UNIVERSITÉ DU QUÉBEC À MONTRÉAL

THE ROLE OF THE BANKING SECTOR AND FINANCIAL MARKETS ON ECONOMIC DEVELOPMENT

THESIS
PRESENTED
AS PARTIAL REQUIREMENT
FOR THE PH.D IN ECONOMICS

BY
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FEBRUARY 2015

UