}\theta^k \mathbb{E}_t\left[\beta^p \epsilon_{t+k}^z \frac{1}{c_{p,t+k}}\left(\frac{P_t}{P_{t+k}}\right)^{-\epsilon} y_{t+k}\frac{1}{x_{t+k}}\right]\end{array} \tag{A.20}$$

Factoring out, we get

$$\begin{array}{c}\pi_t^* \sum_{k=0}^{\infty}\theta^k \mathbb{E}_t\left[\beta^p \frac{1}{c_{p,t+k}}\left(\frac{P_t}{P_{t+k}}\right)^{1-\epsilon} y_{t+k}\right] = \\ \frac{\epsilon}{\epsilon-1}\sum_{k=0}^{\infty}\theta^k \mathbb{E}_t\left[\beta^p \frac{1}{c_{p,t+k}}\left(\frac{P_t}{P_{t+k}}\right)^{-\epsilon} y_{t+k}\frac{1}{x_{t+k}}\right]\end{array} \tag{A.21}$$

which define two auxiliary variables

$$\pi_t^* x_{2,t} = \frac{\epsilon}{\epsilon-1} x_{1,t} \tag{A.22}$$

where

$$x_{2,t} = \sum_{k=0}^{\infty}\theta^k \mathbb{E}_t\left[\beta^p \epsilon_{t+k}^z \frac{1}{c_{p,t+k}}\left(\frac{P_t}{P_{t+k}}\right)^{1-\epsilon} y_{t+k}\right] \tag{A.23}$$

$$= \epsilon_t^z \frac{1}{c_{p,t}} y_t + \beta^p \theta \mathbb{E}_t \pi_{t+1}^{\epsilon-1} x_{2,t+1} \tag{A.24}$$

and

$$x_1 = \sum_{k=0}^{\infty}\theta^k \mathbb{E}_t\left[\beta^p \epsilon_{t+k}^z \frac{1}{c_{p,t+k}}\left(\frac{P_t}{P_{t+k}}\right)^{-\epsilon} y_{t+k}\frac{1}{x_{t+k}}\right] \tag{A.25}$$

$$= \epsilon_t^z \frac{1}{c_{p,t}} y_t \frac{1}{x_t} + \beta^p \theta \mathbb{E}_t \pi_{t+1}^{\epsilon} x_{1,t+1} \tag{A.26}$$

A.3 Steady state

One can always normalise the technology parameter A so that $y = 1$ in steady-state, so the trick is to express all the variables as a ratio to y.

$$y = 1 \tag{A.27}$$

$$\pi = 1 \tag{A.28}$$

$$\pi^* = 1 \tag{A.29}$$

$$q_k = 1 \tag{A.30}$$

$$x = \frac{\epsilon}{\epsilon - 1} \tag{A.31}$$

$$b_e = \frac{\beta^e \mu Y m_e \pi (1-\delta_k)}{x(1+R^{b_e})} \frac{1}{1-\beta_e(1-\delta_k) - \left(\frac{1}{1+R^{e_e}} - \frac{\beta_e}{\pi}\right) m_e \pi (1-\delta_k)} \tag{A.32}$$

$$k_e = \frac{\left(1+R^{b_e}\right) b_e}{m_e \pi q_k (1-\delta_k)} \tag{A.33}$$

$$i = \delta_k k_e \tag{A.34}$$

$$c_p = d\left(\frac{1+R^d}{\pi} - 1\right) + \alpha(1-\mu)\frac{y}{x} + \left(1 - \frac{1}{x}\right) Y + j_{cb} \tag{A.35}$$

$$c_i = b_i \left(1 - \frac{1+R^{b_i}}{\pi}\right) + (1-\alpha)(1-\mu)\frac{y}{x} + j_{cb} \tag{A.36}$$

$$c_e = \frac{y}{x} + b_e\left(1 - \frac{1+R^{b_e}}{\pi}\right) - \alpha(1-\mu)\frac{y}{x} - (1-\alpha)(1-\mu)\frac{y}{x} - q_k k_e \delta_k + j_{cb} \tag{A.37}$$

$$\lambda_i = \frac{1}{c_i}\left(\frac{1}{(1+R^{b_i})} - \frac{\beta_i}{\pi}\right) \tag{A.38}$$

$$\lambda_e = \frac{1}{c_e}\left(\frac{1}{(1+R^{b_e})} - \frac{\beta_e}{\pi}\right) \tag{A.39}$$

$$h_p = \frac{j c_p}{(1-\beta_p)}\left(\frac{1}{q_h}\right) \tag{A.40}$$

$$h_i = \frac{b_i\left(1+R^{b_i}\right)}{m_i \pi}\left(\frac{1}{q_h}\right) \tag{A.41}$$

$$q_h = \frac{j c_p}{(1-\beta_p)} + \frac{b_i\left(1+R^{b_i}\right)}{m_i \pi} \tag{A.42}$$

$$w_p = \alpha\left(1-\mu\right)\frac{y}{xl_p} \tag{A.43}$$

$$l_p = \left(\alpha\left(1-\mu\right)\frac{y}{x}\frac{1}{c_p}\right)^{1/(\varphi+1)} \tag{A.44}$$

$$w_i = \left(1-\alpha\right)\left(1-\mu\right)\frac{y}{xl_i} \tag{A.45}$$

$$l_i = \left(\left(1-\alpha\right)\left(1-\mu\right)\frac{y}{x}c_i^{-\sigma_i}\right)^{1/(\varphi+1)} \tag{A.46}$$

$$A = \frac{Y}{k_e^{\mu} l_p^{\alpha(1-\mu)} l_i^{(1-\alpha)(1-\mu)}} \tag{A.47}$$

$$l = l_p + l_i \tag{A.48}$$

$$w = w_p + w_i \tag{A.49}$$

$$x_1 = \frac{\frac{1}{X}Y}{1-\beta^p\theta\pi^{\epsilon}}\frac{1}{c_p} \tag{A.50}$$

$$x_2 = \frac{Y}{1-\beta^p\theta\pi^{\epsilon-1}}\frac{1}{c_p} \tag{A.51}$$

Under PC

$$R = R^d = R^{b_i} = R^{b_e} = \frac{\pi}{\beta^p} - 1 \tag{A.52}$$

$$j_{cb} = 0 \tag{A.53}$$

$$d = b_e + b_i \tag{A.54}$$

Under imperfect competition

$$R_{kb} = \frac{1}{\beta_b} - 1 + \delta_b \tag{A.55}$$

$$mc_b = \frac{R_{kb}^{\chi_b} R^{1-\chi_b}}{\chi_b^{\chi_b}\left(1-\chi_b\right)^{(1-\chi_b)}} \tag{A.56}$$

$$k_b = \frac{\left(b_e + b_i\right)}{\left(\frac{R_{kb}}{R}\left(\frac{1-\chi_b}{\chi_b}\right)\right)^{(1-\chi_b)}} \tag{A.57}$$

$$m = \frac{k_b\frac{R_{kb}}{R}\left(\frac{1-\chi_b}{\chi_b}\right)R + mc_b\left(b_e+b_i\right) + \delta_k k_e\left(1-q_k\right) + \left(R_{kb}-\delta_{kb}\right)k_b}{-3-2R} \tag{A.58}$$

$$d = k_b\frac{R_{kb}}{R}\left(\frac{1-\chi_b}{\chi_b}\right) - m \tag{A.59}$$

$$j_b = R^{b_e}b_e + R^{b_i}b_i - mc_b\left(b_e+b_i\right) + \left(R - R^d\right)d \tag{A.60}$$

$$j_{cb} = (1 + R)\, m \tag{A.61}$$

Under MC

$$R^d = \frac{\pi}{\beta^p} - 1 \tag{A.62}$$

$$R = \frac{\varsigma_d - 1}{\varsigma_d} R^d \tag{A.63}$$

$$R^{b_i} = \frac{\varsigma_{b_i}}{\varsigma_{b_i} - 1} mc_b \tag{A.64}$$

$$R^{b_e} = \frac{\varsigma_{b_e}}{\varsigma_{b_e} - 1} mc_b \tag{A.65}$$

Under CC

$$R^d = \frac{\pi}{\beta^p} - 1 \tag{A.66}$$

$$R = \frac{\varsigma_d - 1}{\varsigma_d} R^d \frac{N - 1}{N} \tag{A.67}$$

$$R^{b_i} = \frac{\varsigma_{b_i}}{\varsigma_{b_i} - 1} mc_b \frac{N}{N - 1} \tag{A.68}$$

$$R^{b_e} = \frac{\varsigma_{b_e}}{\varsigma_{b_e} - 1} mc_b \frac{N}{N - 1} \tag{A.69}$$

Under BC

$$R^d = \frac{\pi}{\beta^p} - 1 \tag{A.70}$$

$$R = \frac{N - \varsigma_d N + \varsigma_d - 1}{\varsigma_d - \varsigma_d N + 1} R^d \tag{A.71}$$

$$R^{b_i} = \frac{\varsigma_{b_i} - \varsigma_{b_i} N + 1}{N - \varsigma_{b_i} N + \varsigma_{b_i} - 1} mc_b \tag{A.72}$$

$$R^{b_e} = \frac{\varsigma_{b_e} - \varsigma_{b_e} N + 1}{N - \varsigma_{b_e} N + \varsigma_{b_e} - 1} mc_b \tag{A.73}$$

A.4 Marginal cost of producing loans

Bankers minimise their costs from bank equity $k_{b,t}$ and from getting funds on monetary market and deposits $(m_t + d_t)$, which come at factor prices $R_{kb,t}$ and R_t, respectively, subject to a Cobb and Douglas (1928) production function of loans $b_{e,t}+b_{i,t} = k_{b,t}^{\chi_b} (m_t + d_t)^{1-\chi_b}$. The minimal cost is given by the following problem

$$C = \min_{k_{b,t}, m_t+d_t} R_{kb,t} k_{b,t} + R_t (m_t + d_t) \tag{A.74}$$

such that

$$b_{e,t} + b_{i,t} = k_{b,t}^{\chi_b} (m_t + d_t)^{1-\chi_b} \tag{A.75}$$

We solve the constraint for $k_{b,t}$ and get

$$k_{b,t} = \left(\frac{b_{e,t} + b_{i,t}}{(m_t + d_t)^{1-\chi_b}} \right)^{\frac{1}{\chi_b}} \tag{A.76}$$

We can rewrite the minimal cost

$$C = \min_{k_{b,t}, m_t+d_t} R_{kb,t} \left(\frac{b_{e,t} + b_{i,t}}{(m_t + d_t)^{1-\chi_b}} \right)^{\frac{1}{\chi_b}} + R_t (m_t + d_t) \tag{A.77}$$

The first order condition of that problem is

$$R_t = \frac{1-\chi_b}{\chi_b} R_{kb,t} \left(\frac{b_{e,t} + b_{i,t}}{(m_t + d_t)} \right)^{\frac{1}{\chi_b}} \tag{A.78}$$

$$= \frac{1-\chi_b}{\chi_b} R_{kb,t} \left(\frac{k_{b,t}}{(m_t + d_t)} \right)^{\frac{1}{\chi_b}} \tag{A.79}$$

The optimal use of monetary and deposit funds $((m_t + d_t)^*)$ in the production function of loans is

$$(m_t + d_t)^* = \left(\frac{1-\chi_b}{\chi_b} \frac{R_{kb,t}}{R_t} \right)^{\chi_b} (b_{e,t} + b_{i,t}) \tag{A.80}$$

Putting it into the constraint we get the optimal use of capital $k_{b,t}^*$

$$k_{b,t}^* = \left(\frac{\chi_b}{1-\chi_b} \frac{R_t}{R_{kb,t}} \right)^{1-\chi_b} (b_{e,t} + b_{i,t}) \tag{A.81}$$

Now plugging $(m_t + d_t)^*$ and $k_{b,t}^*$ into the initial minimisation problem, we get

$$C^* = \left[R_{kb,t}\left(\frac{\chi_b}{1-\chi_b}\frac{R_t}{R_{kb,t}}\right)^{1-\chi_b} + R_t\left(\frac{1-\chi_b}{\chi_b}\frac{R_{kb,t}}{R_t}\right)^{\chi_b}\right](b_{e,t}+b_{i,t}) \tag{A.82}$$

$$= \left[\left(\frac{\chi_b}{1-\chi_b}\right)^{1-\chi_b} + \left(\frac{1-\chi_b}{\chi_b}\right)^{\chi_b}\right] R_{kb,t}^{\chi_b} R_t^{1-\chi_b}(b_{e,t}+b_{i,t}) \tag{A.83}$$

$$= \left[\frac{1-\chi_b+\chi_b}{(1-\chi_b)^{1-\chi_b}\,\chi_b^{\chi_b}}\right] R_{kb,t}^{\chi_b} R_t^{1-\chi_b}(b_{e,t}+b_{i,t}) \tag{A.84}$$

$$= \left(\frac{R_{kb,t}}{\chi_b}\right)^{\chi_b}\left(\frac{R_t}{(1-\chi_b)}\right)^{1-\chi_b}(b_{e,t}+b_{i,t}) \tag{A.85}$$

The marginal cost of producing loans is equal to the derivative of cost in relation to loans $(b_{e,t}+b_{i,t})$

$$mc_{b,t} = \left(\frac{R_{kb,t}}{\chi_b}\right)^{\chi_b}\left(\frac{R_t}{(1-\chi_b)}\right)^{1-\chi_b} \tag{A.86}$$

A.5 Inverse demand function of deposits and loans with substitution factors

We can write the following function of expenses

$$EXP_{d,t} = \sum_{i=1}^{N} R_t^d(i)\, d_t(i) = R_t^d d_t \tag{A.87}$$

$$R_t^d = \frac{EXP_{d,t}}{d_t} \tag{A.88}$$

From the standard function of demand we can write

$$d_t(j) = \left(\frac{R_t^d(j)}{R_t^d}\right)^{-\varsigma_{d,t}} d_t = \frac{R_t^d(j)^{-\varsigma_{d,t}}}{R_t^{d^{1-\varsigma_{d,t}}}} R_t^d d_t \tag{A.89}$$

As $EXP_{d,t} = R_t^d d_t$, we get

$$d_t(j) = \frac{R_t^d(j)^{-\varsigma_{d,t}}}{R_t^{d^{1-\varsigma_{d,t}}}} EXP_{d,t} \tag{A.90}$$

We inverse the direct function of demand

$$R_t^d(j)^{-\varsigma_d} = \frac{d_t(j)}{EXP_{d,t}} R_t^{d^{1-\varsigma_{d,t}}} \tag{A.91}$$

$$R_t^d(j) = \frac{d_t(j)^{-\frac{1}{\varsigma_{d,t}}}}{EXP_{d,t}^{-\frac{1}{\varsigma_{d,t}}}} R_t^{d^{\frac{\varsigma_{d,t}-1}{\varsigma_{d,t}}}} \tag{A.92}$$

We insert Eq. A.88

$$R_t^d(j) = \frac{d_t(j)^{-\frac{1}{\varsigma_{d,t}}}}{EXP_{d,t}^{-\frac{1}{\varsigma_{d,t}}}} EXP_{d,t}^{\frac{\varsigma_{d,t}-1}{\varsigma_{d,t}}} \tag{A.93}$$

$$R_t^d(j) = \frac{d_t(j)^{-\frac{1}{\varsigma_{d,t}}}}{EXP_{d,t}^{-\frac{1}{\varsigma_{d,t}}}} \frac{EXP_{d,t}^{\frac{\varsigma_{d,t}-1}{\varsigma_{d,t}}}}{d_t^{\frac{\varsigma_{d,t}-1}{\varsigma_{d,t}}}} \tag{A.94}$$

$$R_t^d(j) = \frac{d_t(j)^{-\frac{1}{\varsigma_{d,t}}}}{d_t^{\frac{\varsigma_{d,t}-1}{\varsigma_{d,t}}}} EXP_{d,t} \tag{A.95}$$

We know that $d_t = \sum_{j=1}^{N} d_t(j)$ and so finally, assuming that all banks take total expenditure as given in each period, their perceived inverse demand function must be

$$R_t^d(j) = \frac{d_t(j)^{-\frac{1}{\varsigma_{d,t}}}}{\sum_{i=1}^{N} d_t(i)^{\frac{\varsigma_{d,t}-1}{\varsigma_{d,t}}}} EXP_{d,t} \tag{A.96}$$

Similarly, we can write the inverse demand function for each types of loans (denoted by index k)

$$R_t^{b_k}(j) = \frac{b_{k,t}(j)^{-\frac{1}{\varsigma_{b_{k,t}}}}}{\sum_{i=1}^{N} b_{k,t}(i)^{\frac{\varsigma_{b_{k,t}}-1}{\varsigma_{b_{k,t}}}}} EXP_{bk,t} \tag{A.97}$$

A.6 Demand function of deposits and loans with strategic interactions

From the standard function of demand we can write

$$d_t(j) = \left(\frac{R_t^d(j)}{R_t^d}\right)^{-\varsigma_{d,t}} d_t = \frac{R_t^d(j)^{-\varsigma_{d,t}}}{R_t^{d^{1-\varsigma_{d,t}}}} R_t^d d_t \tag{A.98}$$

As $EXP_{d,t} = R_t^d d_t$, we get

$$d_t(j) = \frac{R_t^d(j)^{-\varsigma_{d,t}}}{R_t^{d^{1-\varsigma_{d,t}}}} EXP_{d,t} \tag{A.99}$$

We know that

$$R_t^d = \left[\sum_{i=1}^{N} R_t^d(i)^{-\left(\varsigma_{d,t}-1\right)}\right]^{-\frac{1}{\varsigma_{d,t}-1}} \tag{A.100}$$

We replace A.100 in A.99 and get the direct demand function of deposit with strategic interactions

$$d_t(j) = \frac{R_t^d(j)^{-\varsigma_{d,t}}}{\sum_{i=1}^{N} R_t^d(i)^{-\left(\varsigma_{d,t}-1\right)}} EXP_{d,t} \tag{A.101}$$

Similarly, we can write the demand function with strategic interactions for each types of loans (denoted by index k)

$$b_{k,t}(j) = \frac{R_t^{b_k}(j)^{-\varsigma_{b_k,t}}}{\sum_{i=1}^{N} R_t^{b_k}(i)^{-\left(\varsigma_{b_k,t}-1\right)}} EXP_{bk,t} \tag{A.102}$$

A.7 Shocks analysis

A.7.1 Productivity shock

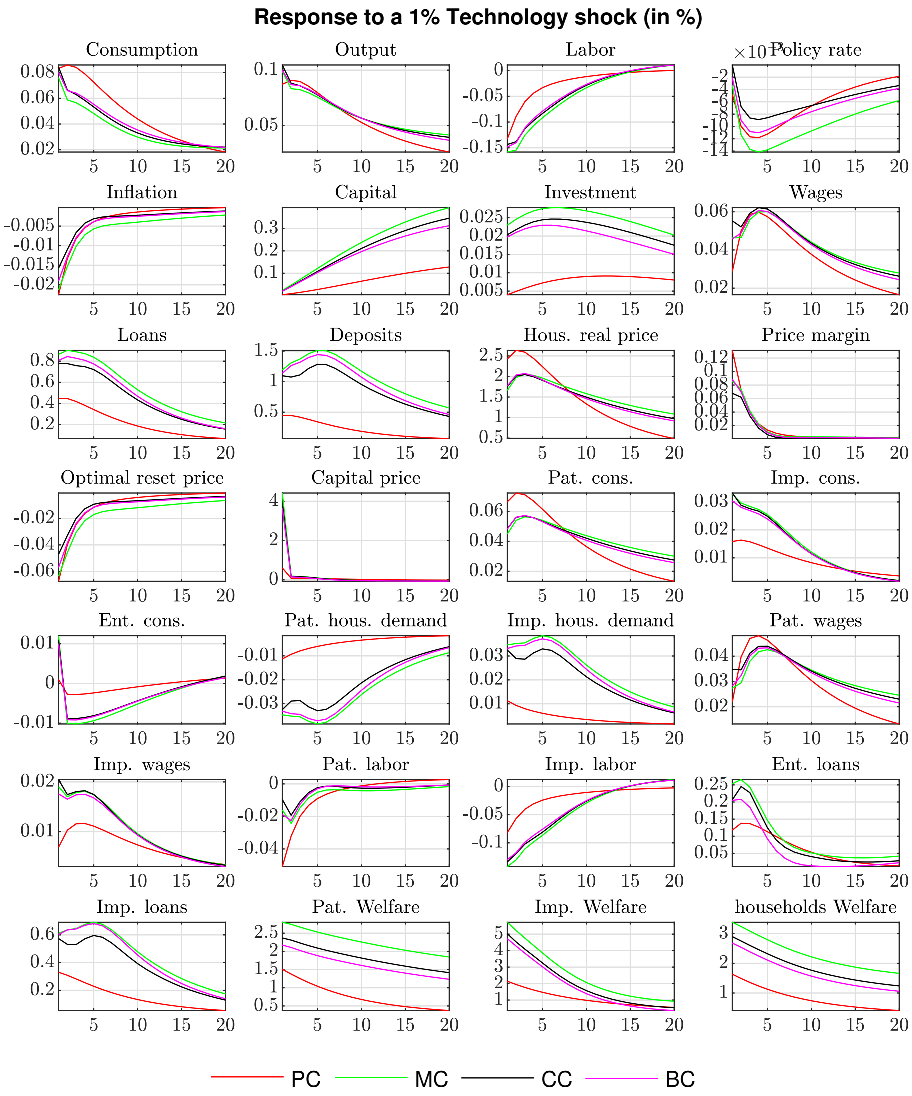

FIGURE A.1 – Response to a 1% productivity shock

A.7.2 Partial equilibrium on loan market after a positive productivity shock

Fig. A.2 provides a theoretical overview of what happens in the banking market after a productivity shock in a monopolistic competitive environment. Loan demand depends negatively on rates. At equilibrium (point A), the average cost is equal to the average revenue (RM = CM) which implies that bank profits are zero. If the monetary policy rate goes down after a positive productivity shock, marginal cost decreases and banks are encouraged to lower their interest rates. We move to the right along the demand curve leading to higher demand for loans (point B). Lower marginal cost moves the Cm curve to the right so that the marginal revenue corresponding to point B equals the marginal cost. However, at this point, the average cost is higher than the average revenue, which leads to lower bank profit pushing the less profitable banks to leave the market. The demand for loans with respect to the remaining banks increased, resulting in a shift to the right of RM curve and thus a return to the equilibrium bank profit equal to 0. Finally, the fall in the rate in MC is attenuated compared to PC.

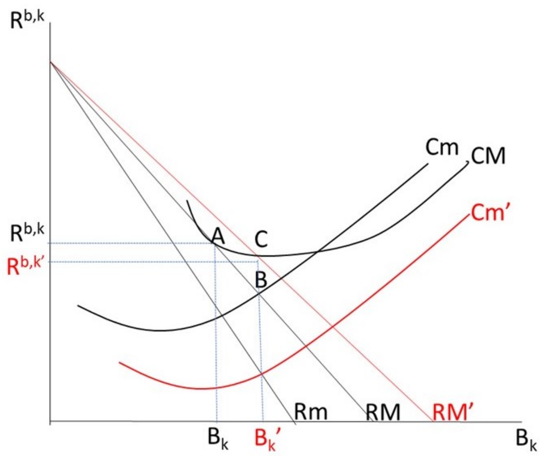

FIGURE A.2 – Adjustment in the banking market under MC after a positive productivity shock

A.7.3 Monetary policy shock

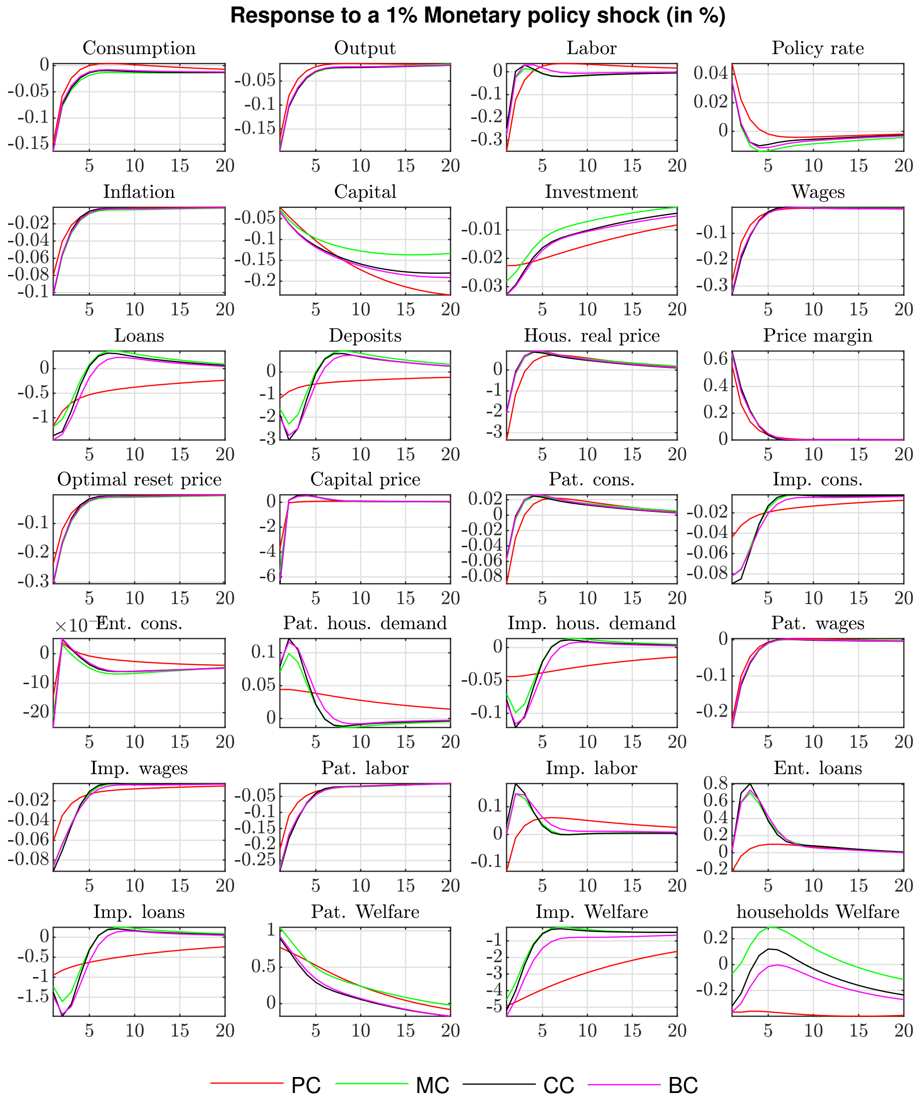

FIGURE A.3 – Response to a 1% monetary policy shock

A.8 Data

This section presents the data used for the theoretical matching, the measurement equations and the data transformations performed in order to match the data to the variables of the model.

All the following data are collected from FRED, Federal Reserve Bank of St. Louis. The code in parenthesis corresponds to the identifier of the series.

A.8.1 Economic data

Real gross domestic product : billions of chained 2012 dollars, quarterly, seasonally adjusted annual rate (GDPC1).
Real investment : fixed private investment, billions of dollars, quarterly, seasonally adjusted annual rate (FPI).
Labor : nonfarm business sector, average weekly hours, Index 2012=100, quarterly, seasonally adjusted (PRS85006023).
Price inflation : gross domestic product, implicit price deflator, Index 2012=100, quarterly, seasonally adjusted (GDPDEF).
Real wage : nonfarm business sector : compensation per hour, Index 2012=100, quarterly, seasonally adjusted (COMPNFB).
Real housing price : all transaction house price index for the united states, Index 1980 :Q1=100, quarterly, not seasonally adjusted (USSTHPI).
Federal fund rate : effective Federal Funds Rate, percent, quarterly, not seasonally adjusted (FEDFUNDS).
Population : civilian noninstitutional population (CNP16OV).

A.8.2 Financial data

Deposit (DEP) : deposits, all commercial banks, billions of U.S. dollars, seasonally adjusted (DPSACBM027SBOG).
Loan to firms (LTF) = (NCBDBIQ027S) + (BLNECLBSNNCB) + (OLALBSNNCB) + (NNBDILNECL) + (OLALBSNNB) + (MLBSNNCB) + (NNBTML).
Loan to households (LTHH) = (HNOTMLQ027S) + (CCLBSHNO).
Nominal interest rate on loans to firms (NIROLTF) = (AAA)*(NCBDBIQ027S)/Loan to firms + (MPRIME) * ((BLNECLBSNNCB) + (OLALBSNNCB) + (NNBDILNECL) + (OLALBSNNB))/Loan to firms + (MORTGAGE30US) * ((MLBSNNCB)+(NNBTML))/Loan to firms.
Nominal interest rate on loans to households (NIROLTHH) = (MORTGAGE30US) * (HNOTMLQ027S)/Loan to households + (TERMCBAUTO48NS) * (CCLBSHNO)/Loan to households.

A.8.3 Data used to calculate financial data

(NCBDBIQ027S) : Nonfinancial corporate business, debt securities ; liability, level, millions of dollars, not seasonally adjusted.
(BLNECLBSNNCB) : Nonfinancial corporate business, depository institution loans not elsewhere classified ; liability, level, billions of dollars, not seasonally adjusted.
(OLALBSNNCB) : Nonfinancial corporate business ; other loans and advances ; liability, billions of dollars, not seasonally adjusted.
(NNBDILNECL) : Nonfinancial noncorporate business ; depository institution loans not elsewhere classified ; liability, billions of dollars, not seasonally adjusted.
(OLALBSNNB) : Nonfinancial noncorporate business ; other loans and advances ; liability, level, billions of dollars, not seasonally adjusted.
(MLBSNNCB) : Nonfinancial corporate business ; total mortgages ; liability, billions of dollars, not seasonally adjusted.
(NNBTML) : Nonfinancial noncorporate business ; total mortgages ; liability, level, billions of dollars, not seasonally adjusted.
(HNOTMLQ027S) : Households mortgage : households and nonprofit organisations ; total mortgages ; liability, level, millions of dollars, not seasonally adjusted.
(CCLBSHNO) : Households consumer loans : households and nonprofit organisations ; consumer credit ; liability, level, billions of dollars, not seasonally adjusted.
(AAA) : Moody's Seasoned AAA Corporate Bond Yield : percent, not seasonally adjusted.
(MPRIME) : Bank Prime Loan Rate : percent, not seasonally adjusted.
(MORTGAGE30US) : 30-Year Fixed Rate Mortgage Average in the United States : percent, not seasonally adjusted.
(TERMCBAUTO48NS) : Finance rate on consumer instalment loans at commercial banks : new autos 48 month loan, percent, not seasonally adjusted.

A.8.4 Data transformation

As in Smets and Wouters (2003, 2007), the following data transformations are required to estimate the model with relevant data

$$GDP_t = 100\ln\left(\frac{GDPC1_t}{CNP16OV_t}\right) \tag{A.103}$$

$$INV_t = 100\ln\left(\left(\frac{FPI_t}{GDPDEF_t}\right)CNP16OV_t^{-1}\right) \tag{A.104}$$

$$WAGE_t = 100\ln\left(\left(\frac{COMPNFB_t}{GDPDEF_t}\right)CNP16OV_t^{-1}\right) \tag{A.105}$$

$$LABOR_t = 100\ln\left(PRS85006023_t\left(\frac{CE16OV_t}{100}\right)CNP16OV_t^{-1}\right) \tag{A.106}$$

$$INF_t = 100 \ln \left(\frac{GDPDEF_t}{GDPDEF_{t-1}} \right) \tag{A.107}$$

$$QINF_t = 100 \ln \left(\left(\frac{USSTHPI_t}{GDPDEF_t} \right) CNP16OV_t^{-1} \right) \tag{A.108}$$

$$RATE_t = \frac{FEDFUNDS_t}{4} \tag{A.109}$$

$$HHRATE_t = \frac{NIROLTF_t}{4} \tag{A.110}$$

$$ENTRATE_t = \frac{NIROLTHH_t}{4} \tag{A.111}$$

$$ENTLOAN_t = 100 \ln \left(\left(\frac{LTF_t}{GDPDEF_t} \right) CNP16OV_t^{-1} \right) \tag{A.112}$$

$$HHLOAN_t = 100 \ln \left(\left(\frac{LTHH_t}{GDPDEF_t} \right) CNP16OV_t^{-1} \right) \tag{A.113}$$

$$DEPOSIT_t = 100 \ln \left(\left(\frac{DEP_t}{GDPDEF_t} \right) CNP16OV_t^{-1} \right) \tag{A.114}$$

where $CE16OV_t$ and $CNP16OV_t$ are transformed in indexes of the same base.

A.8.5 Measurement equation

The following observable equations are in line with Darracq Pariès et al. (2011) and Pfeifer (2019).

$$GDP_{obs,t} = \ln \left(\frac{y_t}{y} \right) \tag{A.115}$$

$$INV_{obs,t} = \ln \left(\frac{i_t}{i} \right) \tag{A.116}$$

$$WAGE_{obs,t} = \ln \left(\frac{w_t}{w} \right) \tag{A.117}$$

$$LABOR_{obs,t} = \ln \left(\frac{l_t}{l} \right) \tag{A.118}$$

$$INF_{obs,t} = \ln \left(\pi_t \right) \tag{A.119}$$

$$QINF_{obs,t} = \ln \left(\frac{q_{h,t}}{q_h} \right) \tag{A.120}$$

$$RATE_{obs,t} = \left(100 \left(\frac{1+R_t}{1+R} - 1 \right) \right) \tag{A.121}$$

$$HH\_RATE_{obs,t} = \left(100 \left(\frac{1+R_t^{b_i}}{1+R^{b_i}} - 1 \right) \right) \tag{A.122}$$

$$ENT\_RATE_{obs,t} = \left(100\left(\frac{1+R_t^{b_e}}{1+R^{b_e}} - 1\right)\right) \tag{A.123}$$

$$ENT\_LOAN_{obs,t} = \ln\left(\frac{b_{e,t}}{b_e}\right) \tag{A.124}$$

$$HH\_LOAN_{obs,t} = \ln\left(\frac{b_{i,t}}{b_i}\right) \tag{A.125}$$

$$DEPOSIT_{obs,t} = \ln\left(\frac{d_t}{d}\right) \tag{A.126}$$

3 Chapter III: Risk Aversion, Credit and Banking

3.1 Introduction

Changes in the economic environment are assumed to influence risk and time preferences. In particular, Malmendier and Nagel (2011); Cohn et al. (2015) emphasize the counter-cyclical nature of risk aversion based on the emotion of fear of agents so that risk aversion changes in bust and boom scenarios. In the aftermath of a crisis, banks are less willing to lend and households and entrepreneurs are less willing to borrow. Time preferences are also impacted since the intertemporal elasticity of substitution is positively correlated with the level of wealth (Atkeson and Ogaki, 1996) .

The typical households' preferences in a macroeconomic dynamic stochastic general equilibrium (DSGE) framework are modelled with constant relative risk aversion (CRRA) utility functions. Since these preferences are inter-temporal in this framework, the coefficients for relative risk aversion (RRA) and inter-temporal elasticity of substitution (EIS) are linked to each other- RRA is equal to the inverse of the EIS. The RRA coefficient of consumption represents the attitude of households toward risky outcomes within a given time period (intra-temporal preference), while the EIS represents the attitude of households toward smoothing consumption between periods (intertemporal preference).

With respect to the modeling of risk aversion, the recent DSGE literature suffers from problems. First, RRA is usually assumed to be constant over time (Christiano et al., 2005; Smets and Wouters, 2003, 2007). Some authors offset the income effect and substitution effect on savings by assuming a log-utility function (Iacoviello, 2005; Gerali et al., 2010). This parameter is almost always assumed identical across each type of agents in the models. DSGE models also failed to reproduce the positive empirical correlation between consumption and loan rates, a problem pointed out by Angelini et al. (2014b) about Gerali et al. (2010). Finally, those models only consider financial shocks coming from a change in the value of collateral, or from an exogenous increase in interest rates while the slow recovery of credit after the crisis may have stemmed from a change in demand (Kremp and Sevestre, 2013).

In this paper, we study how heterogenous and time-varying preferences can solve some of these shortcomings. To this end, we first assume a specific CRRA utility function for each type of agents (patient and impatient households, entrepreneurs and bankers) to differentiate preferences according to agents' characteristics. This specification allows to analyse several RRA scenarios and to simulate and compare the transmission mechanisms to a benchmark case where all agents have an identical RRA. Second, we estimate our model with Bayesian techniques, using US data from 1975 to 2018, to analyse and estimate the effects of RRA shocks. This shock is characterised by an exogenous change in the preferences of agents whose source may be a change in the economic environment or its behaviour. It is expected to impact output, consumption, and investment in the way that it makes agents more risk-averse with a higher preference for the present [1].

1. Our RRA shock differs from a simple preference shock because it considers inter and intra-temporal dimensions. It also differs from risk shocks. Indeed, risk shocks model the typical effect of a recession by

Our paper is related to two stands of literature. First, to a behavioural economics literature arguing that preferences are heterogenous and time-varying and, second, to DSGE models with financial frictions and a banking sector. Developments in behavioural economics point out that preferences are heterogeneous across agent's characteristics. The heterogeneity of RRA is highlighted in particular by Guiso and Paiella (2008) and Alan and Browning (2010). They show that risk preferences differ considerably from one individual to another and that they are essential to explain differences in behaviour between individuals. Evidences about a heterogenous EIS parameter are also highlighted by Attanasio and Weber (1989) and by Vissing-Jørgensen (2002).
Beyond heterogeneities, the hypothesis of a time-varying parameters was advanced for instance by Guiso et al. (2018). Indeed, in the light of the global financial crisis (GFC) fallout, some authors consider risk aversion as an explanatory factor of the slow recovery and the dynamics of the real economy and credit during and after the GFC. Benchimol (2014) explores empirically the idea of a time-varying risk aversion which is shown to be a non-negligible component of output slowdown during the last crises in the Eurozone. In addition, Atkeson and Ogaki (1996) and Crossley and Low (2011) show that the intertemporal preference parameter varies over time, rejecting the idea of a constant parameter. In particular, it is assumed to depend on the variations of wealth. To our knowledge, only few papers integrate the idea of a time-varying coefficient in a DSGE framework. Benchimol and Fourçans (2017) consider a time-varying RRA coefficient in the households' utility function but assess its variations only through rolling window estimations. Bretscher et al. (2019) use Epstein-Zin utility function to show that the response of macro-economic variables to volatility shocks are stronger when households' risk aversion is higher. Torul (2018) uses alternative formulations of risk aversion and show that a stochastic RRA generates a better fit with the observed volatilities of the real variables.

From the perspective of DSGE models, we are closely related to the paper of Gerali et al. (2010) integrating financial frictions and a banking sector. No consensus about how to integrate financial frictions within DSGE models has yet emerged. The first wave of modelling introduces a financial accelerator (Bernanke et al., 1999) involving an inverse relationship between borrowers' net worth and the external finance premium. Choi and Cook (2004) thereby analyse the balance sheet channel in emerging markets. Christiano et al. (2010) also study the business cycle implications of financial frictions in light of this concept. Another approach considers a financial accelerator working through the amplification role of nominal debt and collateral constraints. First introduced by Kiyotaki and Moore (1997) and incorporated into a DSGE model by Iacoviello (2005), this approach introduces frictions that directly affect the quantity of loans. Other recent works based on

considering that when firms borrow, they suffer a risk premium that reflects the opinion of lenders that the firm represents or not a risky bet (Christiano et al., 2014). Thus, the rate spread fluctuates with the risk : when the risk increases, the spread increases leading to a decline in the credit, and then a decline in investment, consumption, and output.

this framework study the role of credit supply by adding an imperfectly competitive banking sector to analyse a credit crunch scenario. Our study is based on this second approach by extending the model of Gerali et al. (2010). As in Christiano et al. (2005) and Smets and Wouters (2003, 2007), we introduce market imperfections and price rigidities to reproduce the main characteristics of the business cycle. Following Bernanke et al. (1999), we assume monopolistic competition in the retail market. Retailers purchase an intermediate good, produced by entrepreneurs at the wholesale price, transform it into a consumption good at no cost. We assume that retailers are the source of nominal rigidities. Imperfect competition and rigidities are also assumed in the banking sector in a way similar to Gerali et al. (2010) such that monopolistic competition between banks and sticky rates are assumed.

Our model improves the results of the existing literature. In particular, it solves shortcomings of the Gerali et al. (2010)'s model, pointed out by Angelini et al. (2014b) by matching the positive correlation between consumption and loan rates. Second, we obtain two sets of results. The first one is that the transmission mechanism of shocks is generally attenuated for higher levels of RRA, attenuating the response of consumption and output. This result is explained by the reaction of individuals following changes in real interest rates. Indeed, since higher RRA implies increasing the curvature of the inter-temporal utility function, RRA transforms the response of consumption after a change in the real rate. This finding points to a first effect : the *consumption smoothing behaviour*. We note however that these results are magified by a second effect when we are faced with borrowers. The increase in real rate is acting on the borrowing constraint, pushing borrowers to reveal a willingness to deleverage in order to maintain their future consumption. This result puts forward a second effect whose interpretation is close to the *precautionary motive*.
The second set of findings comes from the estimation of aversion shocks. We find that a positive RRA shock substantially influences the real economy through changes in consumption and credit demand. This allows to put forward a new source of variation of quantity of credit in addition to financial frictions based on collateral constraint and to credit crunch scenarios introduced by Gerali et al. (2010) and Brzoza-Brzezina and Makarski (2011). Finally, by estimating our model through Bayesian technique for US data from 1976 to 2018 , we confirm the hypothesis of the heterogeneity of the parameters of risk aversion and of inter-temporal substitution : we find that the heterogeneous value of the RRA parameter depends on the agent's characteristics. Specifically, we find that patients households are more risk averse than entrepreneurs and bankers, themselves more risk-averse than impatient households.

The remainder of the paper is organised as follows. Section 3.2 presents the theoretical setup. Section 3.3 discusses the data, the calibration and prior distributions and presents the estimation. Section 3.4 presents our first set of impulse response functions (IRFs) obtained under simulation. They compare transmission mechanisms of economic shocks under alternative RRA scenario. Section 3.5 presents our second set of IRFs obtained under estimation. They analyse the impact of a RRA for each agents. Concluding remarks and policy implications are presented in sections 3.7 and 3.8. Finally the Appendix presents additional theoretical results.

3.2 The model

The economy is populated by six types of agents : patient and impatient households, entrepreneurs, bankers, retailers, capital producers, and a central bank. Our model, summarised in Fig. 3.1, substantially extends Iacoviello (2005) by considering CRRA utility functions and including a banking sector close to Gerali et al. (2010).

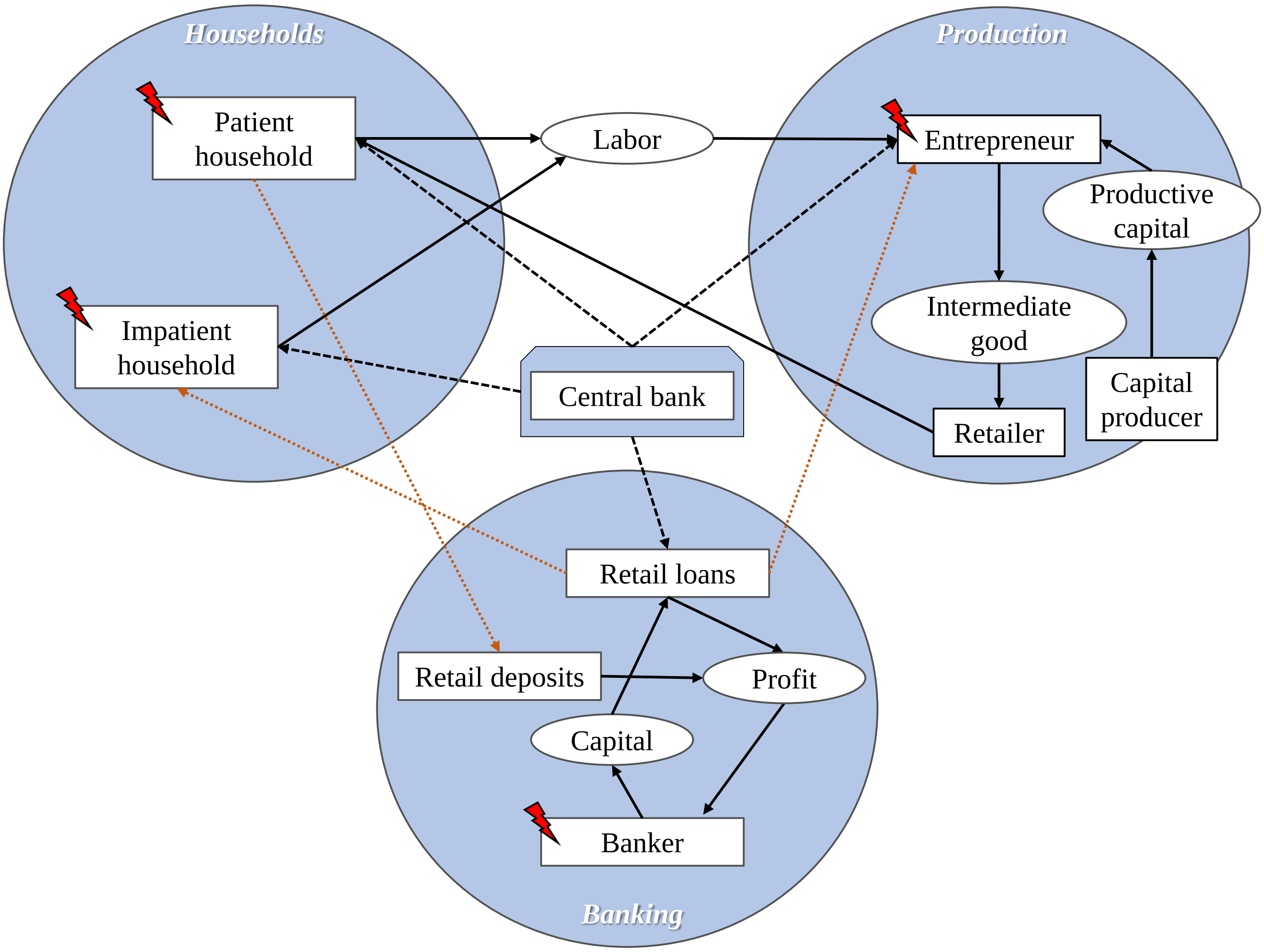

FIGURE 3.1 – Our model in a nutshell. Note : the red flash denotes the agent-specific relative risk aversion shock.

Households supply labor, purchase goods for consumption, and accumulate housing. Entrepreneurs produce a homogeneous intermediate good using productive capital and labor supplied by households. Beyond the fact we assume agents with heterogeneous levels of risk aversion, we consider that they differ in their degree of impatience : entrepreneurs and impatient households discount the future more heavily than patient ones. This assumption introduced by Iacoviello (2005) determines their profiles in the banking sector thereby entrepreneurs and impatient households are borrowers and patient households are lenders. Retailers are the source of nominal rigidities. Following Bernanke et al. (1999) retailers buy intermediate goods from entrepreneurs in a competitive market, brand them at no cost and sell the final differentiated goods at a price which includes a mark-up over the purchasing cost. This allows considering monopolistic competition on the good market. Also, we assume price rigidities in line with Gerali et al. (2010). Financial frictions are introduced through the use of collateral constraints : borrowers face a borrowing constraint which is tied to their value of tomorrow's collateral holding. We consider the stock of housing as collateral for impatient households and the stock of capital for entrepreneurs. A change in the value of these assets changes the value of loans granted by the bank. The introduction of capital producers is a modelling device introduced to consider varying prices of capital, important as it determines the entrepreneurs' collateral value. Intermediaries are introduced according to Gerali et al. (2010) assuming a segmented retail banking sector with both a loan and a deposit branch. Retail banks operate in a regime of monopolistic competition implying that they set interest rates. In order to introduce bank capital as an internal source of funding for banks, we assume that bankers are the sole owner of the banks, such that the entire profit are used by bankers to consume or accumulate bank capital. Finally, the central bank adjusts money supply and transfers to support its interest rate rule.

In what follows, all agent preferences are assumed to follow a CRRA utility functional form implying the formulation of the coefficient of RRA, σ_k, (where k denotes each type of agents) which is also the inverse of EIS. We assume two cases : first, σ_k is a calibrated parameter which takes alternately different values, allowing to compare alternative scenarios of RRA. Second, $\sigma_{k,t}$ is formulated as a time-varying coefficient detailed in Section 3.2.10 in order to introduce risk aversion shocks.

3.2.1 Patient households

There is a continuum of patient households p that follow a CRRA utility function separable in consumption, housing and labor (leisure) such as

$$E_0 \sum_{k=0}^{\infty} \beta_p^k \left(\epsilon_t^z \frac{c_{p,t+k}^{1-\sigma_{p,t+k}}}{1-\sigma_{p,t+k}} + j \ln h_{p,t+k} - \frac{l_{p,t+k}^{1+\varphi}}{1+\varphi} \right) \tag{3.1}$$

where $c_{p,t}$ is consumption, $h_{p,t}$ is housing and $l_{p,t}$ represents the worked hours. $\beta_p \in \left]0;1\right[$ is the static discount factor of the patient households, φ the inverse of the elasticity of work effort with respect to the real wage (Frisch elasticity), j the weight of housing services in the household preferences and ϵ_t^z is a preference shock that affects consumption, it follows an AR(1) , i.e. first-order autoregressive, process detailed in Section 3.2.10.

Patient households maximise their lifetime utility function (Eq. 3.1) subject to an intertemporal budget constraint

$$c_{p,t} + q_{h,t}\left(h_{p,t} - h_{p,t-1}\right) + d_t = \frac{1 + R_{t-1}^d}{\pi_t} d_{t-1} + w_{p,t} l_{p,t} + j_{r,t} + j_{cb,t} \tag{3.2}$$

where $q_{h,t} = Q_{h,t}/\pi_t$ is the real housing price, [2] π_t the gross inflation rate, and $w_{p,t} = W_{p,t}/\pi_t$ the patient households' real wage. d_t is the real amount of deposit, R_t^d is the nominal interest rate on deposits. $j_{r,t}$ denotes dividend received from the retail firms and $j_{cb,t}$ the seigniorage transfer from the central bank.

The maximisation of the objective function of patient households (Eq. 3.1) subject to the budget constraint (Eq. 3.2) with respect to consumption yields the following first order condition (FOC)

$$\epsilon_t^z c_{p,t}^{-\sigma_{p,t}} = \beta_p E_t \left[\frac{1 + R_t^d}{\pi_{t+1}} \epsilon_{t+1}^z c_{p,t+1}^{-\sigma_{p,t+1}} \right] \tag{3.3}$$

representing the Euler equation of patient households. Patient households choose, at each period, between consuming or saving one unit and consume R_t^d/π_{t+1} units tomorrow given $u'_{c,t+1}$ extra units of utility. As this utility comes in the future, it is discounted by β_p.

The FOC related to the housing demand is

$$\frac{j}{h_{p,t}} = q_{h,t} \epsilon_t^z c_{p,t}^{-\sigma_{p,t}} - \beta_p E_t \left[q_{h,t+1} \epsilon_{t+1}^z c_{p,t+1}^{-\sigma_{p+1}} \right] \tag{3.4}$$

where the housing demand of patient households depends negatively on house prices and positively on consumption, with a RRA equal to $\sigma_{p,t}$.

The FOC related to the supply of labor is

$$l_{p,t}^{\varphi} = w_{p,t} \epsilon_t^z c_{p,t}^{-\sigma_{p,t}} \tag{3.5}$$

where the labor supply of patient households depends positively on real wages with an elasticity equal to $1/\varphi$ and negatively on consumption with an elasticity equal to $\sigma_{p,t}/\varphi$.

3.2.2 Impatient households

There is a continuum of impatient households indexed by i following a CRRA utility function separable in consumption, housing and labor (leisure), as in the patient households case (Eq. 3.1), such as

$$E_0 \sum_{k=0}^{\infty} \beta_i^k \left(\epsilon_t^z \frac{c_{i,t+k}^{1-\sigma_{i,t+k}}}{1 - \sigma_{i,t+k}} + j \ln h_{i,t+k} - \frac{l_{i,t+k}^{\varphi+1}}{\varphi + 1} \right) \tag{3.6}$$

2. $Q_{h,t}$ is the nominal housing price. Unlike Gerali et al. (2010), our model does not consider the depreciation rate of housing immobilisation for simplification purposes.

where $c_{i,t}$ is consumption, $h_{i,t}$ is housing and $l_{i,t}$ represents the worked hours. $\beta_i \in]0;1[$ is the discount factor of impatient households assumed to be lower than the patient one (β_p). As a result impatient households discount the future more heavily than patient ones. This assumption allows to determine the profile of households in the loan market (Iacoviello, 2005). ϵ_t^z is the same preference shock as for patient households.

Impatient households maximise their lifetime utility function (Eq. 3.6) subject to an inter-temporal budget constraint such as

$$c_{i,t} + q_{h,t}\left(h_{i,t} - h_{i,t-1}\right) + \frac{1 + R_{t-1}^{b_i}}{\pi_t} b_{i,t-1} = b_{i,t} + w_{i,t} l_{i,t} + j_{cb,t} \tag{3.7}$$

where $w_{i,t} = W_{i,t}/\pi_t$ is the real wage of impatient households, $j_{cb,t}$ the seigniorage transfer from the central bank, $b_{i,t}$ is the real amount of impatient households' loans and $R_t^{b_i}$ is the nominal interest rate on impatient households' loans [3].

In line with Kiyotaki and Moore (1997), lenders ask that borrowers attach collateral [4] when issuing debt. If a borrower fails to pay interest or principal on a loan or security before due date, the lender reclaims the borrowers' assets by paying a proportional transaction cost of $(1 - m_{i,t}) E_t \left[q_{h,t+1} h_{i,t} \pi_{t+1}\right]$. Hence, the maximum borrowable amount, $b_{i,t}$, is bounded according to the following collateral constraint

$$\left(1 + R_t^{b_i}\right) b_{i,t} \leq E_t \left[m_{i,t} q_{h,t+1} h_{i,t} \pi_{t+1}\right] \tag{3.8}$$

where $m_{i,t}$ is the impatient households' exogenous loan-to-value (LTV) ratio detailed in Section 3.2.10. This shock allows for studying the effect of credit supply restrictions on the real economy. The amount of credits banks make available to each type of household, for a given value of their housing stock, can be summarised by $m_{i,t}$.

The maximisation of the objective function of impatient households (Eq. 3.6) subject to the budget constraint (Eq. 3.7) and the collateral constraint (Eq. 3.8) with respect to consumption yields the following FOC

$$\epsilon_t^z c_{i,t}^{-\sigma_{i,t}} = \beta_i E_t \left[\frac{1 + R_t^{b_i}}{\pi_{t+1}} \epsilon_{t+1}^z c_{i,t+1}^{-\sigma_{i,t+1}}\right] + \lambda_{i,t}\left(1 + R_t^{b_i}\right) \tag{3.9}$$

The FOC related to the demand for housing is

$$\frac{j}{h_{i,t}} = q_{h,t} \epsilon_t^z c_{i,t}^{-\sigma_{i,t}} - \beta_i E_t \left[q_{h,t+1} \epsilon_{t+1}^z c_{i,t+1}^{-\sigma_{i+1}} + \lambda_{i,t} m_{i,t} q_{h,t+1} \pi_{t+1}\right] \tag{3.10}$$

The FOC related to the impatient households labor supply is

$$l_{i,t}^{\varphi} = w_{i,t} \epsilon_t^z c_{i,t}^{-\sigma_{i,t}} \tag{3.11}$$

3. It reflects that loans are set in nominal terms, a feature from the financial friction literature (Iacoviello, 2005; Gerali et al., 2010; Guerrieri and Iacoviello, 2017).

4. Collateral assets trade at a market price.

The functional form of the Euler (Eq. 3.9) and the housing demand (Eq. 3.10) equations of impatient households differs from patient households' corresponding equations (Eq. 3.3 and Eq. 3.4) because of the shadow value $\lambda_{i,t}$ of the borrowing constraint. According to the impatient households' Euler equation (Eq. 3.9), and housing demand equation (Eq. 3.10), $\lambda_{i,t}$ can be interpreted as the increase in lifetime utility obtained by borrowing $\left(1+R_t^{b_i}\right)$ units (Iacoviello, 2005).

3.2.3 Entrepreneurs

Entrepreneurs produce intermediate goods y_t following a Cobb and Douglas (1928) constant return to scale production function given by

$$y_t = A_t k_{e,t-1}^{\alpha} l_{p,t}^{\mu(1-\alpha)} l_{i,t}^{(1-\mu)(1-\alpha)} \tag{3.12}$$

where $k_{e,t}$ is the capital input, $l_{p,t}$ and $l_{i,t}$ are the patient and impatient households' labor inputs, respectively, and A_t is the total factor productivity detailed in Section 3.2.10. α is the output elasticity of capital and μ the labor income share of patient households.

Following Bernanke et al. (1999) and Iacoviello (2005), output cannot be transformed immediately into consumption which causes sticky prices. Retailers purchase intermediate good from entrepreneurs at a wholesale price $P_{w,t}$ to transform it into a composite final good of price P_t. Then, $x_t = P_t/P_{w,t}$ represents the markup of final over intermediate goods.

Our economy is populated by an infinity of entrepreneurs e maximising their CRRA lifetime utility function which depends only on consumption such as

$$E_0 \sum_{k=0}^{\infty} \beta_e^k \frac{c_{e,t+k}^{1-\sigma_{e,t+k}}}{1-\sigma_{e,t+k}} \tag{3.13}$$

where $c_{e,t}$ is the entrepreneurs' consumption, β_e the discount factor such that entrepreneurs discount the future more heavily than patient households. Entrepreneurs maximise their lifetime utility function (Eq. 3.13) subject to the following inter-temporal budget constraint

$$c_{e,t} + \frac{1+R_{t-1}^{b_e}}{\pi_t} b_{e,t-1} + w_{p,t} l_{p,t} + w_{i,t} l_{i,t} + q_{ke,t} k_{e,t} = \frac{y_t}{x_t} + b_{e,t} + q_{ke,t}\left(1-\delta_{ke}\right) k_{e,t-1} + j_{cb,t} \tag{3.14}$$

where $q_{ke,t}$ is the real price of one unit of capital in term of consumption and δ_{ke} the depreciation rate of physical capital. $b_{e,t}$ is the real amount of entrepreneurs' loans and $R_t^{b_e}$ the nominal interest rate on entrepreneurs' loans. y_t/x_t denotes revenues obtained from the sale of wholesale goods where $1/x_t$ represents the price in terms of the consumption good of the wholesale good produced by each entrepreneur. $j_{cb,t}$ is the seigniorage transfer from the central bank to entrepreneurs.

As for impatient households, lenders require that borrowers attach collateral when issuing debt. The collateral constraint of entrepreneurs is tied to their endowment of capital. If an entrepreneur fails to pay interest or principal on a loan or security when due, the lender reclaims the entrepreneur's assets by paying a proportional transaction cost of $(1-m_{e,t})\,E_t\left[q_{ke,t+1}\left(1-\delta_{ke}\right)k_{e,t}\pi_{t+1}\right]$. Hence, the maximum amount to borrow, $b_{e,t}$, is bounded according to the following collateral constraint

$$\left(1+R_t^{b_e}\right)b_{e,t} \leq E_t\left[m_{e,t}q_{ke,t+1}\left(1-\delta_{ke}\right)k_{e,t}\pi_{t+1}\right] \tag{3.15}$$

where $m_{e,t}$ is the exogenous LTV ratio detailed in Section 3.2.10. The presence of this borrowing constraint implies that the amount of credit entrepreneurs will be able to accumulate is a multiple of their net worth.

The maximisation of the objective function (Eq. 3.13) subject to the budget constraint (Eq. 3.14) and to the collateral constraint (Eq. 3.15) with respect to consumption, yields the following FOC

$$c_{e,t}^{-\sigma_{e,t}} = \beta_e E_t\left[\frac{1+R_t^{b_e}}{\pi_{t+1}}c_{e,t+1}^{-\sigma_{e,t+1}}\right] + \lambda_{e,t}\left(1+R_t^{b_e}\right) \tag{3.16}$$

where $\lambda_{e,t}$ is the shadow value of entrepreneurs collateral constraint.

The FOC related to the demand of capital is

$$c_{e,t}^{-\sigma_{e,t}}q_{ke,t} = \beta_e E_t\left[c_{e,t+1}^{-\sigma_{e,t+1}}\left(\alpha\frac{y_{t+1}}{x_{t+1}k_{e,t}} + q_{ke,t+1}\left(1-\delta_{ke}\right)\right) + \lambda_{e,t}m_{e,t}q_{ke,t+1}\pi_{t+1}\left(1-\delta_{ke}\right)\right] \tag{3.17}$$

As entrepreneurs use patient and impatient households' labor as input for production, we also get two types of labor demand, one for patients and one for impatient households [5].

The FOC related to the labor demand of patient households is

$$w_{p,t} = \frac{\mu\left(1-\alpha\right)}{l_{p,t}}\frac{y_t}{x_t} \tag{3.18}$$

and the FOC related to the labor demand of impatient households is

$$w_{i,t} = \frac{\left(1-\mu\right)\left(1-\alpha\right)}{l_{i,t}}\frac{y_t}{x_t} \tag{3.19}$$

3.2.4 Retailers

Retailers purchase the wholesale good y_t to entrepreneurs at a wholesale price P_t^w, differentiate them at no cost, and resell differentiated goods $y_t\left(z\right)$ at a market price P_t. The ratio (markup) of market prices over wholesale prices is $x_t = P_t/P_t^w$. Hence price adjustment costs and monopolistic competition at the retail level are assumed (Bernanke et al., 1999; Iacoviello, 2005).

5. Our paper does not assume any difference in skills between the two groups

Retailers bundle the intermediate goods, y_t, according to the following constant elasticity of substitution (CES) technology

$$y_t = \left[\int_0^1 y_t(z)^{\frac{\epsilon_{y,t}-1}{\epsilon_{y,t}}} dz\right]^{\frac{\epsilon_{y,t}}{\epsilon_{y,t}-1}} \tag{3.20}$$

where $\epsilon_{y,t}$ is the time-varying elasticity of substitution between intermediate goods detailed in Section 3.2.10.

Given the aggregate output index (Eq. 3.20) the price index is

$$P_t = \left[\int_0^1 P_t(z)^{1-\epsilon_t} dz\right]^{\frac{1}{1-\epsilon_{y,t}}} \tag{3.21}$$

so that each retailer faces an individual demand curve such as

$$y_t(z) = \left(\frac{P_t(z)}{P_t}\right)^{-\epsilon_{y,t}} y_t \tag{3.22}$$

Each retailer chooses the market price $P_t(z)$ taking the demand curve (Eq. 3.22) and the wholesale price P_t^w as given. This corresponds to solving the following problem

$$E_t \sum_{k=0}^{\infty} \theta^k \Lambda_{t,k}^p \left[\left(P_t(z) - P_{t+k}^w\right) y_{t+k}^*(z) - \frac{\kappa_p}{2}\left(\frac{P_t(z)}{P_{t-1}(z)} - \pi_{t-1}^{\iota_p}\overline{\pi}^{1-\iota_p}\right)^2 P_t y_t\right] \tag{3.23}$$

where $\Lambda_{t,k}^p = \beta_p U_{c,t+k}/U_{c,t}$ is the stochastic discount factor, κ_p is the quadratic adjustment cost observed by retailers when they change their price beyond what indexation allows and, ι_p are the relative weights of past and steady state inflation in the equation of price indexation, subject to an individual demand constraint given by Eq. 3.22,

The first order condition associated with the retailer problem is

$$1-\epsilon_{y,t}+\frac{\epsilon_{y,t}}{x_t}-\kappa_p\left(\pi_t - \pi_{t-1}^{\iota_p}\overline{\pi}^{1-\iota_p}\right)\pi_t+\beta_p\left(\frac{c_{p,t}}{c_{p,t+1}}\right)\kappa_p\left(\pi_{t+1} - \pi_t^{\iota_p}\overline{\pi}^{1-\iota_p}\right)\pi_{t+1}\frac{y_{t+1}}{y_t} = 0 \tag{3.24}$$

Note that in our model, we assume a negative markup shock which implies an exogenous time-variant elasticity of substitution $\epsilon_{y,t}$. A positive shock to $\epsilon_{y,t}$ will decrease the optimal value of markups.

3.2.5 Capital goods producers

We introduce a capital producer sector to determine the capital price which is an important value in our model as it determines the value of entrepreneurs' collateral. Capital producers are in a competitive market. Their aim is to produce new capital and to sell it to entrepreneurs at the nominal market price Q_k. The profit maximisation of the capital good producers delivers a dynamic equation for the real price of capital similar to Smets and Wouters (2003, 2007).

Following Gerali et al. (2010), capital producers buy an amount i_t of final good at the beginning of each period and the stock of old undepreciated capital $(1-\delta_{ke})\,k_{e,t-1}$ from entrepreneurs. Old capital can be converted one to one into new capital. We assume quadratic adjustment costs. Finally, the amount that capital good producers can produce is given by

$$k_{e,t} = (1-\delta_{ke})k_{e,t-1} + \left[1 - \frac{\kappa_i}{2}\left(\frac{\epsilon_t^{qk} i_t}{i_{t-1}} - 1\right)^2\right] i_t \tag{3.25}$$

where κ_i is the adjustment cost of a change in investment and ϵ_t^{qk} is a shock to the efficiency of investment, which follows an AR(1) process, detailed in Section 3.2.10.

3.2.6 Retail banks

3.2.6.1 Loan and deposit demand

Monopolistic competition at the banking level is introduced to capture the existence of market power. In line with Gerali et al. (2010) we use a Dixit and Stiglitz (1977) framework to aggregate deposits and loans demand. A CES utility function for saving and borrowing, with elasticity of substitution equal to $\varsigma_{d,t}$, $\varsigma_{b_i,t}$ and $\varsigma_{b_e,t}$, is assumed. Each agent buys deposit (loan) contracts from every single bank to save (borrow) one unit of resource. This modeling device used by Gerali et al. (2010) captures the existence of market power in the banking industry. $\varsigma_{d,t}$, $\varsigma_{b_i,t}$ and $\varsigma_{b_e,t}$ are stochastic processes (detailed in Section 3.2.10) allowing to consider markup shocks for the banking sector, taking into account the shock impacting the spread between policy and retail rates.

The optimal behaviour requires that deposit demand is obtained by maximising he level of total savings. In other words, agent i will choose how much to deposit at bank j by maximising the level of total savings

$$\min_{d_{p,t}(i,j)} \int_0^1 R_t^d\,(j)\,d_{p,t}\,(i,j)\,dj \tag{3.26}$$

subject to the aggregation technology

$$d_t\,(i) = \left[\int_0^1 d_t\,(i,j)^{\frac{\varsigma_{d,t}-1}{\varsigma_{d,t}}}\,dj\right]^{\frac{\varsigma_{d,t}}{\varsigma_{d,t}-1}} \tag{3.27}$$

where $\varsigma_{d,t}$ is the time-varying elasticity of substitution between deposits.

Aggregating the FOC over all patient households leads to the following deposit demand

$$d_t\,(j) = \left(\frac{R_t^d\,(j)}{R_t^d}\right)^{-\varsigma_{d,t}} d_t \tag{3.28}$$

where the aggregated deposit rate R_t^d is defined as

$$R_t^d = \left[\int_0^1 R_t^d\left(j\right)^{1-\varsigma_{d,t}} dj\right]^{\frac{1}{1-\varsigma_{d,t}}} \tag{3.29}$$

In what follows, we note b_k equal to the sum of loans to impatient households b_i and entrepreneurs b_e.

Entrepreneurs and impatient households seek the amount of loans $b_{k,t}(i,j)$ allocated to each bank so as to minimise their level of expenditure (total due repayment)

$$\min_{b_{k,t}(i,j)} \int_0^1 R_t^{b_k}\left(j\right) b_{k,t}\left(i,j\right) dj \tag{3.30}$$

subject to the aggregation technology

$$b_{k,t}\left(i\right) = \left[\int_0^1 b_{k,t}\left(i,j\right)^{\frac{\varsigma_{b_k,t}-1}{\varsigma_{b_k,t}}} dj\right]^{\frac{\varsigma_{b_k,t}}{\varsigma_{b_k,t}-1}} \tag{3.31}$$

where $\varsigma_{b_k,t}$ is the time-varying elasticity of substitution whose exogenous changes are interpreted as a change to the banking interest rate spread arising independently from monetary policy.

Aggregating FOC over all borrowers gives their loan demand

$$b_{k,t}(j) = \left(\frac{R_t^{b_k}\left(j\right)}{R_t^{b_k}}\right)^{-\varsigma_{bk,t}} b_{k,t} \tag{3.32}$$

and the aggregated borrowers' loan rate $R_t^{b_k}$ is defined as

$$R_t^{b_k} = \left[\int_0^1 R_t^{b_k}\left(j\right)^{1-\varsigma_{bk,t}} dj\right]^{\frac{1}{1-\varsigma_{bk,t}}} \tag{3.33}$$

3.2.6.2 Loan activity

Each bank j produces loans $b_{e,t}$ and $b_{i,t}$ according to

$$b_{e,t}\left(j\right) + b_{i,t}\left(j\right) = k_{b,t-1}^{\chi_b}\left(j\right)\left(m_t\left(j\right) + d_t\left(j\right)\right)^{1-\chi_b} \tag{3.34}$$

which is equivalent to a balance sheet constraint suggesting that each bank finances its loans by obtaining funds from deposits $d_t\left(j\right)$, monetary market $m_t\left(j\right)$, and bank equity (bank capital) $k_{b,t}\left(j\right)$. Eq. 3.34 captures basic elements of financial intermediation's balance sheet.χ_b represents the bank capital share in the loan production function.

The banks' production function (Eq. 3.34) allows us to calculate a positive marginal cost $mc_{b,t}(j)$ associated to the production of loans (details are given in appendix A.3). Given the nominal rate of funds from the central bank or from the banking sector, R_t, and the interest rate on bank capital, $R_{kb,t}$, the constant nominal marginal cost of loans [6] is

$$mc_{b,t}(j) = \frac{R_t^{1-\chi_b} R_{kb,t}^{\chi_b}}{(1-\chi_b)^{1-\chi_b} \chi_b^{-\chi_b}} \tag{3.35}$$

while the optimal input ratio for the bank is

$$\frac{m_t(j) + d_t(j)}{k_{b,t}(j)} = \frac{R_{kb,t}}{R_t} \frac{1-\chi_b}{\chi_b} \tag{3.36}$$

This allows to add endogenous interest rate spreads into the financial accelerator model. In fact, due to the monopolistic competition, deposits face an upward sloping demand curve (Eq. 3.28) and loans a downward sloping curve (Eq. 3.32). Consequently, the market power of banks leads them to set their optimal interest rates. Each bank j chooses the interest rate maximising its profit $j_{b,t}(j)$ given by

$$j_{b,t}(j) = \begin{bmatrix} R_t^{b_e}(j)\, b_{e,t}(j) + R_t^{b_i}(j)\, b_{i,t}(j) - mc_{b,t}(j)\left(b_{e,t}(j) + b_{i,t}(j)\right) \\ + \left(R_t - R_t^d(j)\right) d_t(j) - \sum_{k=d,b_i,b_e} \frac{\kappa_k}{2}\left(\frac{R_t^k(j)}{R_{t-1}^k(j)} - 1\right)^2 R_t^k k_t \end{bmatrix} / \pi_{t+1} \tag{3.37}$$

where κ_d , κ_{b_i} and κ_{b_e} are parameters determining the speed of adjustment to changes in the policy rate.

3.2.6.3 Optimal interest rate setting

Retail deposit and retail loan branches are differentiated. The only task of the first one is to accumulate deposits d_t. For each unit of deposit, the benefits generated by the bank j are equal to the difference between the interbank rate, R_t, and the deposit rate, R_t^d [7].

The problem for the retail deposit branch j is to set the interest rate R_t^d to maximise its profits given by

$$E_t \sum_{t=0}^{\infty} \Lambda_{t,t+k}^b \left[\left(R_t - R_t^d(j)\right) d_t(j) - \frac{\kappa_d}{2}\left(\frac{R_t^d(j)}{R_{t-1}^d(j)} - 1\right)^2 R_t^d d_t\right] \tag{3.38}$$

under the individual deposit demand condition (Eq. 3.28) where $\Lambda_{t,t+k}^b = \beta_p U'_{c,t+k}/U'_{c,t}$ is the stochastic discount factor of bankers, sole owners of the banks, $R_t^d(j)$ is the chosen

6. Banks rent at the cost R_{kb} the amount of capital that they desire, while bankers accumulate this capital.

7. R_t represents the rate at which transfers between the two banks are registered.

deposit rate, R_t^d is taken as given by the individual bank, $d_t(j)$ is the demand of deposits for bank j and d_t is the economy-wide demand for deposits.

Imposing a symmetric equilibrium where each bank faces the same optimisation problem yields the following FOC

$$\begin{aligned} & -1+\varsigma_{d,t}-\varsigma_{d,t}\frac{R_t}{R_t^d}-\kappa_d\left(\frac{R_t^d}{R_{t-1}^d}-1\right)\frac{R_t^d}{R_{t-1}^d}+ \\ & \beta_b E_t\left[\frac{c_{b,t+1}^{-\sigma_{b,t+1}}}{c_{b,t}^{-\sigma_t}}\kappa_d\left(\frac{R_{t+1}^d}{R_t^d}-1\right)\left(\frac{R_{t+1}^d}{R_t^d}\right)^2\frac{d_{t+1}}{d_t}\right] \end{aligned} \tag{3.39}$$

The deposit interest rate is set by taking into account the expected future level of the policy rate. The speed of adjustment to changes in the policy rate depends inversely on the intensity of the adjustment costs (κ_d) and positively on the degree of competition in the banking sector (inverse of $\varsigma_{d,t}$).

The problem for the retail loan bank j is to choose the interest rates $R_t^{b_i}$ and $R_t^{b_e}$ maximising its following profit

$$E_t\sum_{t=0}^{\infty}\Lambda_{t,t+k}^b\left[\begin{array}{c} R_t^{b_e}(j)\,b_{e,t}(j)+R_t^{b_i}(j)\,b_{i,t}(j)-mc_{b,t}(j)\left(b_{e,t}(j)+b_{i,t}(j)\right)- \\ \frac{\kappa_{b_e}}{2}\left(\frac{R_t^{b_e}(j)}{R_{t-1}^{b_e}(j)}-1\right)^2R_t^{b_e}b_{e,t}-\frac{\kappa_{b_i}}{2}\left(\frac{R_t^{b_i}(j)}{R_{t-1}^{b_i}(j)}-1\right)^2R_t^{b_i}b_{i,t}\end{array}\right] \tag{3.40}$$

under the loan demand constraints of impatient households and entrepreneurs (Eq. 3.32). $R_t^{b_i}(j)$ and $R_t^{b_e}(j)$ are the chosen rates, $R_t^{b_i}$ and $R_t^{b_e}$ are taken as given, $b_{i,t}(j)$ and $b_{e,t}(j)$ are loans granted by bank j and $b_{i,t}$ and $b_{e,t}$ are the economy wide demand of loans.

After imposing a symmetric equilibrium, we obtain the following FOC associated with the bank problem for impatient households' loan rate

$$\begin{aligned} & 1-\varsigma_{b_i,t}+\varsigma_{b_i,t}\frac{mc_{b,t}}{R_t^{b_i}}-\kappa_{b_i}\left(\frac{R_t^{b_i}}{R_{t-1}^{b_i}}-1\right)\frac{R_t^{b_i}}{R_{t-1}^{b_i}}+ \\ & \beta_b E_t\left[\kappa_{b_i}\frac{c_{b,t+1}^{-\sigma_{b,t+1}}}{c_{b,t}^{-\sigma_t}}\left(\frac{R_{t+1}^{b_i}}{R_t^{b_i}}-1\right)\left(\frac{R_{t+1}^{b_i}}{R_t^{b_i}}\right)^2\frac{b_{i,t+1}}{b_{i,t}}\right] \end{aligned} \tag{3.41}$$

The FOC associated with the bank problem for entrepreneurs' loan rate is

$$\begin{aligned} & 1-\varsigma_{b_e,t}+\varsigma_{b_e,t}\frac{mc_{b,t}}{R_t^{b_e}}-\kappa_{b_e}\left(\frac{R_t^{b_e}}{R_{t-1}^{b_e}}-1\right)\frac{R_t^{b_e}}{R_{t-1}^{b_e}}+ \\ & \beta_b E_t\left[\kappa_{b_e}\frac{c_{b,t+1}^{-\sigma_{b,t+1}}}{c_{b,t}^{-\sigma_t}}\left(\frac{R_{t+1}^{b_e}}{R_t^{b_e}}-1\right)\left(\frac{R_{t+1}^{b_e}}{R_t^{b_e}}\right)^2\frac{b_{e,t+1}}{b_{e,t}}\right] \end{aligned} \tag{3.42}$$

Loan rates are set by banks taking into account the expected future path of marginal costs.

3.2.7 Bankers

Bankers solve a relatively short horizon problem. As a result, they have a simple objective function, which is different from that of the banking sector. Bankers allow introducing bank capital as an internal source of funding for banks. They also face a CRRA lifetime utility function allowing us to take into account the bankers' RRA. Bankers consume and accumulate bank capital. Bankers' utility only depend on consumption and their lifetime utility function is

$$E_0 \sum_{k=0}^{\infty} \beta_b^k \frac{c_{b,t+k}^{1-\sigma_{b,t+k}}}{1-\sigma_{b,t+k}} \tag{3.43}$$

where $c_{b,t}$ is bankers' consumption. $\beta_b \in]0;1[$ is the static discount factor such that bankers discount the future in the same way than households. Bankers budget constraint is

$$c_{b,t} + k_{b,t} = (1 + R_{kb,t-1} - \delta_{kb}) k_{b,t-1} + j_{b,t}(j) \tag{3.44}$$

where $j_{b,t}$ is the profit payment received by bankers from bank j activity detailed by Eq. 3.37, $k_{b,t}$ the bank capital, $R_{kb,t-1}$ the bank capital's rental rate and δ_{kb} the bank capital depreciation rate. As bankers are the sole owners of the banks, they get all profit from intermediation activity and can only invest in bank capital. Those features allow to consider bank capital as an internal source of funding for banks. Thus, changes in equity in each period correspond to the reinvested bank earnings, i.e., profits net of the part distributed and consumed by bankers.

The maximisation of the objective function (Eq. 3.43) subjects to the budget constraint (Eq. 3.44) with respect to consumption and bank capital yields the FOC

$$c_{b,t}^{-\sigma_{b,t}} = \beta_b E_t \left[c_{b,t+1}^{-\sigma_{b,t}+1} \left(1 + R_{kb,t} - \delta_{kb}\right) \right] \tag{3.45}$$

3.2.8 Monetary policy

The model is closed with the following monetary policy reaction function

$$1 + R_t = (1 + R_{t-1})^{\rho_R} \left(\overline{\pi}^{\rho_\pi} \left(\frac{y_t}{y_{t-1}} \right)^{\rho_y} \left(1 + \overline{R}\right) \right)^{1-\rho_R} \exp\left(\varepsilon_{r,t}\right) \tag{3.46}$$

where ρ_π and ρ_π are policy coefficients reflecting the weight of inflation and the output gap, respectively, and the parameter $\rho_R \in]0;1[$ captures the degree of interest rate smoothing. $\varepsilon_{r,t}$ is an exogenous *ad hoc* shock that accounts for fluctuations in the nominal interest rate, and $\overline{\pi}$ can be interpreted as the steady-state inflation rate.

Some assumptions about the central bank behaviour will be made. First, we assume a standard monetary policy rule for the central bank interest rate decision as in Taylor (1993). Second, we assume that profits made by the central bank on seigniorage are rebated in a lump-sum transfer to households and entrepreneurs.

The transfer from the central bank is equal to

$$j_{cb,t} = (1 + R_t)\, m_t \tag{3.47}$$

3.2.9 Aggregation

Equilibrium in the goods market is expressed as

$$y_t = c_{p,t} + c_{i,t} + c_{e,t} + c_{b,t} + i_t + adj_t \tag{3.48}$$

where adj_t represent the sum of adjustment costs (adjustment cost on prices and interest rates).
Equilibrium in the housing market is given by

$$h_{p,t} + h_{i,t} = 1 \tag{3.49}$$

Aggregated labor is

$$l_t = l_{p,t} + l_{i,t} \tag{3.50}$$

Aggregated wage is

$$w_t = w_{p,t} + w_{i,t} \tag{3.51}$$

3.2.10 Stochastic structure

The structural shocks are assumed to follow a first-order autoregressive functional form such as

$$X_t = (1 - \rho_X)\,\overline{X} + \rho_X X_{t-1} + \eta_t^X \tag{3.52}$$

where $X_t \in \left\{\epsilon_t^z, A_{e,t}, m_{i,t}, m_{e,t}, \epsilon_t, \epsilon_t^{qk}, \varsigma_{d,t}, \varsigma_{b_i,t}, \varsigma_{b_e,t}, \sigma_{p,t}, \sigma_{i,t}, \sigma_{e,t}, \sigma_{b,t}\right\}$, $\overline{X}$ is the steady-state value of X_t, $\rho_X \in [0, 1[$ is the first-order autoregressive parameter of the shock X_t and the innovation η_t^X is an $i.i.d$ normal error term with zero mean and standard deviation σ_X.

3.3 Estimation

We estimate our model with Bayesian techniques. In this section, we present the data, the calibration, the prior distribution of parameters, and then, we report the estimated posterior distribution of parameters. We estimate the parameters driving the model and we calibrate those determining the steady state. Our calibration allows to match the main statistics of the data.

3.3.1 Data

In our estimation, we use quarterly U.S. data covering the period 1975Q2 to 2018Q3. The 12 observable variables we use are the real consumption, real investment, labor, price inflation (GDP deflator), wage inflation, real housing price, Federal fund rate, nominal interest rate on loans to firms, nominal interest rate on loans to households, loan to firms, loan to households and deposits. [8] All these variables, except interest rates, are expressed in log (first) difference real terms (using the GDP deflator) as in Smets and Wouters (2007). These data are also seasonally adjusted through the standard Census X12-ARIMA(0,1,1) methodology. More information about the data transformations are available in Appendix A.4.4.

3.3.2 Calibration

Calibrated parameters : Several structural parameter values are calibrated in line with the literature. These calibrated parameters are reported in Table 3.1. In particular, we calibrate $\beta_p = 0.994$ to obtain a deposit rate close to 2 percent. The discount factor of impatient households and entrepreneurs, respectively β_i and β_e are calibrated to 0.95 to ensure the binding of the collateral constraint in the steady-state. [9] The banker's discount factor β_b is assumed to be equal to that of the patient households as in Hollander and Liu (2016). The labor disutility is $\varphi = 1$ in line with the value of Gerali et al. (2010) and the index of price stickiness κ_p and price indexation ι_p are calibrated to respectively 50 and 0.15. The depreciation rate of capital δ_k is 0.025 as in Brzoza-Brzezina et al. (2013). Based on the recent U.S. commercial banks' balance sheet conditions we calibrate the bank capital share in the production function χ_b to 0.09 and the bank capital depreciation rate δ_{kb} to 0.1.

Description	**Symbol**	**Value**
Patient households' static discount factor	β_p	0.994
Impatient households' static discount factor	β_i	0.95
Entrepreneurs' static discount factor	β_e	0.95
Bankers' static discount factor	β_b	0.994
Inverse Frisch elasticity of labor supply	φ	1
Depreciation rate of physical capital	δ_k	0.025
Bank capital share in the loan production function	χ_b	0.09
Bank capital depreciation rate	δ_{kb}	0.1
Price stickiness	κ_p	50
Price indexation	ι_p	0.15
Steady state value of inflation	$\overline{\pi}$	1

TABLE 3.1 – Calibrated parameters.

Prior distributions : The prior distribution of the estimated parameters are reported in Table 3.2 and Table 3.3. Priors are consistent with the previous literature. The steady-state

8. See Appendix A.4 for more details about these data.

9. In the steady-state, the borrowing constraints are binding if and only if the Lagrange multipliers (λ_i and λ_e) are greater than 0. As $\lambda_i = \frac{1}{c_i^{\sigma_{i,t}}}(\beta_p - \beta_i)$ and $\lambda_e = \frac{1}{c_e^{\sigma_{e,t}}}(\beta_p - \beta_e)$, they are greater than zero if and only if $\beta_p > \beta_i$ and $\beta_p > \beta_e$. Satisfying these constraints implies that borrowers always prefer to borrow rather than favour precautionary savings.

value of RRA for all agents ($\overline{\sigma_p}$, $\overline{\sigma_i}$, $\overline{\sigma_e}$ and $\overline{\sigma_b}$) is assumed to follow a Normal distribution with a mean of 1.5 and a standard deviation of 1. The interest rate adjustment cost parameters (κ_d, κ_{bi} and κ_{be}) are calibrated in line with Hollander and Liu (2016), and are assumed to follow a Gamma distribution with a mean of 4 and a standard deviation of 1. The investment adjustment cost (κ_i) follows a Normal distribution with a mean of 10 and a standard deviation of 0.5. The LTV ratio of impatient households ($\overline{m_i}$) and entrepreneurs ($\overline{m_e}$) are close to what Gerali et al. (2010) and Iacoviello and Neri (2010) set with a prior mean of 0.75 and 0.35, respectively, and a standard deviation of 0.05 for both parameters. The prior on the parameter governing the relative weight of housing in the utility function, j, is 0.2, which is close to the calculated ratio of US residential investment to GDP. The prior on the share of patient households μ is 0.8 in line with the evidence of Iacoviello and Neri (2010). The capital share in the production function α is 0.25, a value commonly used in the literature. The steady-state price markup $\bar{\epsilon}$ is calibrated to 6, leading to a price markup of 20%, a common value in the literature. For the banking parameters, only few papers estimate the values for the US in the literature. The elasticity of substitution for deposit $\overline{\varsigma_d}$ is -1.47 calculated as the average monthly spread between deposit rate [10] and the effective federal fund rate (monetary policy rate). The elasticity of substitution for impatient households $\overline{\varsigma_{bi}}$ and entrepreneurs $\overline{\varsigma_{be}}$ loans are calibrated to respectively 3.3 and 2.7 reflecting the average monthly spread between loan rate to impatient households and firms respectively and monetary policy rate. Our calibration and prior distributions allow to determine steady state ratios matching key statistics of the data (for more details, see Appendix A.6)

10. The deposit rate is the National Rate on Non-Jumbo Deposits obtained from FRED database

Prior name	Distribution	Mean	Std.	Posterior mean	Posterior std
$\overline{\sigma_p}$	Inv. Gamma	1.5	1	2.3242	0.0144
$\overline{\sigma_i}$	Inv. Gamma	1.5	1	0.2873	0.0278
$\overline{\sigma_e}$	Inv. Gamma	1.5	1	2.0812	0.1328
$\overline{\sigma_b}$	Inv. Gamma	1.5	1	0.7347	0.0130
j	Beta	0.2	0.05	0.2610	0.0056
α	Beta	0.25	0.05	0.2695	0.0013
μ	Beta	0.8	0.05	0.8276	0.0013
$\overline{\epsilon}$	Normal	6	1	5.1196	0.0881
κ_d	Gamma	4	1	4.3344	0.0619
κ_{bi}	Gamma	4	1	3.5459	0.0723
κ_{be}	Gamma	4	1	3.8903	0.0400
κ_i	Normal	10	0.5	8.5771	0.0099
ρ_y	Beta	0.2	0.1	0.1373	0.0074
ρ_π	Normal	2	0.5	1.8726	0.0380
ρ_R	Beta	0.8	0.1	0.7947	0.0026
$\overline{m_i}$	Beta	0.75	0.05	0.7101	0.0055
$\overline{m_e}$	Beta	0.35	0.05	0.3524	0.0013
ς_{bi}	Normal	3.3	1	3.3859	0.0348
ς_{be}	Normal	2.7	1	2.5477	0.0664
ς_d	Normal	-1.47	1	-1.2266	0.0211

TABLE 3.2 – Prior and posterior distributions of structural parameters.

Prior name	Distribution	Mean	Std.	Posterior mean	Posterior std
ρ_{A_e}	Beta	0.75	0.1	0.7270	0.0007
ρ_{m_i}	Beta	0.75	0.1	0.8873	0.0109
ρ_{m_e}	Beta	0.75	0.1	0.7110	0.0023
ρ_{ϵ_y}	Beta	0.25	0.1	0.3029	0.0063
ρ_{ς_d}	Beta	0.5	0.1	0.6466	0.0103
$\rho_{\varsigma_{b_i}}$	Beta	0.5	0.1	0.5077	0.0050
$\rho_{\varsigma_{be}}$	Beta	0.5	0.1	0.5489	0.0013
ρ_{σ_p}	Beta	0.5	0.1	0.4714	0.0018
$\rho_{\sigma i}$	Beta	0.5	0.1	0.3851	0.0057
ρ_{σ_e}	Beta	0.5	0.1	0.6374	0.0100
ρ_{σ_b}	Beta	0.5	0.1	0.5196	0.0037
ρ_{ϵ_z}	Beta	0.5	0.1	0.5397	0.0084
$\rho_{\epsilon_{qk}}$	Beta	0.5	0.1	0.4871	0.0049
σ_{A_e}	Inv-gamma	0.001	inf	0.0138	0.0008
σ_{R_e}	Inv-gamma	0.001	inf	0.0043	0.0003
σ_{m_i}	Inv-gamma	0.001	inf	0.1015	0.0203
σ_{m_e}	Inv-gamma	0.001	inf	0.1002	0.0160
σ_{ϵ_y}	Inv-gamma	0.001	inf	2.1359	0.5173
σ_{ς_d}	Inv-gamma	0.001	inf	4.2126	0.5138
$\sigma_{\varsigma_{b_i}}$	Inv-gamma	0.001	inf	0.3915	0.0223
$\sigma_{\varsigma_{be}}$	Inv-gamma	0.001	inf	0.4436	0.0294
σ_{σ_p}	Inv-gamma	0.001	inf	0.0021	0.0034
$\sigma_{\sigma i}$	Inv-gamma	0.001	inf	0.4873	0.0435
$\sigma_{\sigma e}$	Inv-gamma	0.001	inf	0.2543	0.3481
σ_{σ_b}	Inv-gamma	0.001	inf	0.1866	0.0068
σ_{ϵ_z}	Inv-gamma	0.001	inf	0.6875	0.0365
$\sigma_{\epsilon_{qk}}$	Inv-gamma	0.001	inf	0.0071	0.0017

TABLE 3.3 – Prior and posterior distributions of exogenous process

3.3.3 Posterior Estimates

First, we find a heterogenous parameter of risk aversion between agents. This result is in line with behavioural economics literature pointing out that preferences are heterogeneous across agent's characteristics (Guiso and Paiella, 2008; Alan and Browning, 2010; Attanasio and Weber, 1989; Vissing-Jørgensen, 2002). They show that risk preferences differ considerably from one individual to another and are essential to explain differences in behaviour between individuals. For instance, we find that the estimated RRA of patient households (2.3242) is higher than the impatient one (0.2873) (result in line with Hollander and Liu (2016)) implying that patient households are less impacted by changes in the economic or financial environment and have a lower preference to smooth their consumption. We also find evidence that patient households are more risk-averse than entrepreneurs (2.0812), which are both more risk-averse than bankers (0.7347).

Moreover, results of our estimation highlight two empirical facts of the American banking market. First, the LTV ratio for entrepreneurs (0.3524) is lower than the impatient households' LTV ratio (0.7101) which stipulates that households can more easily collateralised their loans. Second, we find that the loan rate adjustment cost of entrepreneurs (2.5477) is smaller than the loan rate adjustment cost of impatient households (3.3859) as in Hollander and Liu (2016). This reveals that there are more frequent adjustments on the entrepreneurs than impatient households' loan rate.

3.4 Simulation

In this section, we study how the transmission mechanism of shocks is affected by the use of alternative values of RRA for each agent. Our model retains two categories of shocks, classified as economic (productivity, monetary policy, and price markup shocks) or financial (impatient households and entrepreneurs' LTV and loan spread shock). For the sake of simplicity, we only present the reactions of the main variables to productivity and monetary policy shocks. We perform simulations under 5 scenarii : the first one is the baseline case where each agent has the same degree of risk aversion, equal to 1 (red line). In scenario 2 (green line), 3 (black line), 4 (pink line) and 5 (red dashed line), we increase the calibrated value of RRA coefficient for each agent, patient and impatient households, entrepreneurs and bankers, respectively. The calibrated values of other variables are kept unchanged.

Simulation results are in line with the New Keynesian literature. In particular, as we assume collateral constraints for borrowers and debt contract in nominal terms, the transmission mechanisms of shocks allow a financial accelerator and a nominal debt effect, similar to Iacoviello (2005). Moreover, the sluggishness of the retail bank rates is another force affecting the propagation of shocks to the real economy (Gerali et al., 2010) (see Appendix A.7 for more details).

Our IRFs are affected by a change in the level of RRA, and the intensity depends on agent characteristics. In order to consider agent characteristics in our analysis, we divide them into two categories : lenders and borrowers.

3.4.1 Lender's RRA

We first analyse how a change in the level of RRA for lenders (patient households) affects the transmission mechanism of productivity and monetary policy shocks. We compare the baseline case (first scenario - red line) with the second scenario (green line) corresponding to an increase in patient households' RRA coefficient.

Productivity shock. IRFs of the productivity shock are reported in Fig. 3.2.The baseline case is standard : after a positive productivity shock, the real deposit rate decreases leading to an increase in consumption (Euler equation) and labor supply and a decrease in housing demand for patient households. However, we find that the intensity of the changes depends on the sensitivity of consumption to real deposit rate. In fact, the higher the degree of RRA, the less consumption is sensitive to a change in real deposit rate, meaning that patient households are less interested in smoothing consumption. This implies that the positive response of consumption is attenuated (see Eq. 3.3), the negative response of housing demand is amplified (see Eq. 3.4) and the positive response of labor supply is amplified (see Eq. 3.5).

Monetary policy shock. IRFs of the monetary policy shock are reported in Fig. 3.3. As for the productivity shock, the baseline case is standard : after a monetary policy shock, real deposit rate increases encouraging households to postpone their consumption. As labor responds positively to the change in consumption and housing demand responds negatively, we observe a decrease in labor supply and an increase in housing demand by patient households. When the sensitivity of consumption to real deposit rate is attenuated (after an increase of the RRA coefficient), the negative response of consumption is mitigated in line with the inter-temporal smoothing effect. The response of housing demand and labor supply is then amplified.

Finally, our simulation highlights that the level of present and future consumption responds to the real deposit rate. After a negative demand shock, real deposit rates increases leading to lower consumption. The impact on consumption is less important when agents are more risk-averse. Conversely, after a positive supply shock, real deposit rate decreases leading to a positive impact on consumption, and this positive impact is lower for more risk-averse agents.

3.4.2 Borrower's RRA

In this part, we analyse how a change in the level of risk aversion for borrowers (impatient households and entrepreneurs) affects the transmission mechanism of productivity and monetary policy shocks. We compare the baseline case (red line) with the third and fourth scenarii (black line and pink line respectively) corresponding to an increase in impatient households and entrepreneurs' RRA coefficients.

Borrowers' Euler equations (Eq. 3.9 and 3.16) are different from the Euler equation of lenders (Eq. 3.3) as they reveal an increase in utility of current consumption obtained from borrowing $\left(1 + R^{b_k}\right)$ units. The assumption of a collateral constraint always binding implies that the extra-utility of consumption is positive and increases with the level of RRA. Thus, the higher the RRA coefficient, the more extra-utility obtained from borrowing, giving the intuition that agents need to borrow less to maintain an identical utility of consumption. This assumption ($\lambda_k > 0$) is essential as the effect of borrowing on utility does not compensate the initial effect of a change in real rate of loans- this is the *the consumption smoothing effect* according to which an increase in RRA makes borrowers less sensitive to a change in real rates of loans and thus reduces the intensity of their consumption response.

Productivity shock.(IRFs are presented in Fig. 3.2). After a positive productivity shock, the more risk-averse borrowers being less sensitive to changes in real rate of loans, the effect on consumption is mitigated and also the negative effect on borrowing. Thus, the responses of impatient households' housing demand and investment are attenuated.

Monetary policy shock (IRFs are presented in Fig. 3.3) After a monetary policy shock, nominal interest rates on loans rise. The increase in nominal rates leads to a decline in consumption and borrowing for all agents. However, this decline is reduced for the more risk-averse borrowers because they are less sensitive to changes in rates. Thus, the intensity of the consumption and investment response is lower for more risk-averse agents, also leading to an attenuating effect on the impatient households' demand of housing and investment.

Finally, we find that the more risk-averse borrowers are less impacted by changes in the financial market : loan variations are less important as agents are risk-averse. Increasing the impatient household and entrepreneur's RRA coefficient leads to a mitigation of the response of consumption under a *consumption smoothing effect* and, at the same time *a precautionary motive* that pushes borrowers to deleverage when real rates rise in order to maintain their consumption over time.

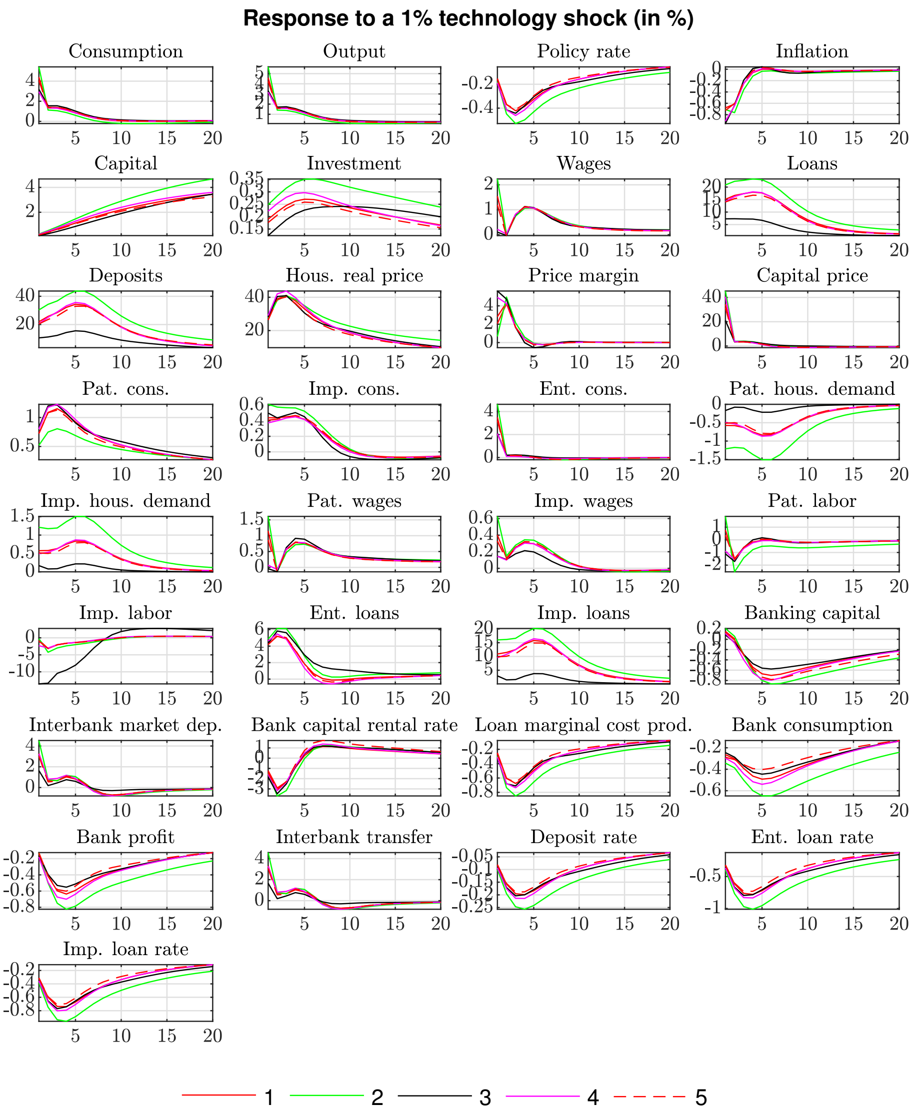

FIGURE 3.2 – Impulse response functions to a 1% technology shock with the calibrated model (in %)

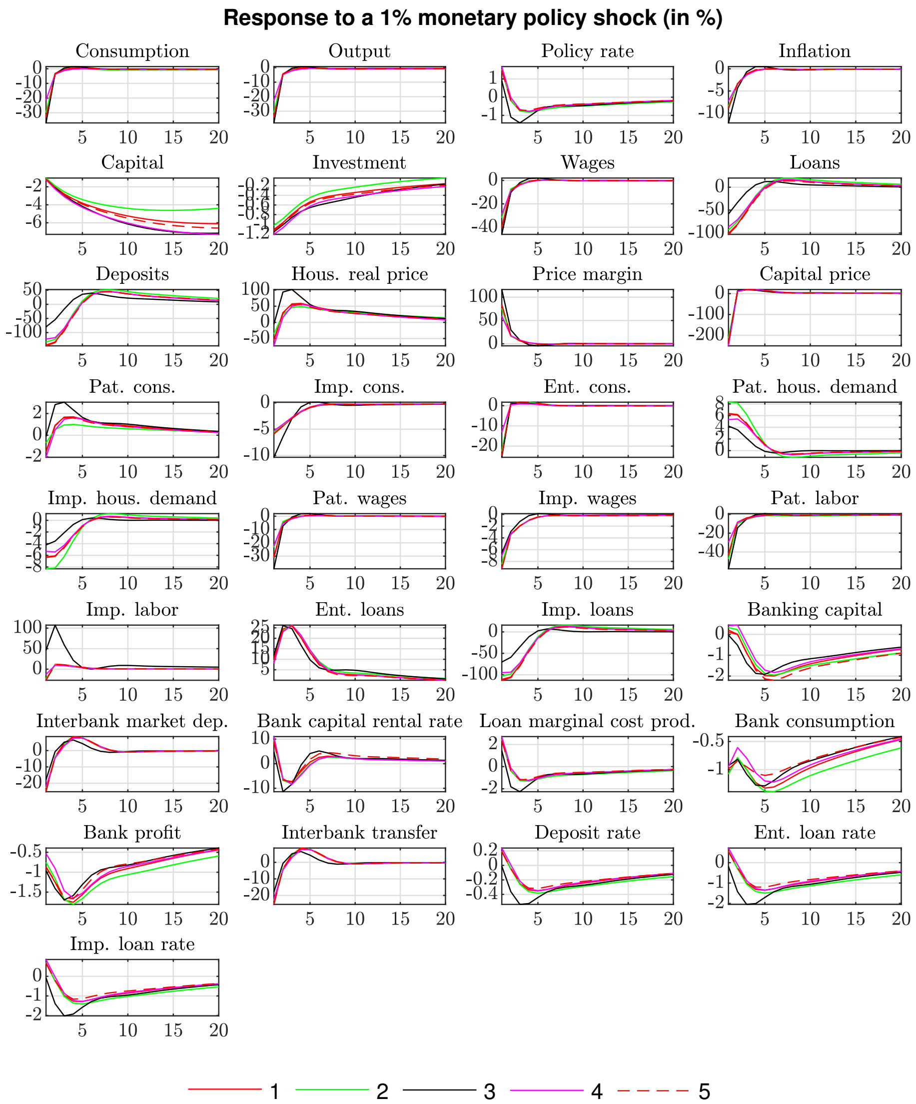

FIGURE 3.3 – Impulse response functions to a 1% monetary policy shock with the calibrated model (in %)

3.5 Estimation results

We study the transmission channels of a positive RRA shock for each agent : patient households, impatient households, entrepreneurs and bankers. In other words, we analyse the effect of an exogenous increase in the level of RRA, *ceteris paribus*. We find that a positive RRA shock increases real consumption in line with a *consumption smoothing effect*. In the case of borrowers, the *consumption smoothing effect* is combined with a *deleveraging effect* close to the interpretation of the precautionary motive. The impact on real interest rates is mitigated in line with Wachter (2006) and Bekaert et al. (2010). In fact, the *consumption smoothing effect* is expected to increase real rates but this effect is not straightforward when a *deleveraging effect* occurs, as the decrease in the loan demand pulls the nominal interest rate down.

3.5.1 Patient households RRA shock

After a patient households' RRA shock (Fig. 3.4) the behaviour of patient households in terms of consumption, housing demand and labor supply is affected. First, this shock leads to an increase in consumption : if agents are more risk-averse, they prefer present rather than future and uncertain consumption. Also, as RRA coefficient (σ_p) represents the inverse of inter-temporal elasticity of substitution, an increase in σ_p changes the attitude of households toward smoothing consumption between periods : agent are less interested in smoothing consumption. Second, housing demand increases as we have a positive relationship between current consumption and housing demand (see Eq. 3.4). Labor supply decreases as we have a negative relationship between consumption and labor supply (see Eq. 3.5). Those effects are transmitted to the rest of the economy. Under the effect of an increase in patient households' consumption, the aggregate consumption increases, corresponding to a positive demand shock. This type of shock is characterised by an higher level of production, a rise in prices and an increase in interest rates. The rise in interest rates impairs credit conditions and eventually loan demand.

3.5.2 Impatient households RRA shock

The impatient households' RRA shock (Fig. 3.5) changes the behaviour of impatient households in term of consumption, housing demand and labor supply. The initial impact on consumption and labor is the same as for patient households : current consumption increases through the effect of *consumption smoothing* and labor supply decreases. The effect on housing demand (see Eq. 3.10) depends positively on consumption and negatively on $\lambda_{i,t}$ (corresponding to the increase of utility obtained from borrowing $\left(1 + R^{b_i}\right)$ units). The value of $\lambda_{i,t}$ is positive and increases with the level of risk aversion. Finally, we observe a decrease in housing demand for impatient households, suggesting that the *consumption smoothing effect* (positive in our case) is outweighed by the *deleveraging effect* (negative in our case). The transmission mechanism to consumption, output, inflation and policy rate are the same than for the shock on patient households.

3.5.3 Entrepreneurs RRA shock

The entrepreneurs' RRA shock (Fig. 3.6) affects the behaviour of entrepreneurs in term of consumption and capital demand. The effect on consumption is positive as entrepreneurs become less interested by smoothing consumption over time. This positive effect on current consumption has a positive impact on capital demand (see Eq. 3.17), but this impact is outweighed by the negative relationship between capital demand and λ_e, which is higher when entrepreneurs are more risk-averse . Finally, we observe a negative total impact on capital demand, which reveals that the *deleveraging effect* outweighs the *consumption smoothing effect*. As for impatient households' RRA shock, the impact on entrepreneurs' loans is negative implying a negative demand shock on loan markets.

3.5.4 Bankers RRA shock

The bankers' RRA shock (Fig. 3.6) changes the behaviour of bankers in term of consumption (see Eq. 3.45). Bankers' consumption increases such that aggregate consumption, output and inflation are higher. Transmission mechanisms on main economic variables are the same as those observed after a RRA shock on patient households. However, as bankers are more risk-averse, they are less willing to lend, which is reflected into a decrease in loans granted to impatient households and entrepreneurs.

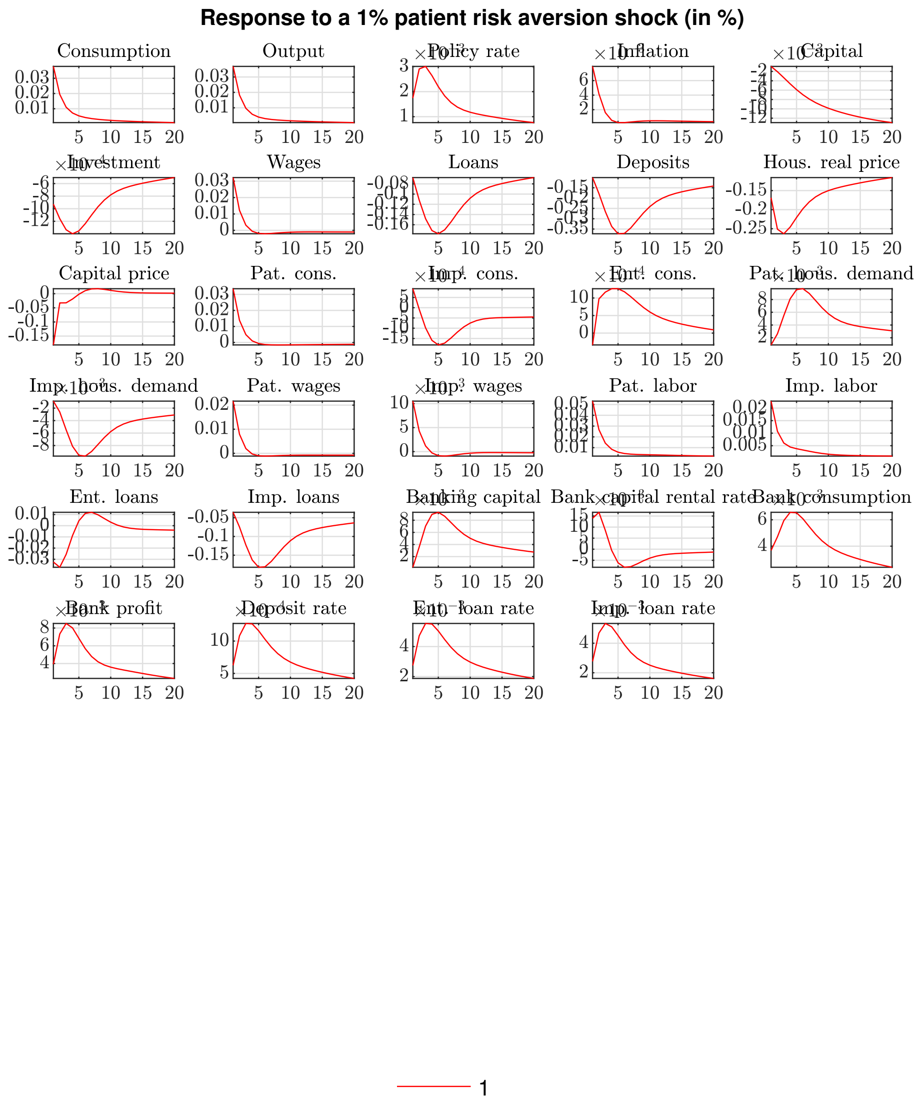

FIGURE 3.4 – Impulse response functions to a 1% patient household RRA shock with the estimated model (in %)

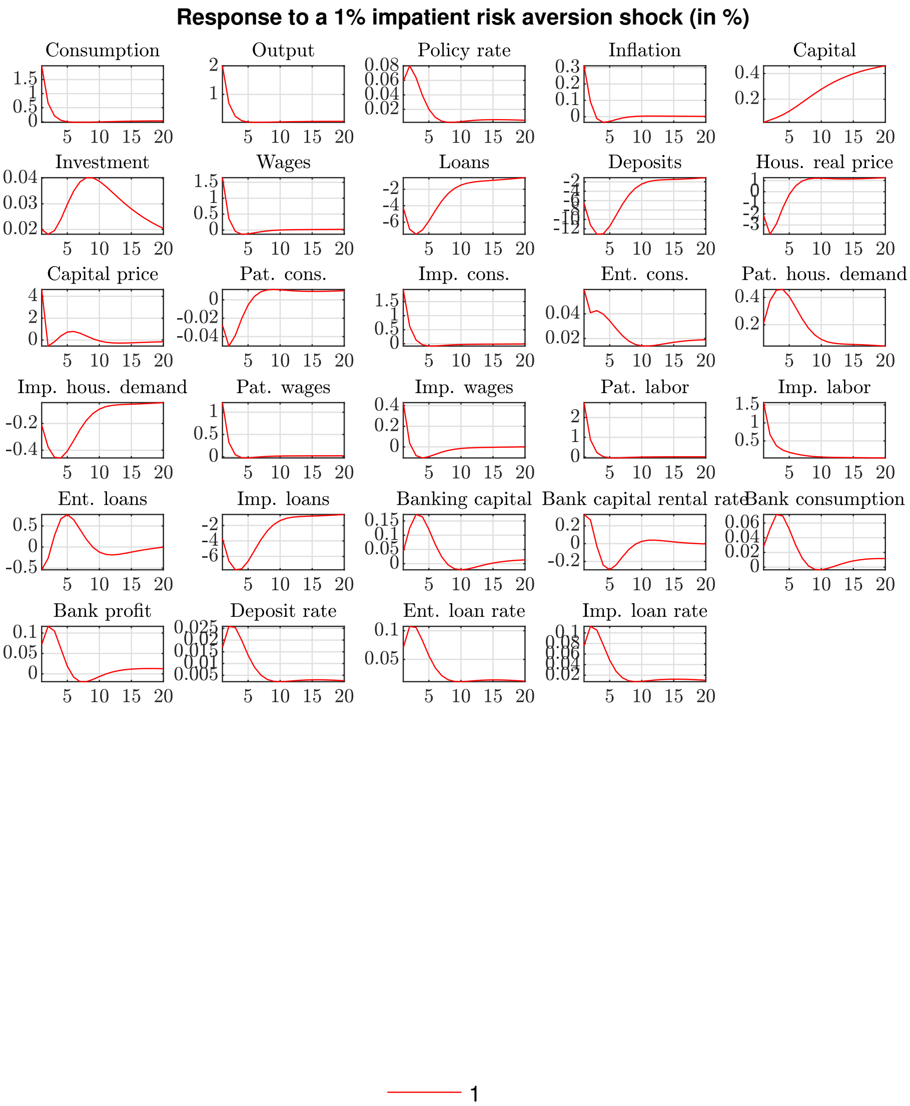

FIGURE 3.5 – Impulse response functions to a 1% impatient household RRA shock with the estimated model (in %)

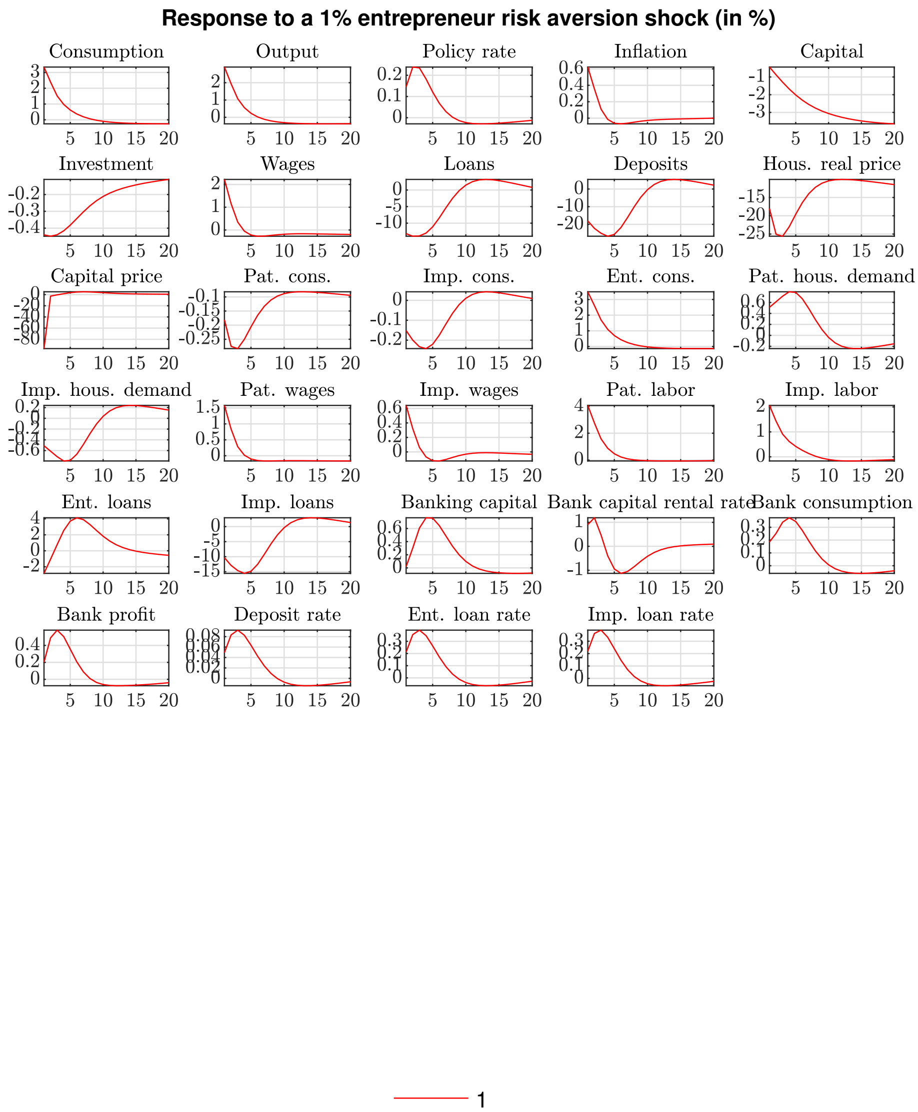

FIGURE 3.6 – Impulse response functions to a 1% entrepreneur RRA shock with the estimated model (in %)

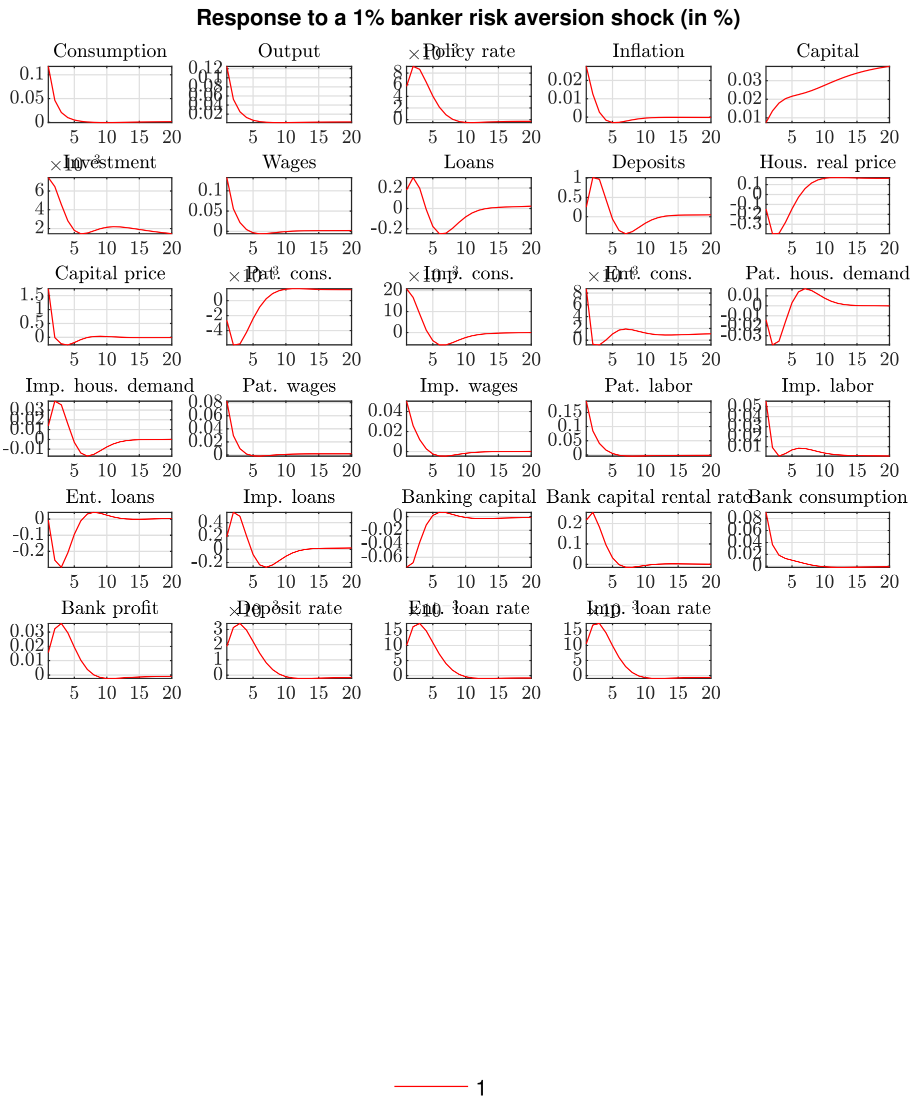

FIGURE 3.7 – Impulse response functions to a 1% banker RRA shock with the estimated model (in %)

3.6 Estimated shocks

A visual inspection of the estimated shocks indicates if shocks are correctly distributed and allows to detect the presence of trends. Fig. 3.8 shows several interesting features captured by the estimated shocks such as the Lehman Brothers collapse and the corresponding RRA increase and impatient LTV decrease.

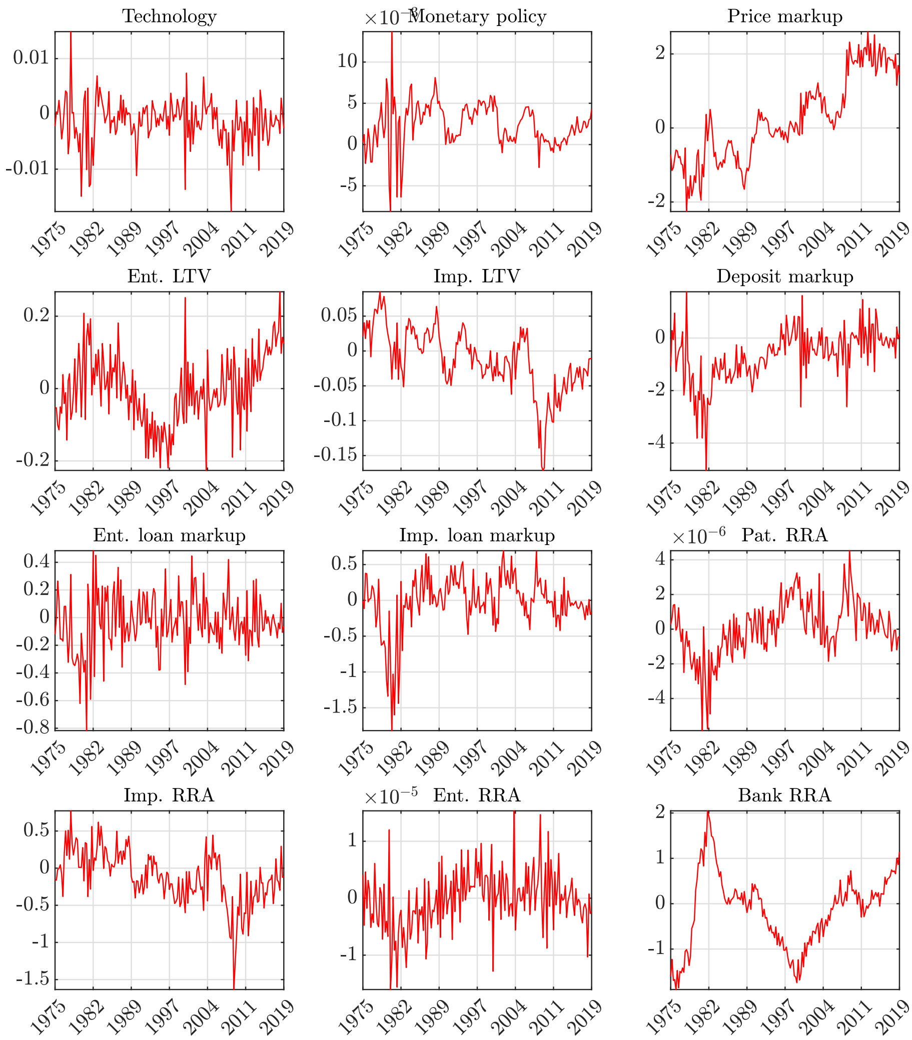

FIGURE 3.8 – Distribution of estimated shocks

Fig. 3.8 reveals three main results. First, RRA is time-varying for all agents. Second, the timing of the sharp variations are different among the risk-averse agents. Especially, if we analyse the timing of the variations, Fig. 3.8 highlights a long period before the crisis of 2008 where bankers are governed by no risk-averse behaviours. They become risk-averse after the crisis and the amplitude of their RRA shock is higher than that of rest of the economy. Second, patient households and entrepreneurs RRA are impacted by the GFC when it occurred while the banking sector was impacted with a lag, which indicates the consequences of the GFC on the banking system was stronger than the GFC itself. Finally, we find that impatient households and bankers are the most subject to RRA shocks.

3.7 Concluding remarks

In line with developments in behavioural economics, we introduce heterogenous and time-varying RRA in our model. First, our results confirm the existence of a heterogeneous RRA depending on agents' characteristics. We provide evidences about a level of RRA higher for patient households than for other agents giving the intuition that they are less impacted by changes in the economic and financial environment and have a lower preference to smooth their consumption over time. These realistic results disentangle the widely accepted assumption of uniform RRA assumed in the literature. Second, the analysis of estimated shocks confirms the time-varying nature of RRA, showing that after the occurence of a crisis, agents modify their risk aversion behaviour. It also highlights the different timing of a change in RRA in response to a crisis among agents. Bankers, entrepreneurs, and households do not display the same dynamics in their RRA over time.

Taking account of those assumptions (heterogeneous and time-varying RRA), we make two sets of analysis.
We find that the presence of a higher level of RRA among agents could hinder the transmission mechanism of economic decisions. The decomposition of this transmission channel is as follows. After an economic shock, the real interest rate impacts the preferences of the agents and then their behaviour. For instance, as a result of an interest rate increase, savings are more attractive while consumption is less as it costs more to consume today than to consume in the future. As shown in this paper, RRA modifies the magnitude of this effect by influencing the agents' sensitivity to rate changes. Consequently, a risk-averse agent will lower his consumption and increase his savings, but to a lesser extent. The expected effect of economic policy will, therefore, be mitigated.
Second, we analyse the transmission mechanism that appears when the RRA undergoes an exogenous shock. As we have shown, this may be the case following serious financial crisis event such as a bank collapse. In this context, given the inverse relationship between the aversion and the inter-temporal substitution effect, two dimensions related to the rise of the RRA should be taken into account : an inter-temporal dimension and an intra-temporal dimension. Regarding the inter-temporal dimension, the drop in the inter-temporal substitution effect leads to an increase in the current consumption. This effect, known as the *consumption smoothing effect*, smooths agent's consumption over time. Thus, all agents show the same response to a positive RRA shock by increasing their current consumption. Concerning the intra-temporal dimension, RRA changes lead agents to adopt less risky behaviours. Borrowers are, therefore, seeking to deleverage in order to maintain their future consumption. Thus, following a positive shock of aversion, borrowers lower the amount of new loans which contributed to lower the investment and the purchase of housings.

3.8 Policy implications

Our paper disentangles two very different key concepts, risk and risk aversion (RRA). Although it is often used in different contexts, the risk is the possibility that an outcome will not be as expected. RRA is the aversion about this possibility. Both of them may be influenced through preemptive actions, but not of the same nature. For instance, banking supervision decisions should decrease risk in the banking system. However, communication is more apt to reduce RRA. The risk can be current, past, or future. The RRA is the adjustment of the people to that very risk but one can adjust both ex-post and ex-ante, meaning anticipating the risk or reacting to the risk. It seems that consumption is indeed affected by ex-post risk aversion (EP RRA), which is directly affected by a risk shock. But it is not sure that consumption is affected by ex-ante risk aversion (EX RRA).

Moreover, RRA could explain the slow recovery of credit which has been observed following the GFC. Despite the expansionary monetary policy aimed at boosting credit, inter and intra-temporal preferences have changed the sensitivity of the response. The impact on the economy was difficult to perceive as banks struggled to grant new credit to increasingly risk-averse agents. This idea is consistent with the literature showing that access to credit over the recovery period was more demand-driven than supply-driven in line with an increase in credit rationing (Kremp and Sevestre, 2013)

A Appendix Chapter III

A.1 Model Summary

This section presents the theoretical equations of our model

$$c_{p,t} + q_{h,t}\left(h_{p,t} - h_{p,t-1}\right) + d_t = \frac{1 + R_{t-1}^{d}}{\pi_t} d_{t-1} + w_{p,t} l_{p,t} + \tau_{p,t} \tag{A.1}$$

$$c_{p,t}^{-\sigma_{p,t}} = \beta_p E_t \left[\frac{1 + R_t^{d}}{\pi_{t+1}} c_{p,t+1}^{-\sigma_{p,t+1}} \right] \tag{A.2}$$

$$\frac{j}{h_{p,t}} = q_{h,t} c_{p,t}^{-\sigma_{p,t}} - \beta_p E_t \left[q_{h,t+1} c_{p,t+1}^{-\sigma_{p+1}} \right] \tag{A.3}$$

$$l_{p,t}^{\varphi} = w_{p,t} c_{p,t}^{-\sigma_{p,t}} \tag{A.4}$$

$$c_{i,t} + q_{h,t}\left(h_{p,t} - h_{p,t-1}\right) + \frac{1 + R_{t-1}^{b_i}}{\pi_t} b_{i,t-1} = b_{i,t} + w_{i,t} l_{i,t} + \tau_{i,t} \tag{A.5}$$

$$\left(1 + R_t^{b_i}\right) b_{i,t} \leq E_t \left[m_{i,t} q_{h,t+1} h_{i,t} \pi_{t+1} \right] \tag{A.6}$$

$$c_{i,t}^{-\sigma_{i,t}} = \beta_i E_t \left[\frac{1 + R_t^{b_i}}{\pi_{t+1}} c_{i,t+1}^{-\sigma_{i,t+1}} \right] + \lambda_{i,t} \left(1 + R_t^{b_i}\right) \tag{A.7}$$

$$\frac{j}{h_{i,t}} = q_{h,t} c_{i,t}^{-\sigma_{i,t}} - \beta_i E_t \left[q_{h,t+1} c_{i,t+1}^{-\sigma_{i+1}} + \lambda_{i,t} m_{i,t} q_{h,t+1} \pi_{t+1} \right] \tag{A.8}$$

$$l_{i,t}^{\varphi} = w_{i,t} c_{i,t}^{-\sigma_{i,t}} \tag{A.9}$$

$$y_t = A_t k_{e,t-1}^{\alpha} l_{p,t}^{\mu(1-\alpha)} l_{i,t}^{(1-\mu)(1-\alpha)} \tag{A.10}$$

$$c_{e,t} + \frac{1 + R_{t-1}^{b_e}}{\pi_t} b_{e,t-1} + w_{p,t} l_{p,t} + w_{i,t} l_{i,t} + q_{ke,t} k_{e,t} = \frac{y_t}{x_t} + b_{e,t} + q_{ke,t}\left(1 - \delta_{ke}\right) k_{e,t-1} + \tau_{e,t} \tag{A.11}$$

$$\left(1 + R_t^{b_e}\right) b_{e,t} \leq E_t \left[m_{e,t} q_{ke,t+1} \left(1 - \delta_{ke}\right) k_{e,t} \pi_{t+1} \right] \tag{A.12}$$

$$c_{e,t}^{-\sigma_{e,t}} = \beta_e E_t \left[\frac{R_t^{b_e}}{\pi_{t+1}} c_{e,t+1}^{-\sigma_{e,t+1}} \right] + \lambda_{e,t} \left(1 + R_t^{b_e}\right) \tag{A.13}$$

$$c_{e,t}^{-\sigma_{e,t}} q_{ke,t} = \beta_e E_t \left[c_{e,t+1}^{-\sigma_{e,t+1}} \left(\alpha \frac{y_{t+1}}{x_{t+1} k_{e,t}} + q_{ke,t+1} \left(1-\delta_{ke}\right) \right) + \lambda_{e,t} m_{e,t} q_{ke,t+1} \pi_{t+1} \left(1-\delta_{ke}\right) \right] \tag{A.14}$$

$$w_{p,t} = \frac{\mu \left(1-\alpha\right)}{l_{p,t}} \frac{y_t}{x_t} \tag{A.15}$$

$$w_{i,t} = \frac{\left(1-\mu\right)\left(1-\alpha\right)}{l_{p,t}} \frac{y_t}{x_t} \tag{A.16}$$

$$\pi_t^* x_{2,t} = \frac{\epsilon_y}{\epsilon_y - 1} x_{1,t} \tag{A.17}$$

$$1 = \theta \pi_t^{\epsilon-1} + \left(1-\theta\right) \left(\pi_t^*\right)^{1-\epsilon} \tag{A.18}$$

$$x_{2,t} = c_{p,t}^{-\sigma_p} Y_t + \beta^p \theta E_t \pi_{t+1}^{\epsilon-1} x_{2,t+1} \tag{A.19}$$

$$x_1 = c_{p,t}^{-\sigma_p} Y_t \frac{1}{X_t} + \beta^p \theta E_t \pi_{t+1}^{\epsilon} x_{1,t+1} \tag{A.20}$$

$$k_{e,t} = (1-\delta_{ke}) k_{e,t-1} + \left[1 - \frac{\kappa_i}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 \right] i_t \tag{A.21}$$

$$1 = q_k \left(1 - \frac{\kappa_i}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 \right) - \kappa_i \left(\frac{i_t}{i_{t-1}} - 1 \right) \left(\frac{i_t}{i_{t-1}} \right) + \beta_e \left(\frac{c_{e,t+1}}{c_{e,t}} \right)^{-\sigma_{e,t}} q_k \kappa_i \left(\frac{i_{t+1}}{i_t} - 1 \right) \left(\frac{i_{t+1}}{i_t} \right)^2 \tag{A.22}$$

$$b_{e,t}\left(j\right) + b_{i,t}\left(j\right) = A_{b,t} k_{b,t-1}^{\chi_b}\left(j\right) \left(m_t\left(j\right) + d_t\left(j\right)\right)^{1-\chi_b} \tag{A.23}$$

$$mc_{b,t}\left(j\right) = \frac{1}{A_{b,t}} \frac{R_t^{1-\chi_b} R_{kb,t}^{\chi_b}}{\left(1-\chi_b\right)^{1-\chi_b} \chi_b^{-\chi_b}} \tag{A.24}$$

$$\frac{m_t\left(j\right) + d_t\left(j\right)}{k_{b,t-1}\left(j\right)} = \frac{R_{kb,t}}{R_t} \frac{1-\chi_b}{\chi_b} \tag{A.25}$$

$$j_{b,t}\left(j\right) \pi_{t+1} = \begin{array}{c} R_t^{b_e}\left(j\right) b_{e,t}\left(j\right) + R_t^{b_i}\left(j\right) b_{i,t}\left(j\right) - mc_{b,t}\left(j\right)\left(b_{e,t}\left(j\right) + b_{i,t}\left(j\right)\right) \\ + \left(R_t - R_t^d\left(j\right)\right) d_t\left(j\right) - \sum_{k=d,b_i,b_e} \frac{\kappa_k}{2} \left(\frac{R_t^k(j)}{R_{t-1}^k(j)} - 1 \right)^2 R_t^k k_t \end{array} \tag{A.26}$$

$$\begin{aligned} & -1 + \varsigma_{d,t} - \varsigma_{d,t} \frac{R_t}{R_t^d} - \kappa_d \left(\frac{R_t^d}{R_{t-1}^d} - 1 \right) \frac{R_t^d}{R_{t-1}^d} + \\ & \beta_b E_t \left[\frac{c_{b,t+1}^{-\sigma_{b,t+1}}}{c_{b,t}^{-\sigma_t}} \kappa_d \left(\frac{R_{t+1}^d}{R_t^d} - 1 \right) \left(\frac{R_{t+1}^d}{R_t^d} \right)^2 \frac{d_{t+1}}{d_t} \right] \end{aligned} \tag{A.27}$$

$$\begin{aligned} & 1 - \varsigma_{b_i,t} + \varsigma_{b_i,t} \frac{mc_{b,t}}{R_t^{b_i}} - \kappa_{b_i} \left(\frac{R_t^{b_i}}{R_{t-1}^{b_i}} - 1 \right) \frac{R_t^{b_i}}{R_{t-1}^{b_i}} + \\ & \beta_b E_t \left[\kappa_{b_i} \frac{c_{b,t+1}^{-\sigma_{b,t+1}}}{c_{b,t}^{-\sigma_t}} \left(\frac{R_{t+1}^{b_i}}{R_t^{b_i}} - 1 \right) \left(\frac{R_{t+1}^{b_i}}{R_t^{b_i}} \right)^2 \frac{b_{i,t+1}}{b_{i,t}} \right] \end{aligned} \tag{A.28}$$

$$1 - \varsigma_{b_e,t} + \varsigma_{b_e,t}\frac{mc_{b,t}}{R_t^{b_e}} - \kappa_{b_e}\left(\frac{R_t^{b_e}}{R_{t-1}^{b_e}} - 1\right)\frac{R_t^{b_e}}{R_{t-1}^{b_e}} + \tag{A.29}$$

$$\beta_b E_t\left[\kappa_{b_e}\frac{c_{b,t+1}^{-\sigma_{b,t+1}}}{c_{b,t}^{-\sigma_t}}\left(\frac{R_{t+1}^{b_e}}{R_t^{b_e}} - 1\right)\left(\frac{R_{t+1}^{b_e}}{R_t^{b_e}}\right)^2\frac{b_{e,t+1}}{b_{e,t}}\right]$$

$$c_{b,t} + k_{b,t} = (1 + R_{kb,t-1} - \delta_{kb})k_{b,t-1} + j_{b,t}\,(j) \tag{A.30}$$

$$c_{b,t}^{-\sigma_{b,t}} = \beta_b E_t\left[c_{b,t+1}^{-\sigma_{b,t}+1}\,(1 + R_{kb,t} - \delta_{kb})\right] \tag{A.31}$$

$$1 + R_t = (1 + R_{t-1})^{\rho_R}\left(\overline{\pi}^{\rho_\pi}\left(\frac{y_t}{y_{t-1}}\right)^{\rho_y}\left(1 + \overline{R}\right)\right)^{1-\rho_R}\exp\left(\varepsilon_{r,t}\right) \tag{A.32}$$

$$j_{cb,t} = (1 + R_t)\,m_t \tag{A.33}$$

$$y_t = c_{p,t} + c_{i,t} + c_{e,t} + c_{b,t} + i_t + adj_t \tag{A.34}$$

$$h_{p,t} + h_{i,t} = 1 \tag{A.35}$$

$$l_t = l_{p,t} + l_{i,t} \tag{A.36}$$

$$w_t = w_{p,t} + w_{i,t} \tag{A.37}$$

A.2 Steady-state

The equilibrium is an allocation $\{y, c_p, c_i, c_e, c_b, d, b_i, b_e, l_p, l_i, h_p, h_i, i, k, k_b, j_b, j_{cb}\}$ together with the sequence of value $\left\{P, P^*, x, R, \lambda_i, \lambda_e, q_h, q_k, w_p, w_i, R^d, R^{b_i}, R^{b_e}, R_{kb}\right\}$. One can always normalize the technology parameter A so that $y = 1$ in steady-state, so the trick is to express all the variables as a ratio to y.

$$y = 1 \tag{A.38}$$

$$\pi = 1 \tag{A.39}$$

$$\pi^* = 1 \tag{A.40}$$

$$q_k = 1 \tag{A.41}$$

$$x = \frac{\epsilon}{\epsilon - 1} \tag{A.42}$$

$$R^d = \frac{\pi}{\beta^p} - 1 \tag{A.43}$$

$$R = \frac{\varsigma_d - 1}{\varsigma_d} R^d \tag{A.44}$$

$$R_{kb} = \frac{1}{\beta_b} - 1 + \delta_b \tag{A.45}$$

$$mc_b = \frac{R_{kb}^{\chi_b} R^{1-\chi_b}}{\chi_b^{\chi_b} (1 - \chi_b)^{(1-\chi_b)}} \tag{A.46}$$

$$R^{b_i} = \frac{\varsigma_{b_i}}{\varsigma_{b_i} - 1} mc_b \tag{A.47}$$

$$R^{b_e} = \frac{\varsigma_{b_e}}{\varsigma_{b_e} - 1} mc_b \tag{A.48}$$

$$b_e = \frac{\beta^e \mu Y m_e \pi (1 - \delta_k)}{x (1 + R^{b_e})} \frac{1}{1 - \beta_e (1 - \delta_k) - \left(\frac{1}{1+R^{e_e}} - \frac{\beta_e}{\pi}\right) m_e \pi (1 - \delta_k)} \tag{A.49}$$

$$k_e = \frac{\left(1 + R^{b_e}\right) b_e}{m_e \pi q_k (1 - \delta_k)} \tag{A.50}$$

$$i = \delta_k k_e \tag{A.51}$$

$$k_b = \frac{(b_e + b_i)}{\left(\frac{R_{kb}}{R} \left(\frac{1-\chi_b}{\chi_b}\right)\right)^{(1-\chi_b)}} \tag{A.52}$$

$$m = \frac{k_b \frac{R_{kb}}{R} \left(\frac{1-\chi_b}{\chi_b}\right) R + mc_b (b_e + b_i) + \delta_k k_e (1 - q_k) + (R_{kb} - \delta_{kb}) k_b}{-3 - 2R} \tag{A.53}$$

$$d = k_b \frac{R_{kb}}{R} \left(\frac{1 - \chi_b}{\chi_b} \right) - m \tag{A.54}$$

$$j_{cb} = (1 + R)\, m \tag{A.55}$$

$$j_b = R^{b_e} b_e + R^{b_i} b_i - m c_b \left(b_e + b_i \right) + \left(R - R^d \right) d \tag{A.56}$$

$$c_p = d \left(\frac{1 + R^d}{\pi} - 1 \right) + \alpha \left(1 - \mu \right) \frac{y}{x} + \left(1 - \frac{1}{x} \right) Y + j_{cb} \tag{A.57}$$

$$c_i = b_i \left(1 - \frac{1 + R^{b_i}}{\pi} \right) + \left(1 - \alpha \right) \left(1 - \mu \right) \frac{y}{x} + j_{cb} \tag{A.58}$$

$$c_e = \frac{y}{x} + b_e \left(1 - \frac{1 + R^{b_e}}{\pi} \right) - \alpha \left(1 - \mu \right) \frac{y}{x} - \left(1 - \alpha \right) \left(1 - \mu \right) \frac{y}{x} - q_k k_e \delta_k + j_{cb} \tag{A.59}$$

$$\lambda_i = c_i^{-\sigma_i} \left(\frac{1}{\left(1 + R^{b_i} \right)} - \frac{\beta_i}{\pi} \right) \tag{A.60}$$

$$\lambda_e = c_e^{-\sigma_e} \left(\frac{1}{\left(1 + R^{b_e} \right)} - \frac{\beta_e}{\pi} \right) \tag{A.61}$$

$$h_p = \frac{j}{c_p^{-\sigma_p} \left(1 - \beta_p \right)} \left(\frac{1}{q_h} \right) \tag{A.62}$$

$$h_i = \frac{b_i \left(1 + R^{b_i} \right)}{m_i \pi} \left(\frac{1}{q_h} \right) \tag{A.63}$$

$$q_h = \frac{j}{c_p^{-\sigma_p} \left(1 - \beta_p \right)} + \frac{b_i \left(1 + R^{b_i} \right)}{m_i \pi} \tag{A.64}$$

$$w_p = \alpha \left(1 - \mu \right) \frac{y}{x l_p} \tag{A.65}$$

$$l_p = \left(\alpha \left(1 - \mu \right) \frac{y}{x} c_p^{-\sigma_p} \right)^{1/(\varphi + 1)} \tag{A.66}$$

$$w_i = \left(1 - \alpha \right) \left(1 - \mu \right) \frac{y}{x l_i} \tag{A.67}$$

$$l_i = \left(\left(1 - \alpha \right) \left(1 - \mu \right) \frac{y}{x} c_i^{-\sigma_i} \right)^{1/(\varphi + 1)} \tag{A.68}$$

$$A = \frac{Y}{k_e^{\mu} l_p^{\alpha (1 - \mu)} l_i^{(1 - \alpha)(1 - \mu)}} \tag{A.69}$$

$$l = l_p + l_i \tag{A.70}$$

$$w = w_p + w_i \tag{A.71}$$

$$x_1 = \frac{c_p^{-\sigma_p} \frac{1}{X} Y}{1 - \beta^p \theta \pi^{\epsilon}} \tag{A.72}$$

$$x_2 = \frac{c_p^{-\sigma_p} Y}{1 - \beta^p \theta \pi^{\epsilon - 1}} \tag{A.73}$$

A.3 Marginal cost of producing loans

Banker wants to minimise costs from bank equity $k_{b,t}$ and from getting funds on monetary market and deposits $(m_t + d_t)$, which come at factor prices $R_{kb,t}$ and R_t, respectively, subject to a Cobb and Douglas (1928) production function of loans $b_{e,t} + b_{i,t} = k_{b,t}^{\chi_b} (m_t + d_t)^{1-\chi_b}$. The minimal cost is given by the following problem

$$C = \min_{k_{b,t}, m_t + d_t} R_{kb,t} k_{b,t} + R_t (m_t + d_t) \tag{A.74}$$

such that

$$b_{e,t} + b_{i,t} = k_{b,t}^{\chi_b} (m_t + d_t)^{1-\chi_b} \tag{A.75}$$

We solve the constraint for $k_{b,t}$ and we get

$$k_{b,t} = \left(\frac{b_{e,t} + b_{i,t}}{(m_t + d_t)^{1-\chi_b}} \right)^{\frac{1}{\chi_b}} \tag{A.76}$$

We can rewrite the minimal cost

$$C = \min_{k_{b,t}, m_t + d_t} R_{kb,t} \left(\frac{b_{e,t} + b_{i,t}}{(m_t + d_t)^{1-\chi_b}} \right)^{\frac{1}{\chi_b}} + R_t (m_t + d_t) \tag{A.77}$$

The first order condition of that problem is

$$R_t = \frac{1-\chi_b}{\chi_b} R_{kb,t} \left(\frac{b_{e,t} + b_{i,t}}{(m_t + d_t)} \right)^{\frac{1}{\chi_b}} \tag{A.78}$$

$$= \frac{1-\chi_b}{\chi_b} R_{kb,t} \left(\frac{k_{b,t}}{(m_t + d_t)} \right)^{\frac{1}{\chi_b}} \tag{A.79}$$

The optimal use of monetary and deposit funds $((m_t + d_t)^*)$ in the production function of loans is

$$(m_t + d_t)^* = \left(\frac{1-\chi_b}{\chi_b} \frac{R_{kb,t}}{R_t} \right)^{\chi_b} (b_{e,t} + b_{i,t}) \tag{A.80}$$

Putting it into the constraint we gat the optimal use of capital $k_{b,t}^*$

$$k_{b,t}^* = \left(\frac{\chi_b}{1-\chi_b} \frac{R_t}{R_{kb,t}} \right)^{1-\chi_b} (b_{e,t} + b_{i,t}) \tag{A.81}$$

Now plugging $(m_t + d_t)^*$ and $k_{b,t}^*$ into the initial minimisation problem, we get

$$C^* = \left[R_{kb,t} \left(\frac{\chi_b}{1-\chi_b} \frac{R_t}{R_{kb,t}} \right)^{1-\chi_b} + R_t \left(\frac{1-\chi_b}{\chi_b} \frac{R_{kb,t}}{R_t} \right)^{\chi_b} \right] (b_{e,t} + b_{i,t}) \tag{A.82}$$

$$= \left[\left(\frac{\chi_b}{1-\chi_b} \right)^{1-\chi_b} + \left(\frac{1-\chi_b}{\chi_b} \right)^{\chi_b} \right] R_{kb,t}^{\chi_b} R_t^{1-\chi_b} (b_{e,t} + b_{i,t}) \tag{A.83}$$

$$= \left[\frac{1-\chi_b+\chi_b}{(1-\chi_b)^{1-\chi_b} \chi_b^{\chi_b}} \right] R_{kb,t}^{\chi_b} R_t^{1-\chi_b} (b_{e,t} + b_{i,t}) \tag{A.84}$$

$$= \left(\frac{R_{kb,t}}{\chi_b} \right)^{\chi_b} \left(\frac{R_t}{(1-\chi_b)} \right)^{1-\chi_b} (b_{e,t} + b_{i,t}) \tag{A.85}$$

The marginal cost of producing loans is equal to the derivative of cost in relation to loans $(b_{e,t} + b_{i,t})$

$$mc_{b,t} = \left(\frac{R_{kb,t}}{\chi_b} \right)^{\chi_b} \left(\frac{R_t}{(1-\chi_b)} \right)^{1-\chi_b} \tag{A.86}$$

A.4 Data

This section presents the data used in our Bayesian estimation, the measurement equation and the data transformations performed in order to match the data to the variables of the model.

All the following data are collected from FRED, Federal Reserve Bank of St. Louis. The code in parenthesis correspond to the identifier of the series.

A.4.1 Economic data

Real gross domestic product : billions of chained 2012 dollars, quarterly, seasonally adjusted annual rate (GDPC1).
Real investment : fixed private investment, billions of dollars,quarterly, seasonally adjusted annual rate (FPI).
Labor : nonfarm business sector, average weekly hours, Index 2012=100, quarterly, seasonally adjusted (PRS85006023).
Price inflation : gross domestic product, implicit price deflator, Index 2012=100,quarterly, seasonally adjusted (GDPDEF).
Real wage : nonfarm business sector : compensation per hour, Index 2012=100,quarterly, seasonally adjusted (COMPNFB).
Real housing price : all transaction house price index for the united states, Index 1980 :Q1=100,quarterly, not seasonally adjusted (USSTHPI).
Federal fund rate : effective Federal Funds Rate, percent,quarterly, not seasonally adjusted (FEDFUNDS).
Population : civilian noninstitutional population (CNP16OV).

A.4.2 Financial data

Deposit (DEP) : deposits, all commercial banks, billions of U.S. dollars, seasonally adjusted (DPSACBM027SBOG).
Loan to firms (LTF) = (NCBDBIQ027S) + (BLNECLBSNNCB) + (OLALBSNNCB)+ (NNBDILNECL) + (OLALBSNNB) + (MLBSNNCB) + (NNBTML).
Loan to households (LTHH) = (HNOTMLQ027S) + (CCLBSHNO).
Nominal interest rate on loans to firms (NIROLTF) = (AAA) * (NCBDBIQ027S)/Loan to firms + (MPRIME) * ((BLNECLBSNNCB) + (OLALBSNNCB) + (NNBDILNECL) + (OLALBSNNB))/Loan to firms + (MORTGAGE30US) * ((MLBSNNCB)+(NNBTML))/Loan to firms.
Nominal interest rate on loans to households (NIROLTHH) = (MORTGAGE30US) * (HNOTMLQ027S)/Loan to households + (TERMCBAUTO48NS) * (CCLBSHNO)/Loan to households.

A.4.3 Data used to calculate financial data

(NCBDBIQ027S) : Nonfinancial corporate business, debt securities ; liability, level, millions of dollars, not seasonally adjusted.
(BLNECLBSNNCB) : Nonfinancial corporate business, depository institution loans not elsewhere classified ; liability, level, billions of dollars, not seasonally adjusted.
(OLALBSNNCB) : Nonfinancial corporate business ; other loans and advances ; liability, billions of dollars, not seasonally adjusted.
(NNBDILNECL) : Nonfinancial noncorporate business ; depository institution loans not elsewhere classified ; liability, billions of dollars, not seasonally adjusted.
(OLALBSNNB) : Nonfinancial noncorporate business ; other loans and advances ; liability, level, billions of dollars, not seasonally adjusted.
(MLBSNNCB) : Nonfinancial corporate business ; total mortgages ; liability, billions of dollars, not seasonally adjusted.
(NNBTML) : Nonfinancial noncorporate business ; total mortgages ; liability, level, billions of dollars, not seasonally adjusted.
(HNOTMLQ027S) : Households mortgage : households and nonprofit organizations ; total mortgages ; liability, level, millions of dollars, not seasonally adjusted.
(CCLBSHNO) : Households consumer loans : households and nonprofit organizations ; consumer credit ; liability, level, billions of dollars, not seasonally adjusted.
(AAA) : Moody's Seasoned AAA Corporate Bond Yield : percent, not seasonally adjusted.
(MPRIME) : Bank Prime Loan Rate : percent, not seasonally adjusted.
(MORTGAGE30US) : 30-Year Fixed Rate Mortgage Average in the United States : percent, not seasonally adjusted.
(TERMCBAUTO48NS) : Finance rate on consumer installment loans at commercial banks : new autos 48 month loan, percent, not seasonally adjusted.

A.4.4 Data transformation

As in Smets and Wouters (2003, 2007), the following data transformations are requested to estimate the model with relevant data :

$$GDP_t = 100\ln\left(\frac{GDPC1_t}{CNP16OV_t}\right) \tag{A.87}$$

$$INV_t = 100\ln\left(\left(\frac{FPI_t}{GDPDEF_t}\right)CNP16OV_t^{-1}\right) \tag{A.88}$$

$$WAGE_t = 100\ln\left(\left(\frac{COMPNFB_t}{GDPDEF_t}\right)CNP16OV_t^{-1}\right) \tag{A.89}$$

$$LABOR_t = 100\ln\left(PRS85006023_t\left(\frac{CE16OV_t}{100}\right)CNP16OV_t^{-1}\right) \tag{A.90}$$

$$INF_t = 100 \ln \left(\frac{GDPDEF_t}{GDPDEF_{t-1}} \right) \tag{A.91}$$

$$QINF_t = 100 \ln \left(\left(\frac{USSTHPI_t}{GDPDEF_t} \right) CNP16OV_t^{-1} \right) \tag{A.92}$$

$$RATE_t = \frac{FEDFUNDS_t}{4} \tag{A.93}$$

$$HHRATE_t = \frac{NIROLTF_t}{4} \tag{A.94}$$

$$ENTRATE_t = \frac{NIROLTHH_t}{4} \tag{A.95}$$

$$ENTLOAN_t = 100 \ln \left(\left(\frac{LTF_t}{GDPDEF_t} \right) CNP16OV_t^{-1} \right) \tag{A.96}$$

$$HHLOAN_t = 100 \ln \left(\left(\frac{LTHH_t}{GDPDEF_t} \right) CNP16OV_t^{-1} \right) \tag{A.97}$$

$$DEPOSIT_t = 100 \ln \left(\left(\frac{DEP_t}{GDPDEF_t} \right) CNP16OV_t^{-1} \right) \tag{A.98}$$

where $CE16OV_t$ and $CNP16OV_t$ are transformed in indexes of the same base.

A.4.5 Measurement equation

The following observable equations are in line with Darracq Pariès et al. (2011) and Pfeifer (2019).

$$GDP_{obs,t} = 100 * \ln \left(\frac{y_t}{y} \right) \tag{A.99}$$

$$INV_{obs,t} = 100 \ln \left(\frac{i_t}{i} \right) \tag{A.100}$$

$$WAGE_{obs,t} = 100 \ln \left(\frac{w_t}{w} \right) \tag{A.101}$$

$$LABOR_{obs,t} = 100 \ln \left(\frac{l_t}{l} \right) \tag{A.102}$$

$$INF_{obs,t} = 100 \ln \left(\pi_t \right) \tag{A.103}$$

$$QINF_{obs,t} = 100 \ln \left(\frac{q_{h,t}}{q_h} \right) \tag{A.104}$$

$$RATE_{obs,t} = 100 \left(\frac{1 + R_t}{1 + R} - 1 \right) \tag{A.105}$$

$$HHRATE_{obs,t} = 100 \left(\frac{1 + R_t^{b_i}}{1 + R^{b_i}} - 1 \right) \tag{A.106}$$

$$ENTRATE_{obs,t} = 100\left(\frac{1+R_t^{b_e}}{1+R^{b_e}} - 1\right) \tag{A.107}$$

$$ENTLOAN_{obs,t} = 100\ln\left(\frac{b_{e,t}}{b_e}\right) \tag{A.108}$$

$$HHLOAN_{obs,t} = 100\ln\left(\frac{b_{i,t}}{b_i}\right) \tag{A.109}$$

$$DEPOSIT_{obs,t} = 100\ln\left(\frac{d_t}{d}\right) \tag{A.110}$$

A.5 Definition of estimated parameters

Description	**Symbol**
RRA of patient households	σ_p
RRA of impatient households	σ_i
RRA of entrepreneurs	σ_e
RRA of bankers	σ_b
Deposit rate's adjustment cost	κ_d
Impatient household loan rate's adjustment cost	κ_{bi}
Entrepreneur loan rate's adjustment cost	κ_{be}
Investment adjustment cost	κ_i
Real output gap growth weight in the monetary policy rule	ρ_y
Inflation weight in the monetary policy rule	ρ_π
Interest rate smoothing in the monetary policy rule	ρ_R
Steady-state loan-to-value ratio of impatient households	$\overline{m_i}$
Steady-state loan-to-value ratio of entrepreneurs	$\overline{m_e}$
Capital's share in production function	α
Share of patient households	μ
Share of housing in utility function	j
Deposit rate adjustment cost	ς_d
Entrepreneurs' loan rate adjustment cost	ς_{be}
Impatient households' loan rate adjustment cost	ς_{bh}
Autoregressive parameter of the technology shock	ρ_{A_e}
Autoregressive parameter of the impatient households LTV shock	ρ_{m_i}
Autoregressive parameter of the entrepreneurs LTV shock	ρ_{m_e}
Autoregressive parameter of the patient households aversion shock	ρ_{σ_o}
Autoregressive parameter of the impatient households aversion shock	ρ_{σ_i}
Autoregressive parameter of the entrepreneurs aversion shock	ρ_{σ_e}
Autoregressive parameter of the bankers aversion shock	ρ_{σ_b}
Autoregressive parameter of the price mark-up shock	ρ_{ϵ_y}
Autoregressive parameter of the deposit mark-up shock	ρ_{ς_d}
Autoregressive parameter of the impatient households' loan mark-up shock	$\rho_{\varsigma_{b_i}}$
Autoregressive parameter of the entrepreneurs' loan mark-up shock	$\rho_{\varsigma_{b_e}}$
Autoregressive parameter of the preference shock	ρ_{ϵ_z}
Autoregressive parameter of the investment shock	$\rho_{\epsilon_{qk}}$
Standard error of the technology shock	σ_{A_e}
Standard error of monetary policy shock	σ_{R_e}
Standard error of the impatient households LTV shock	σ_{m_i}
Standard error of the entrepreneurs LTV shock	σ_{m_e}
Standard error of the patient households aversion shock	σ_{σ_o}
Standard error of the impatient households aversion shock	σ_{σ_i}
Standard error of the entrepreneurs aversion shock	σ_{σ_e}
Standard error of the bankers aversion shock	σ_{σ_b}
Standard error of the price mark-up shock	σ_{ϵ_y}
Standard error of the deposit mark-up shock	σ_{ς_d}
Standard error of the impatient households' loan mark-up shock	$\sigma_{\varsigma_{b_i}}$
Standard error of the entrepreneurs' loan mark-up shock	$\sigma_{\varsigma_{b_e}}$
Standard error of the preference shock	σ_{ϵ_z}
Standard error of the investment shock	$\sigma_{\epsilon_{qk}}$

A.6 Steady State ratio

Calibration and prior distribution of parameters allow to find steady-state ratio closed to those of Gerali et al. (2010) and to match key statistics of the data.

Variable	**Representation**	**Value**
Ratio of consumption to GDP	C/Y	0.92
Ratio of investment to GDP	I/Y	0.07
Ratio of loans to GDP	B/Y	1.54
Ratio of bank capital to GDP	K_b/Y	0.02
Ratio of productive capital to GDP	K/Y	3.01
Ratio of impatient households loans to total loans	b_i/Y	0.54
Ratio of entrepreneurs loans to total loans	b_e/Y	1
Annual policy rate	$4 \times R$	4.05
Annual deposit rate	$4 \times R^d$	2.4
Annual impatient households loan rate	$4 \times R^{b_i}$	9.7
Annual entrepreneurs loan rate	$4 \times R^{be}$	10.7

TABLE A.1 – Steady state ratio.

A.7 Shocks analysis

A.7.1 Productivity shock

Fig. A.1 represents a positive productivity shock.
Following a positive productivity shock, production is more efficient which bring inflation down (Galí, 2008). This lead to a wealth effect. Firms are more productive and increase their production. Extra-profits earned under monopolistic competition are related to patient households which enjoy more consumption, and leisure. Impatient households enjoy higher labor wages and increase their consumption and housing demand. Second, our framework makes appear a collateral effect also called in the literature financial accelerator effect. When the economy observes a productivity shock, demand increase for all assets, including housing and capital. House and capital prices are increased, and so, the value of collateral, which allows impatient households and entrepreneurs to borrow more.

A.7.2 Monetary Policy

Figure.A.2 represent a restrictive monetary policy shock.
After a restrictive monetary policy (corresponding to an increase of the policy rate), the transmission mechanism in our framework is affected by three main channels which contribute to amplify and propagate the impulse response functions. First, a debt deflation effect : the rise in real interest rates leads to a decline in prices, which implies an increase of the real value of debt borrowing, impacting negatively the net worth of borrowers, and so, their spending. Second, a collateral effect : the rise in real interest rate leads to a decline of all price including house and capital. A decline in their values leads bank to reduce the number of loans, which lower the available resources of borrowers and therefore reduces aggregate demand. Third, a real rate effect : the rise in real interest rate encourages households to postpone present consumption which acts to lower demand again. Facing declining consumption, entrepreneurs are adapting to lower production which in turn reduces labor income.

A.7.3 Price markup

Fig. A.3 represents a negative price markup shock.
This shock is detailed by Smets and Wouters (2003, 2007). We analyse the impact of a negative price markup shock. As markups are determined by the ability of retailers to set prices over the marginal cost, a negative shock on markup correspond to a fall in prices. As for a productivity shock, we are in the case of a positive supply shock where inflation and output show an opposite response. As for productivity shock, the transmission mechanism works through three main channels such as a wealth effect, an interest rate effect and a collateral effect. As a result, output, consumption, investment, and loans are increased while inflation and interest rate decrease. (See in Appendix).

A.7.4 LTV

Fig. A.4 represents the impatient household LTV shock. A positive LTV shock is interpreted as an exogenous increase of the borrowers' collateral value giving them the opportunity to demand more loans. Each shock corresponds to an increase of its corresponding loan. As in Brzoza-Brzezina and Makarski (2011), a positive LTV shock leads to more consumption and investment leading to an increase in output and inflation. Thus, in turn, correspond to a monetary policy tightening which brings investment and consumption back to baseline.

A.7.5 Spread on loans to household and entrepreneur

Figures A.5 and A.6 represent respectively impatient household and entrepreneur loan spread.

As in Brzoza-Brzezina and Makarski (2011), these two shocks increase the corresponding cost of borrowing leading to a decline in the number of loans. In our framework, a decline in impatient households' loans reduces the ability of impatient households to accumulate housing and so, reduces house prices. Moreover, a reduction in the amount of borrowing reduces entrepreneurs consumption and investment which in turn reduces output. The spread on entrepreneurs loans leads to a decline in aggregate demand which decreases inflation and interest rate.

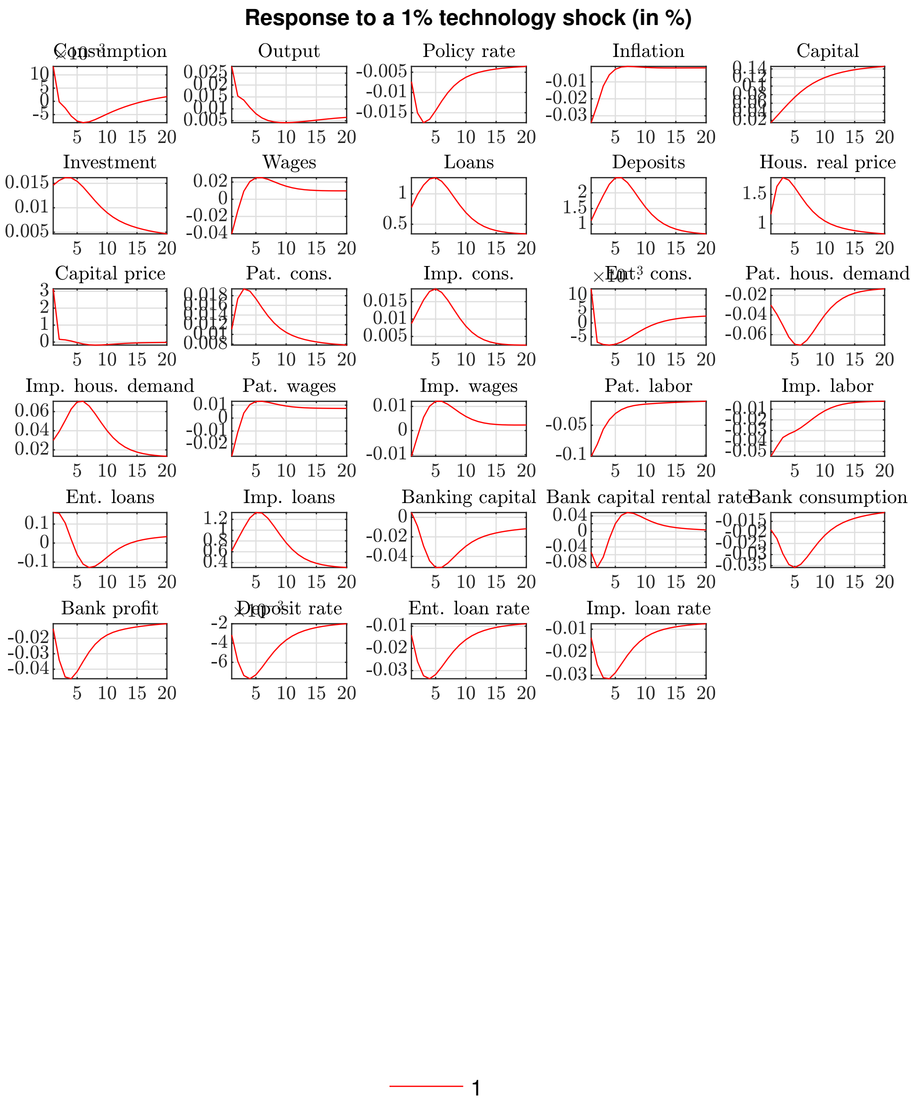

Figure A.1 – Impulse response functions to a 1% technology shock with the estimated model (in %)

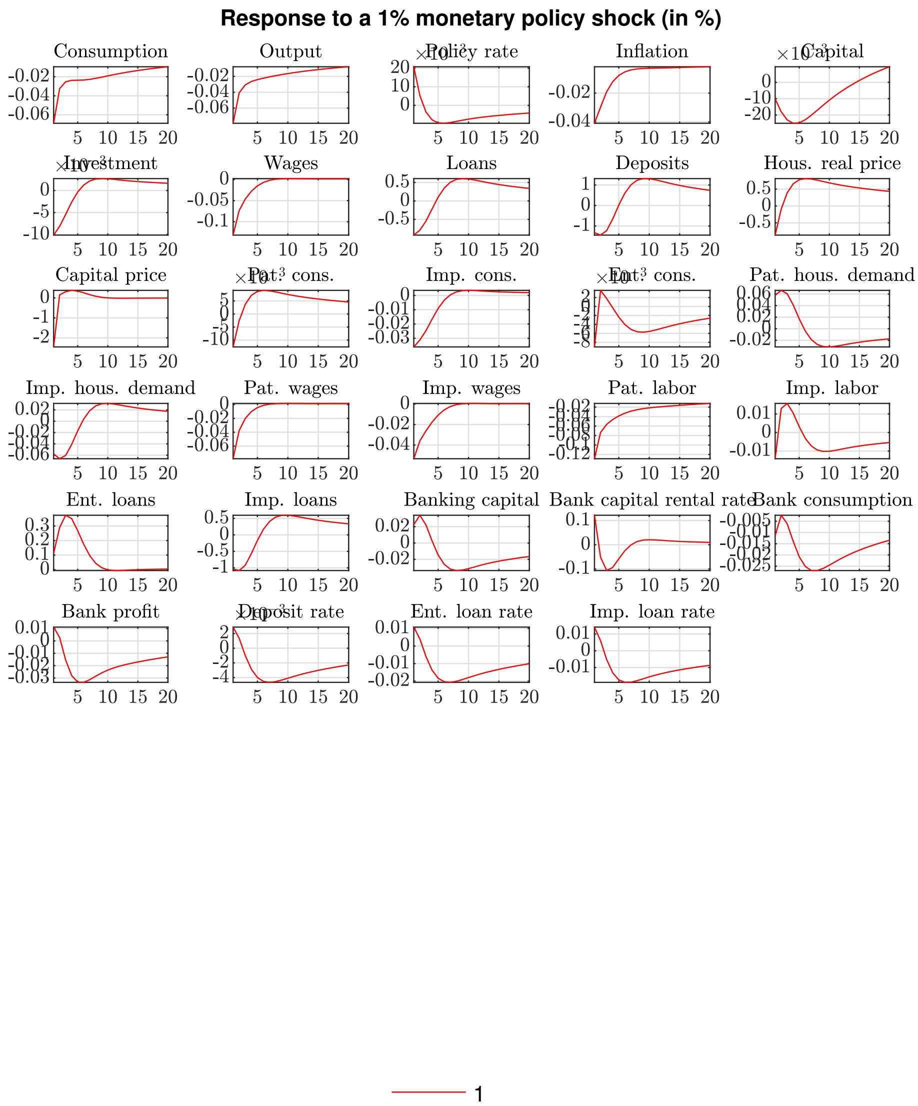

FIGURE A.2 – Impulse response functions to a 1% monetary policy shock with the estimated model (in %)

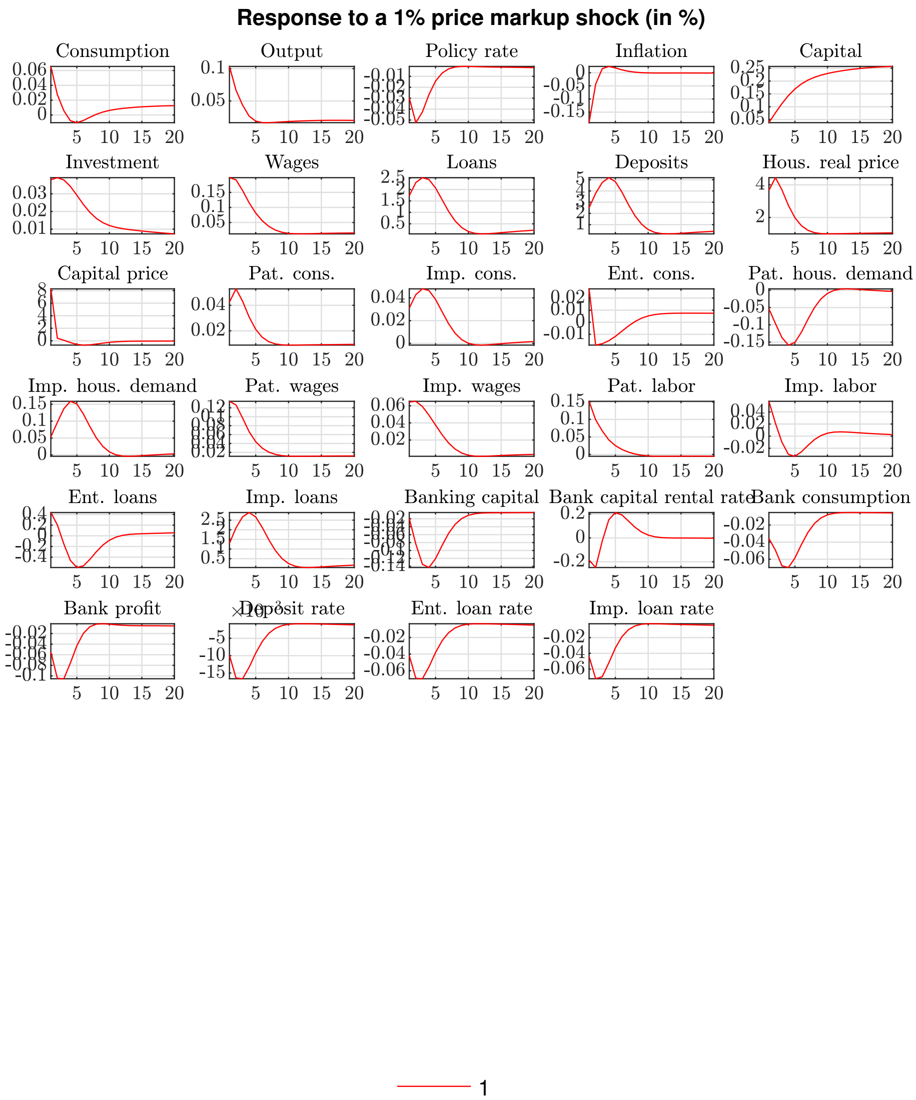

FIGURE A.3 – Impulse response functions to a 1% price markup shock with the estimated model (in %)

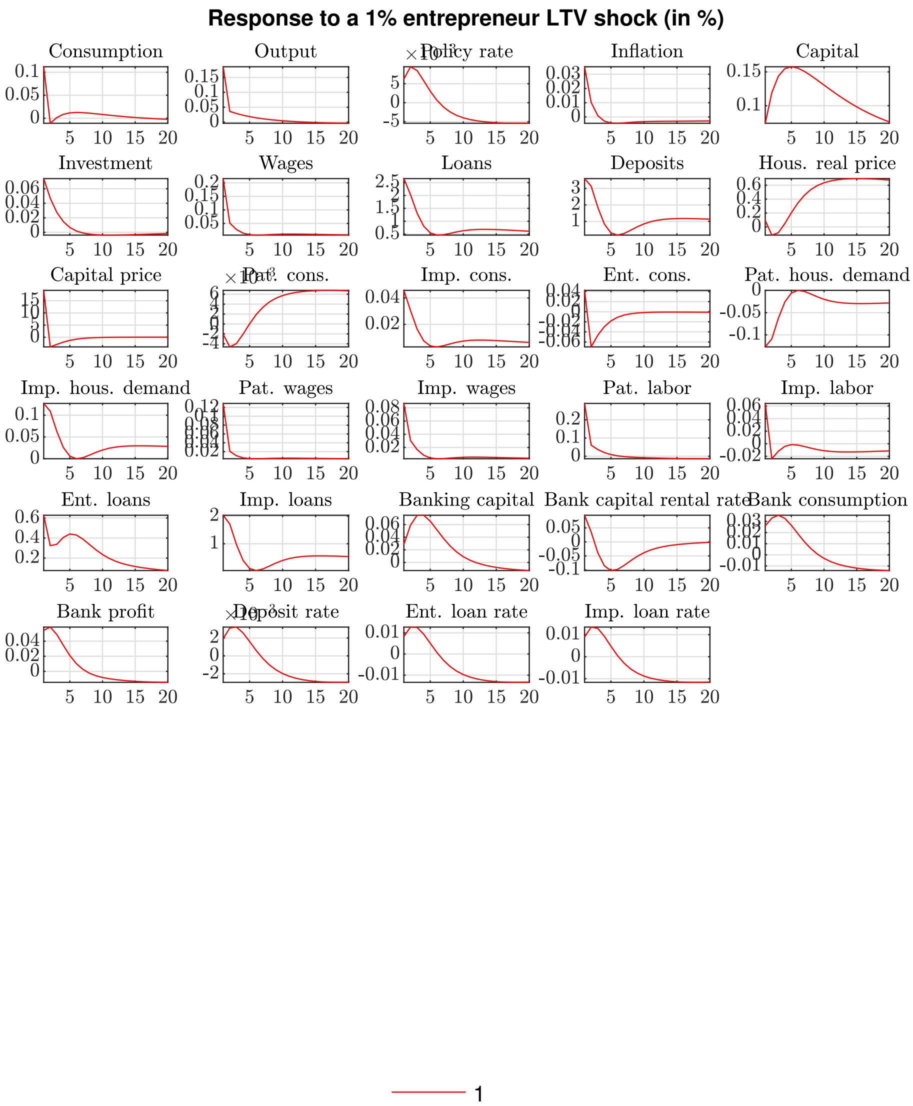

FIGURE A.4 – Impulse response functions to a 1% entrepreneur LTV shock with the estimated model (in %)

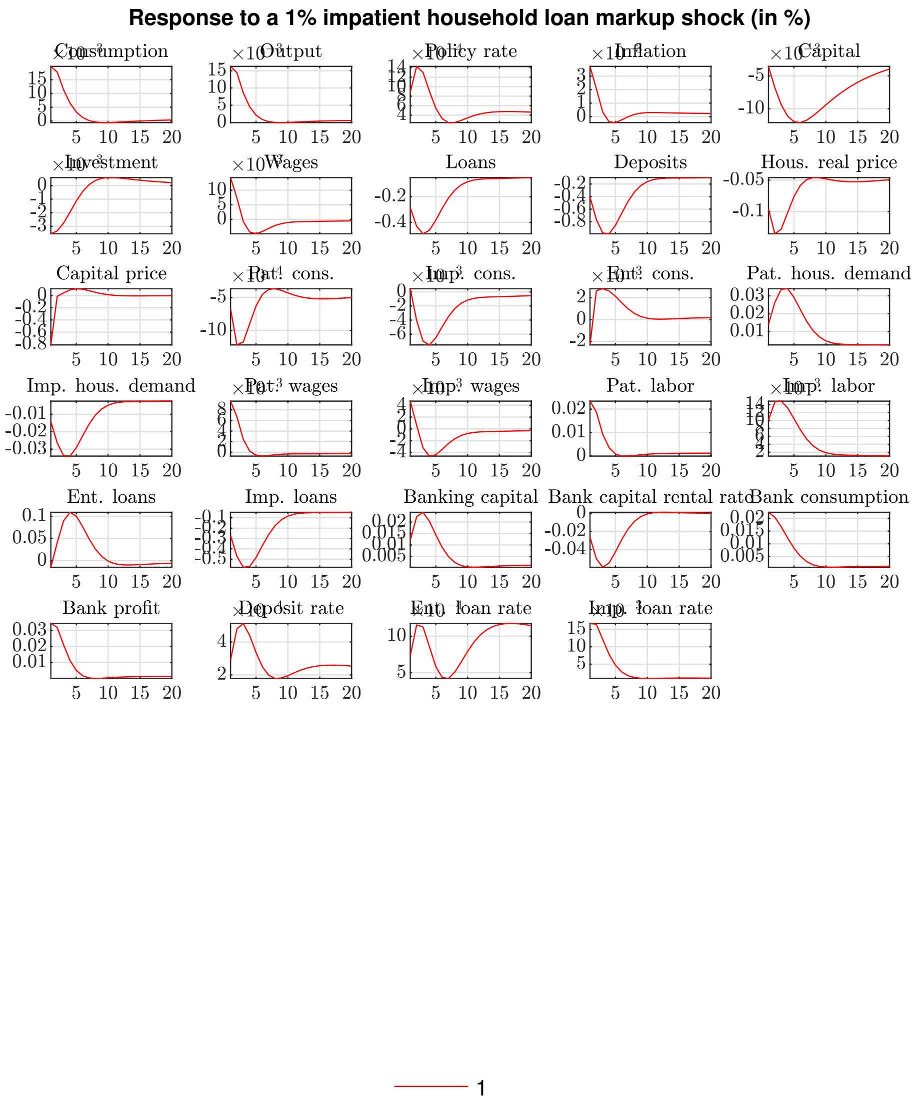

FIGURE A.5 – Impulse response functions to a 1% impatient household loan markup shock with the estimated model (in %)

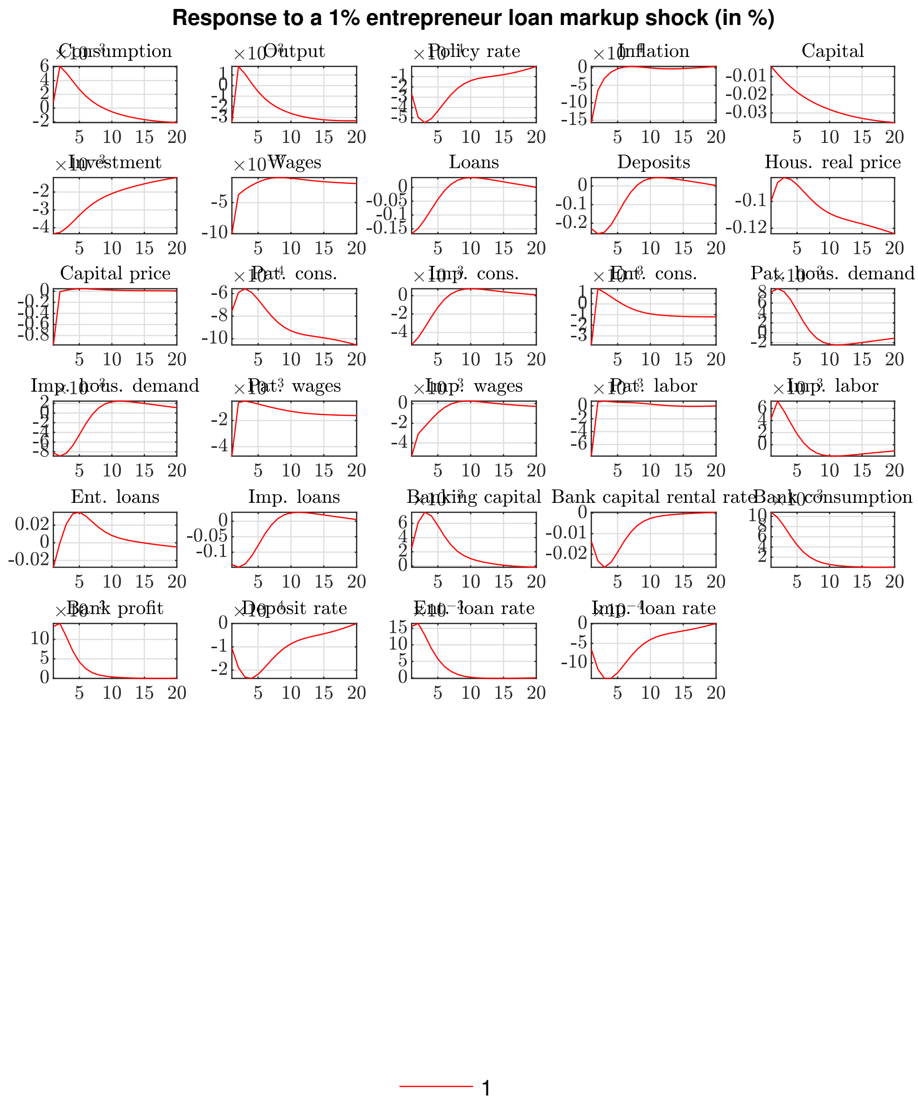

FIGURE A.6 – Impulse response functions to a 1% entrepreneur loan markup shock with the estimated model (in %)

Conclusion générale

Traiter la question des bienfaits de la concurrence bancaire n'est pas simple. Si la littérature donne des réponses divergentes, c'est aussi le cas des décideurs politiques dont les arguments s'opposent depuis de nombreuses années créant un clivage entre les pays concernant l'application de la politique concurrentielle sur le marché bancaire. D'un côté, des pays tels que le Canada et l'Australie mènent des politiques visant à renforcer la concentration du secteur bancaire, prenant comme argument la stabilité financière. D'un autre côté, des pays, tels que les Etats-Unis, cherchent depuis de nombreuse années à éviter la concentration bancaire en menant des politiques concurrentielles antitrust. L'importance de cette question a été ravivée dans le cadre du débat sur l'Union bancaire dans la zone euro. Si cette thèse a pour ambition d'apporter une réponse à ce débat, elle n'y parvient que partiellement, apportant elle aussi des réponses contrastées selon que l'on se situe du côté de la disponibilité des prêts aux entreprises ou du côté de la stabilité financière et du bien-être des ménages. En analysant dans un premier temps la relation entre concurrence bancaire et disponibilité du crédit aux entreprises, nous trouvons qu'une hausse de la concentration devrait entrainer un accès au crédit plus limité, notamment pour les petites et moyennes entreprises. D'autre part, en analysant la relation entre concurrence bancaire, stabilité financière et bien-être social nous trouvons qu'un marché bancaire oligopolistique et concentré est préférable à un marché concurrentiel ou à une structure monopolistique. Les deux premiers chapitres de la thèse traitent ainsi la question de la concurrence bancaire, sous des angles d'analyse et méthodologique différents et ne parviennent pas à donner une réponse tranchée.

Notre thèse s'intéresse également à un autre point théorique important, celui de l'effet d'une variation des préférences sur le cycle des affaires. Les evidences empiriques montrent une reprise lente du crédit dans les pays touchés par la crise financière de 2008, alors que les politiques monétaires visant à assouplir les conditions de crédit se sont largement multipliées. Ainsi, en prenant des éléments de l'économie comportementale telle que l'hétérogénéité et la variabilité temporelle des préférences, nous apportons une réponse structurelle à cette question. Nous montrons qu'une hausse de l'aversion pour le risque conduit les agents à adopter deux types de comportements : baisse du lissage inter-temporel de la consommation et désendettement. Les principaux résultats des différents chapitres sont résumés ci-dessous.

Dans le premier chapitre, "Does bank market power worsen credit conditions ? Bank-firm level evidence from Euro Area", nous testons empiriquement l'effet de la concurrence bancaire sur l'allocation de crédit via un panel de 900 banques reliées a près de 60 000 entreprises. Nous trouvons des résultats en faveur de *l'hypothèse de pouvoir de marché*, selon laquelle une faible concurrence bancaire aggrave les conditions de crédit des entreprises. Les données montrent que ces résultats sont renforcés pour les entreprises les plus affectées par les problèmes d'asymétries d'information (les entreprises petites et les entreprises opaques) et atténués pour les entreprises reliées à des banques dont les incitations à former des relations clientèle sont les plus grandes (les banques communautaires petites et locales).

Dans le deuxième chapitre, "On the desirability of banking competition", nous trouvons des résultats en faveur de la vision de la *concurrence-fragilité* selon laquelle un marché plus concurrentiel réduit les marges bancaires incitant les banques à accroître leur prise de risque. Notre cadre d'analyse nous permet, d'une part de comparer différents types de concurrence bancaire (CPP, concurrence monopolistique, oligopole de Cournot et oligopole de Bertrand) et d'autre part, de prendre en compte le nombre de banques sur le marché comme un indicateur de la concentration bancaire. Finalement, nous trouvons qu'un marché bancaire concentré et en concurrence oligopolistique est à la fois préférable en termes de bien-être social, mais aussi source de stabilité financière.

Enfin, dans le dernier chapitre, "Risk aversion, Credit and Banking : A nonlinear DSGE perspective", nous trouvons qu'une variation des préférences inter et intra temporelles affecte considérablement l'économie et doit donc être considérée par les décideurs politiques afin d'en limiter les potentiels effets négatifs. Deux mécanismes de transmission sont à l'oeuvre à la suite d'une variation du niveau de préférence. Le premier est un effet de lissage de la consommation qui consiste pour les agents à préférer la consommation présente, certaine, plutôt que la consommation future, incertaine. Le deuxième est un effet de désendettement qui consiste pour les emprunteurs à baisser leurs emprunts pour conserver leur pouvoir d'achat futur. Finalement, nous trouvons que les chocs de productivité et de politique monétaire sont atténués en présence d'agents plus averses au risque. Nous trouvons également que les chocs d'aversion ont des effets positifs en terme de consommation mais négatifs en terme de crédit et d'investissement.

Ces travaux laissent place à de nouvelles questions. L'une d'entre elles serait d'introduire l'hypothèse d'endogénéité du nombre de banques dans un modèle DSGE en situation d'oligopole. Le cadre méthodologique consisterait à appliquer un mécanisme d'accumulation du nombre de banques analogue à celui introduit par Faia (2012), et Bilbiie et al. (2012) pour les entreprises. Cela permettrait de considérer les entrées endogènes des banques sur le marché et de modéliser des barrières à l'entrée, hypothèse importante du marché bancaire. De plus, un nouveau mécanisme de transmission des chocs serait à l'oeuvre. Par exemple, à la suite d'un choc positif de politique monétaire, nous pouvons penser que la baisse des taux directeurs entrainerait une hausse de la demande de prêts. Les coûts marginaux diminueraient ainsi que le coût d'entrée sur le marché bancaire. Face à la baisse des coûts d'entrée, le nombre de banques sur le marché augmenterait conduisant à une baisse des parts de marché individuelles des banques et donc à une modification des prêts et des dépôts dans l'économie.
Cette recherche contribuerait au débat en cours en prenant en compte dans l'analyse deux faits empiriques importants, ignorés dans le modèle avec un nombre de banques exogène : le fait que le nombre de banques sur le marché soit lié aux variations du produit intérieur

brut (PIB) (Coccorese, 2017; Jayakumar et al., 2018) et le fait que les marges bancaires soient contra-cycliques.

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Bibliographie

Acharya, V. V., Steffen, S., feb 2015. The “greatest” carry trade ever ? Understanding eurozone bank risks. Journal of Financial Economics 115 (2), 215–236.

Aghion, P., Bloom, N., Blundell, R., Griffith, R., Howitt, P., may 2005. Competition and Innovation : an Inverted-U Relationship. The Quarterly Journal of Economics 120 (2), 701–728.

Agostino, M., Trivieri, F., jan 2014. Does trade credit play a signalling role ? Some evidence from SMEs microdata. Small Business Economics 42 (1), 131–151.

Akerlof, G. A., 1970. The Market for "Lemons" : Quality Uncertainty and the Market Mechanism. The Quarterly Journal of Economics.

Alan, S., Browning, M., 2010. Estimating intertemporal allocation parameters using synthetic residual estimation. Review of Economic Studies 77 (4), 1231–1261.

Albertazzi, U., Ropele, T., Sene, G., Signoretti, Federico M., 2014. The impact of the sovereign debt crisis on the activity of Italian banks. Journal of Banking & Finance 46, 387–402.

Allen, F., Gale, D., June 2004. Competition and Financial Stability. Journal of Money, Credit and Banking 36 (3), 453–480.

Amable, B., Chatelain, J.-B., Bandt, O. D., 1997. Confiance dans le système bancaire et croissance économique. Revue Économique 48 (3), 397–407.

Amiti, M., Weinstein, D. E., nov 2011. Exports and Financial Shocks. The Quarterly Journal of Economics 126 (4), 1841–1877.

Andrade, P., Cahn, C., Fraisse, H., Mésonnier, J.-S., jun 2018. Can the Provision of Long-Term Liquidity Help to Avoid a Credit Crunch ? Evidence from the Eurosystem’s LTRO. Journal of the European Economic Association.

Andrieu, G., Staglianò, R., van der Zwan, P., jun 2018. Bank debt and trade credit for SMEs in Europe : firm-, industry-, and country-level determinants. Small Business Economics 51 (1), 245–264.

Angelini, P., Di Salvo, R., Ferri, G., aug 1998. Availability and cost of credit for small businesses : Customer relationships and credit cooperatives. Journal of Banking & Finance 22 (6-8), 925–954.

Angelini, P., Grande, G., Panetta, F., 2014a. Questioni di Economia e Finanza The negative feedback loop between banks and sovereigns.

Angelini, P., Neri, S., Panetta, F., 2014b. The interaction between capital requirements and monetary policy. Journal of Money, Credit and Banking 46 (6), 1073–1112.

Angeloni, I., Faia, E., 2013. Capital regulation and monetary policy with fragile banks. Journal of Monetary Economics 60 (3), 311–324.

Angeloni, I., Kashyap, A. K., Mojon, B., 2003. Monetary Policy Transmission in the Euro Area : A Study by the Eurosystem Monetary Transmission Network. Cambridge University Press.

Anginer, D., Demirguc-Kunt, A., Zhu, M., jan 2014. How does competition affect bank systemic risk ? Journal of Financial Intermediation 23 (1), 1–26.

Arnold, M., Jenkins, P., Noonan, L., 2018. Banking M&A : the quest to create a European champion. Financial Times.

Arrow, K., October 1962. Economic Welfare and the Allocation of Resources for Invention. In : The Rate and Direction of Inventive Activity : Economic and Social Factors. NBER Chapters. National Bureau of Economic Research, Inc, pp. 609–626.

Arrow, K., Debreu, G., 07 1954. Existence of an equilibrium for a competitive economy. Econometrica 22.

Atkeson, A., Ogaki, M., 1996. Wealth-varying intertemporal elasticities of substitution : Evidence from panel and aggregate data. Journal of Monetary Economics 38 (3), 507–534.

Attanasio, O. P., Weber, G., 1989. Intertemporal substitution, risk aversion and the Euler equation for consumption. Economic Journal 99 (395), 59–73.

Avery, R. B., Samolyk, K. A., apr 2004. Bank Consolidation and Small Business Lending : The Role of Community Banks. Journal of Financial Services Research 25 (2/3), 291–325.

Bain, J., 1956. Barriers to New Competition : Their Character and Consequences in Manufacturing Industries.

Bakir, C., June 2017. How can interactions among interdependent structures, institutions, and agents inform financial stability ? What we have still to learn from global financial crisis. Policy Sciences 50 (2), 217–239.

Banerjee, A. V., Besley, T., Guinnane, T. W., may 1994. Thy Neighbor's Keeper : The Design of a Credit Cooperative with Theory and a Test. The Quarterly Journal of Economics 109 (2), 491–515.

Baumol, W. J., March 1982. Contestable Markets : An Uprising in the Theory of Industry Structure. American Economic Review 72 (1), 1–15.

Beck, T., De Jonghe, O., Schepens, G., apr 2013. Bank competition and stability : Cross-country heterogeneity. Journal of Financial Intermediation 22 (2), 218–244.

Beck, T., Demirguc-Kunt, A., Levine, R., 2006. Bank concentration, competition, and crises : First results. Journal of Banking Finance 30 (5), 1581–1603.

Beck, T., Demirgüç-Kunt, A., Maksimovic, V., 2004. Bank Competition and Access to Finance : International Evidence. Journal of Money, Credit and Banking 36 (3), 627–648.

Beck, T., Demirgüç-Kunt, A., Maksimovic, V., sep 2008. Financing patterns around the world : Are small firms different ? Journal of Financial Economics 89 (3), 467–487.

Bekaert, G., Engstrom, E., Grenadier, S., 2010. Stock and bond returns with moody investors. Journal of Empirical Finance 17 (5), 867–894.

Benchimol, J., 2014. Risk aversion in the Eurozone. Research in Economics 68 (1), 39–56.

Benchimol, J., Fourçans, A., 2017. Money and monetary policy in the Eurozone : an empirical analysis during crises. Macroeconomic Dynamics 21 (3), 677–707.

Berger, A., Klapper, L., Turk-Ariss, R., 2009a. Bank competition and financial stability. Journal of Financial Services Research 35 (2), 99–118.

Berger, A. N., Black, L. K., mar 2011. Bank size, lending technologies, and small business finance. Journal of Banking & Finance 35 (3), 724–735.

Berger, A. N., Bouwman, C. H. S., Kim, D., oct 2017. Small Bank Comparative Advantages in Alleviating Financial Constraints and Providing Liquidity Insurance over Time. The Review of Financial Studies 30 (10), 3416–3454.

Berger, A. N., Goulding, W., Rice, T., jul 2014. Do small businesses still prefer community banks ? Journal of Banking & Finance 44, 264–278.

Berger, A. N., Hannan, T. H., may 1989. The Price-Concentration Relationship in Banking. The Review of Economics and Statistics 71 (2), 291.

Berger, A. N., Hannan, T. H., 1992. The Price-Concentration Relationship in Banking : A Reply. The Review of Economics and Statistics 74 (2), 376–379.

Berger, A. N., Kashyap, A. K., Scalise, J. M., Gertler, M., Friedman, B. M., 1995. The Transformation of the U.S. Banking Industry : What a Long, Strange Trip It's Been. Brookings Papers on Economic Activity 1995 (2), 55.

Berger, A. N., Klapper, L. F., Turk-Ariss, R., apr 2009b. Bank Competition and Financial Stability. Journal of Financial Services Research 35 (2), 99–118.

Berger, A. N., Miller, N. H., Petersen, M. A., Rajan, R. G., Stein, J. C., may 2005. Does function follow organizational form ? Evidence from the lending practices of large and small banks. Journal of Financial Economics 76 (2), 237–269.

Berger, A. N., Saunders, A., Scalise, J. M., Udell, G. F., nov 1998. The effects of bank mergers and acquisitions on small business lending. Journal of Financial Economics 50 (2), 187–229.

Berger, A. N., Udell, G. F., 1995. Relationship Lending and Lines of Credit in Small Firm Finance. The Journal of Business 68 (3), 351–381.

Berger, A. N., Udell, G. F., feb 2002. Small Business Credit Availability and Relationship Lending : The Importance of Bank Organisational Structure. The Economic Journal 112 (477), 32–53.

Bernanke, B., Gertler, M., Gilchrist, S., feb 1996. The Financial Accelerator and the Flight to Quality. The Review of Economics and Statistics 78 (1), 1.

Bernanke, B., Gertler, M., Gilchrist, S., 1999. The financial accelerator in a quantitative business cycle framework. In : Taylor, J. B., Woodford, M. (Eds.), Handbook of macroeconomics. Elsevier, Ch. 21, pp. 1341–1393.

Besley, T., Coate, S., feb 1995. Group lending, repayment incentives and social collateral. Journal of Development Economics 46 (1), 1–18.

Bikker, J. A., Shaffer, S., Spierdijk, L., nov 2012. Assessing Competition with the Panzar-Rosse Model : The Role of Scale, Costs, and Equilibrium. Review of Economics and Statistics 94 (4), 1025–1044.

Bilbiie, F. O., Ghironi, F., Melitz, M. J., 2012. Endogenous entry, product variety, and business cycles. Journal of Political Economy 120 (2), 304–345.

Bonaccorsi di Patti, E., Dell'Ariccia, G., 2004. Bank Competition and Firm Creation. Journal of Money, Credit and Banking 36, 225–251.

Bonaccorsi Di Patti, E., Gobbi, G., apr 2007. Winners or Losers ? The Effects of Banking Consolidation on Corporate Borrowers. The Journal of Finance 62 (2), 669–695.

Boot, A. W., jan 2000. Relationship Banking : What Do We Know ? Journal of Financial Intermediation 9 (1), 7–25.

Boot, A. W., Thakor, A. V., apr 2000. Can Relationship Banking Survive Competition ? The Journal of Finance 55 (2), 679–713.

Boyd, J. H., de Nicoló, G., 2005. The theory of bank risk taking and competition revisited. Journal of Finance 60 (3), 1329–1343.

Bretscher, L., Hsu, A., Tamoni, A., 2019. Implementing stochastic volatility in DSGE models : a comment. Forthcoming in Macroeconomic Dynamics, 1–16.

Broecker, T., 1990. Credit-worthiness tests and interbank competition. Econometrica 58 (2), 429–452.

Brunnermeier, M. K., Eisenbach, T. M., Sannikov, Y., 2013. Macroeconomics with financial frictions : a survey. In : Acemoglu, D., Arellano, M., Dekel, E. (Eds.), Advances in Economics and Econometrics : Tenth World Congress. Vol. 2 of Econometric Society Monographs. Cambridge University Press, pp. 3–94.

Brunnermeier, M. K., Sannikov, Y., 2014. A macroeconomic model with a financial sector. American Economic Review 104 (2), 379–421.

Brzoza-Brzezina, M., Kolasa, M., Makarski, K., 2013. The anatomy of standard DSGE models with financial frictions. Journal of Economic Dynamics and Control 37 (1), 32–51.

Brzoza-Brzezina, M., Makarski, K., 2011. Credit crunch in a small open economy. Journal of International Money and Finance 30 (7), 1406–1428.

Bülbül, D., Schmidt, R. H., Schüwer, U., 2013. Savings Banks and Cooperative Banks in European Banking Systems. SAFE White Papers 5.

Calvo, G., 1983. Staggered prices in a utility-maximizing framework. Journal of Monetary Economics 12 (3), 383–398.

Canales, R., Nanda, R., aug 2012. A darker side to decentralized banks : Market power and credit rationing in SME lending. Journal of Financial Economics 105 (2), 353–366.

Carbó-Valverde, S., Rodríguez-Fernández, F., Udell, G. F., 2009. Bank market power and SME financing constraints. Review of Finance 13 (2), 309–340.

Carlstrom, C. T., Fuerst, T. S., 1997. Agency costs, net worth, and business fluctuations : a computable general equilibrium analysis. American Economic Review 87 (5), 893–910.

Carstens, A., dec 2018. Big tech in finance and new challenges for public policy. Speech at the Financial Times Banking Summit, London, December 2018.

Cetorelli, N., Gambera, M., apr 2001. Banking Market Structure, Financial Dependence and Growth : International Evidence from Industry Data. The Journal of Finance 56 (2), 617–648.

Chatelain, J.-B., Ralf, K., Sep. 2019. Publish and Perish : Creative Destruction and Macroeconomic Theory. Pse working papers, HAL.

Chodorow-Reich, G., 2014. The employment effects of credit market disruptions : Firm-level evidence from the 2008-9 financial crisis. Quarterly Journal of Economics 129 (1), 1–59.

Choi, W. G., Cook, D., 2004. Liability dollarization and the bank balance sheet channel. Journal of International Economics 64 (2), 247–275.

Christiano, L., Eichenbaum, M., Evans, C. L., 2005. Nominal rigidities and the dynamic effects of a shock to monetary policy. Journal of Political Economy 113 (1), 1–45.

Christiano, L., Motto, R., Rostagno, M., 2003. The great depression and the Friedman-Schwartz hypothesis. Journal of Money, Credit and Banking 35 (6), 1119–1197.

Christiano, L. J., Ilut, C. L., Motto, R., Rostagno, M., 2010. Monetary policy and stock market booms. NBER Working Papers 16402, National Bureau of Economic Research.

Christiano, L. J., Motto, R., Rostagno, M., 2014. Risk shocks. American Economic Review 104 (1), 27–65.

Chung, H., Kiley, M. T., Laforte, J.-P., 2010. Documentation of the Estimated, Dynamic, Optimization-based (EDO) model of the U.S. economy : 2010 version. Tech. rep.

Claessens, S., Laeven, L., 2004. Competition in the Financial Sector and Growth : A Cross-Country Perspective. In : Financial Development and Economic Growth. Palgrave Macmillan UK, London, pp. 66–105.

Cobb, C., Douglas, P., 1928. A theory of production. American Economic Review 18 (1), 139–165.

Coccorese, P., March 2017. Banking competition and economic growth. In : Handbook of Competition in Banking and Finance. Chapters. Edward Elgar Publishing, Ch. 12, pp. 230–263.

Cohn, A., Engelmann, J., Fehr, E., Maréchal, M. A., 2015. Evidence for countercyclical risk aversion : an experiment with financial professionals. American Economic Review 105 (2), 860–885.

Colciago, A., Etro, F., 2010. Real business cycles with Cournot competition and endogenous entry. Journal of Macroeconomics 32 (4), 1101–1117.

Cressy, R., Olofsson, C., 1997. European SME Financing : An Overview. Journal of Small Business Economics 9, 87–96.

Crossley, T. F., Low, H. W., 2011. Is The Elasticity Of Intertemporal Substitution Constant ? Journal of the European Economic Association 9 (1), 87–105.

Darracq Pariès, M., Kok, C., Rodriguez-Palenzuela, D., 2011. Macroeconomic propagation under different regulatory regimes : evidence from an estimated DSGE model for the Euro area. International Journal of Central Banking 7 (4), 49–113.

De Jonghe, O., Dewachter, H., Mulier, K., Ongena, S., Schepens, G., 2019. Some Borrowers are More Equal than Others : Bank Funding Shocks and Credit Reallocation. Review of Finance In press.

De Marco, F., 2019. Bank Lending and the European Sovereign Debt Crisis. Journal of Financial and Quantitative Analysis 54 (1), 155–182.

De Santis, R. A., Surico, P., 2013. Bank lending and monetary transmission in the euro area. Economic Policy 28 (75), 423–457.

Degryse, H., De Jonghe, O., Jakovljevii, S., Mulier, K., Schepens, G., 2019. Identifying Credit Supply Shocks with Bank-Firm Data : Methods and Applications. Journal of Financial Intermediation In press.

Delis, M. D., Kouretas, G. P., Tsoumas, C., 2014. Anxious periods and bank lending. Journal of Banking & Finance 38 (C), 1–13.

Dell'ariccia, G., Marquez, R., 2006. Lending Booms and Lending Standards. The Journal of Finance 61 (5), 2511–2546.

Demirguc-Kunt, A., Peria, M. S. M., 2010. A Framework for Analyzing Competition in the Banking Sector. World Bank Policy Research Working Papers (5499).

Dixit, A., Stiglitz, J., 1977. Monopolistic competition and optimum product diversity. American Economic Review 67 (3), 297–308.

Drechsler, I., Savov, A., Schnabl, P., nov 2017. The Deposits Channel of Monetary Policy. The Quarterly Journal of Economics 132 (4), 1819–1876.

Dwenger, N., Fossen, F. M., Simmler, M., jan 2018. Firms' financial and real responses to credit supply shocks : Evidence from firm-bank relationships in Germany. Journal of Financial Intermediation In press.

Epstein, L. G., Zin, S. E., 1989. Substitution, risk aversion, and the temporal behavior of consumption and asset returns : a theoretical framework. Econometrica 57 (4), 937–69.

Erceg, C. J., Guerrieri, L., Gust, C., March 2006. SIGMA : A New Open Economy Model for Policy Analysis. International Journal of Central Banking 2 (1).

European Commission, 2017. Annual Report on European SMEs. European Commission Report.

Faia, E., 2012. Oligopolistic competition and optimal monetary policy. Journal of Economic Dynamics and Control 36 (11), 1760–1774.

Freixas, X., Rochet, J.-C., 2008. Microeconomics of banking. MIT Press.

Fungáčová, Z., Shamshur, A., Weill, L., oct 2017. Does bank competition reduce cost of credit ? Cross-country evidence from Europe. Journal of Banking & Finance 83, 104–120.

Galí, J., 2008. Monetary policy, inflation and the business cycle : an introduction to the New Keynesian framework, 1st Edition. Princeton, NJ : Princeton University Press.

Galí, J., 2015. Monetary policy, inflation and the business cycle : an introduction to the New Keynesian framework, 2nd Edition. Princeton, NJ : Princeton University Press.

Gambacorta, L., 2003. Asymmetric bank lending channels and ECB monetary policy. Economic Modelling 20 (1), 25–46.

Gambacorta, L., 2005. Inside the bank lending channel. European Economic Review 49 (7), 1737–1759.

Gerali, A., Neri, S., Sessa, L., Signoretti, F., 2010. Credit and banking in a DSGE model of the Euro area. Journal of Money, Credit and Banking 42 (6), 107–141.

Giannetti, M., Burkart, M., Ellingsen, T., apr 2011. What You Sell Is What You Lend ? Explaining Trade Credit Contracts. Review of Financial Studies 24 (4), 1261–1298.

Gomes, S., Jacquinot, P., Pisani, M., 2012. The EAGLE. A model for policy analysis of macroeconomic interdependence in the euro area. Economic Modelling 29 (5), 1686–1714.

Guerrieri, L., Iacoviello, M., 2015. OccBin : A toolkit for solving dynamic models with occasionally binding constraints easily. Journal of Monetary Economics 70 (C), 22–38.

Guerrieri, L., Iacoviello, M., 2017. Collateral constraints and macroeconomic asymmetries. Journal of Monetary Economics 90 (C), 28–49.

Guiso, L., Paiella, M., 2008. Risk aversion, wealth, and background risk. Journal of the European Economic Association 6 (6), 1109–1150.

Guiso, L., Sapienza, P., Zingales, L., 2018. Time varying risk aversion. Journal of Financial Economics 128 (3), 403–421.

Gurley, J., Shaw, E., 1960. Money in a Theory of finance.

Guzman, M. G., sep 2000. Bank structure, capital accumulation and growth : a simple macroeconomic model. Economic Theory 16 (2), 421–455.

Hannan, T. N., 1997. Market Share Inequality, the Number of Competitors, and the HHI : An Examination of Bank Pricing. Review of Industrial Organization 12 (1), 23–35.

Hayek, F. H., 1945. The use of knowledge in society.

Hollander, H., Liu, G., 2016. The equity price channel in a New-Keynesian DSGE model with financial frictions and banking. Economic Modelling 52 (PB), 375–389.

Hughes, J. P., Mester, L. J., oct 2013. Who said large banks don't experience scale economies ? Evidence from a risk-return-driven cost function. Journal of Financial Intermediation 22 (4), 559–585.

Iacoviello, M., 2005. House prices, borrowing constraints, and monetary policy in the business cycle. American Economic Review 95 (3), 739–764.

Iacoviello, M., 2015. Financial business cycles. Review of Economic Dynamics 18 (1), 140–164.

Iacoviello, M., Neri, S., 2010. Housing market spillovers : evidence from an estimated DSGE model. American Economic Journal : Macroeconomics 2 (2), 125–164.

Ivashina, V., Scharfstein, D., sep 2010. Bank lending during the financial crisis of 2008. Journal of Financial Economics 97 (3), 319–338.

Jackson, W. E., 1997. Market Structure and the Speed of Price Adjustments : Evidence Of Non-Monotonicity. Review of Industrial Organization 12 (1), 37–57.

Jayakumar, M., Pradhan, R. P., Dash, S., Maradana, R. P., Gaurav, K., 2018. Banking competition, banking stability, and economic growth : Are feedback effects at work ? Journal of Economics and Business 96 (C), 15–41.

Jiménez, G., Ongena, S., Peydró, J., Saurina, J., mar 2014. Hazardous Times for Monetary Policy : What Do Twenty-Three Million Bank Loans Say About the Effects of Monetary Policy on Credit Risk-Taking ? Econometrica 82 (2), 463–505.

Jiménez, G., Ongena, S., Peydró, J.-L., Saurina, J., aug 2012. Credit Supply and Monetary Policy : Identifying the Bank Balance-Sheet Channel with Loan Applications. American Economic Review 102 (5), 2301–2326.

Keeley, M. C., 1990. Deposit insurance, risk, and market power in banking. American Economic Review 80 (5), 1183–1200.

Kiley, M. T., Sim, J., 2017. Optimal monetary and macroprudential policies : Gains and pitfalls in a model of financial intermediation. Journal of Macroeconomics 54 (PB), 232–259.

Kiyotaki, N., Moore, J., 1997. Credit cycles. Journal of Political Economy 105 (2), 211–248.

Knight, F., 1921. Risk, Uncertainty and Profit. No. 14 in Vernon Press Titles in Economics. Vernon Art and Science Inc.

Kollmann, R., Enders, Z., Müller, G. J., 2011. Global banking and international business cycles. European Economic Review 55 (3), 407–426.

Kremp, E., Sevestre, P., 2013. Did the crisis induce credit rationing for French SMEs ? Journal of Banking & Finance 37 (10), 3757–3772.

Langfield, S., Pagano, M., jan 2016. Bank bias in Europe : effects on systemic risk and growth. Economic Policy 31 (85), 51–106.

Lederer, P. J., Hurter, A. P., may 1986. Competition of Firms : Discriminatory Pricing and Location. Econometrica 54 (3), 623.

Leon, F., aug 2015. Does bank competition alleviate credit constraints in developing countries ? Journal of Banking & Finance 57, 130–142.

Liberti, J. M., Mian, A. R., oct 2009. Estimating the Effect of Hierarchies on Information Use. Review of Financial Studies 22 (10), 4057–4090.

Love, I., Martínez Pería, M. S., jan 2015. How Bank Competition Affects Firms' Access to Finance. The World Bank Economic Review 29 (3), 413–448.

Lucas, R. J., January 1976. Econometric policy evaluation : A critique. Carnegie-Rochester Conference Series on Public Policy 1 (1), 19–46.

Malmendier, U., Nagel, S., 2011. Depression babies : do macroeconomic experiences affect risk taking ? Quarterly Journal of Economics 126 (1), 373–416.

Marquez, R., apr 2002. Competition, Adverse Selection, and Information Dispersion in the Banking Industry. Review of Financial Studies 15 (3), 901–926.

Mason, E., 03 1939. Price and production policies of large-scale enterprise. American Economic Review 29.

Maudos, J., de Guevara, J. F., jul 2007. The cost of market power in banking : Social welfare loss vs. cost inefficiency. Journal of Banking & Finance 31 (7), 2103–2125.

Mayer, C., 1988. New Issues in Corporate Finance. European Economic Review 32, 1167–1189.

Meh, C. A., Moran, K., 2010. The role of bank capital in the propagation of shocks. Journal of Economic Dynamics and Control 34 (3), 555–576.

Motto, R., Rostagno, M., Christiano, L. J., 2010. Financial Factors in Economic Fluctuations. Tech. rep.

Nilsen, J. H., 2002. Trade Credit and the Bank Lending Channel. Journal of Money, Credit and Banking 34 (1), 226–253.

Nuoy, D., 2017. Too much of a good thing ? The need for consolidation in the European banking sector. Speech at the VIII Financial Forum, Madrid, 27 September.

Ongena, S., Peydró, J.-L., van Horen, N., nov 2015. Shocks Abroad, Pain at Home ? Bank-Firm-Level Evidence on the International Transmission of Financial Shocks. IMF Economic Review 63 (4), 698–750.

Pagano, M., 1993. Financial markets and growth : An overview. European Economic Review 37, 613–622.

Panzar, J. C., Rosse, J. N., jun 1987. Testing For "Monopoly" Equilibrium. The Journal of Industrial Economics 35 (4), 443–456.

Peek, J., Rosengren, E. S., aug 1998. Bank consolidation and small business lending : It's not just bank size that matters. Journal of Banking & Finance 22 (6-8), 799–819.

Petersen, M. A., Rajan, R. G., mar 1994. The Benefits of Lending Relationships : Evidence from Small Business Data. The Journal of Finance 49 (1), 3.

Petersen, M. A., Rajan, R. G., may 1995. The Effect of Credit Market Competition on Lending Relationships. The Quarterly Journal of Economics 110 (2), 407–443.

Pfeifer, J., 05 2019. A guide to specifying observation equations for the estimation of DSGE models. University of Cologne.

Pigou, A. C., 1922. The Economics of Welfare.

Popov, A., Rocholl, J., oct 2018. Do credit shocks affect labor demand ? Evidence for employment and wages during the financial crisis. Journal of Financial Intermediation 36, 16–27.

Pratt, J. W., 1964. Risk aversion in the small and in the large. Econometrica 32 (1/2), 122–136.

Rajan, R. G., sep 1992. Insiders and Outsiders : The Choice between Informed and Arm's-Length Debt. The Journal of Finance 47 (4), 1367–1400.

Rhoades, S. A., 1995. Market Share Inequality, the HHI, and Other Measures of the Firm-Composition of a Market. Review of Industrial Organization 10, 657–674.

Ryan, R. M., O'Toole, C. M., McCann, F., dec 2014. Does bank market power affect SME financing constraints ? Journal of Banking & Finance 49, 495–505.

Schaeck, K., Cihák, M., 2012. Banking Competition and Capital Ratios. European Financial Management 18 (5), 836–866.

Schoenmaker, D., 2015. The New Banking Union Landscape in Europe : Consolidation Ahead ? Journal of Financial Perspectives 3 (2).

Schumpeter, J., 1912. The theory of economic development.

Smets, F., Wouters, R., 2003. An estimated dynamic stochastic general equilibrium model of the Euro area. Journal of the European Economic Association 1 (5), 1123–1175.

Smets, F., Wouters, R., 2005. Comparing shocks and frictions in US and euro area business cycles : a Bayesian DSGE approach. Journal of Applied Econometrics 20 (2), 161–183.

Smets, F., Wouters, R., 2007. Shocks and frictions in US business cycles : a Bayesian DSGE approach. American Economic Review 97 (3), 586–606.

Smith, A., 1776. An Inquiry into the Nature and Causes of the Wealth of Nations. McMaster University Archive for the History of Economic Thought.

Stein, J. C., oct 2002. Information Production and Capital Allocation : Decentralized versus Hierarchical Firms. The Journal of Finance 57 (5), 1891–1921.

Stigler, G. J., October 1983. The Organization of Industry. No. 9780226774329 in University of Chicago Press Economics Books. University of Chicago Press.

Stiglitz, J. E., Weiss, A., 1981. Credit Rationing in Markets with Imperfect Information. The American Economic Review 71 (3), 393–410.

Strahan, P. E., Weston, J. P., aug 1998. Small business lending and the changing structure of the banking industry. Journal of Banking & Finance 22 (6-8), 821–845.

Sussman, O., Zeira, J., 1995. Banking and Development. CEPR Discussion Papers (1127).

Taylor, J. B., 1993. Discretion versus policy rules in practice. Carnegie-Rochester Conference Series on Public Policy 39 (1), 195–214.

Tirole, J., March 1988. The Theory of Industrial Organization. Vol. 1 of MIT Press Books. The MIT Press.

Torul, O., 2018. On the business cycle implications of alternative risk aversion formulation. Central Bank Review 18, 41–50.

Vissing-Jørgensen, A., 2002. Limited asset market participation and the elasticity of intertemporal substitution. Journal of Political Economy 110 (4), 825–853.

Vives, X., dec 2001. Competition in the Changing World of Banking. Oxford Review of Economic Policy 17 (4), 535–547.

Wachter, J. A., 2006. A consumption-based model of the term structure of interest rates. Journal of Financial Economics 79 (2), 365–399.

Walras, L., 1874. Elements of pur economics.

Weil, P., 2002. L'incertitude, le temps et la théorie de l'utilité. Tech. rep.

Wheelock, D. C., Wilson, P. W., feb 2012. Do Large Banks Have Lower Costs ? New Estimates of Returns to Scale for U.S. Banks. Journal of Money, Credit and Banking 44 (1), 171–199.

Zarutskie, R., sep 2006. Evidence on the effects of bank competition on firm borrowing and investment. Journal of Financial Economics 81 (3), 503–537.

Résumé : Dans cette thèse, nous nous concentrons sur deux déterminants de la disponibilité du crédit et plus largement, du cycle des affaires: la structure du marché bancaire et les préférences des agents à l'égard du risque et du temps. Dans un premier chapitre, nous démontrons une relation empirique négative entre la concentration du marché bancaire et la disponibilité des crédits aux entreprises. Nous montrons également que l'ampleur de cette relation dépend des caractéristiques des firmes et des banques. Dans un second chapitre, théorique, nous comparons, dans le cadre d'un modèle d'Equilibre Général Dynamique Stochastique (DSGE) non linéaire, différentes structures du marché bancaire et analysons leurs effets respectifs sur la stabilité financière et sur le bien-être des ménages. Un marché bancaire oligopolistique avec une forte concentration atténue la transmission des chocs financiers et améliore le bien-être des ménages par rapport aux autres structures de marché. Enfin, dans un dernier chapitre nous analysons, via un modèle DSGE non linéaire, l'effet d'une augmentation de l'aversion au risque des agents sur la transmission des chocs économiques. En outre, en considérant la variabilité temporelle du paramètre d'aversion au risque, nous analysons les mécanismes de transmission d'un choc d'aversion à l'ensemble de l'économie.

Descripteurs : Disponibilité du crédit, concurrence bancaire, aversion au risque, cycle des affaires

Abstract : In this thesis, we focus on two determinants of credit availability and more broadly, the business cycle: banking market structure, and risk and time preferences. First, in an empirical chapter, we demonstrate a negative relationship between the concentration of the banking sector and the availability of credit. We also show that this relationship depends on the specific characteristics of firms and banks. Secondly, in a theoretical chapter, we compare, in the framework of a nonlinear Dynamic Stochastic General Equilibrium (DSGE) model, different banking market structures and we analyse their respective impact on the business cycle and households' welfare. We find that a concentrated oligopolistic structure mitigates the transmission mechanism of financial shocks and improves the households' welfare compared to other market structures. In the final chapter, we analyse, through a nonlinear DSGE model, the impact of an increase in the degree of risk aversion on the transmission mechanisms of economic shocks. Moreover, considering the time-varying nature of risk aversion, we evaluate the transmission mechanisms of risk aversion shocks to the whole economy.

Keywords : Credit availability, bank competition, risk aversion, business cycle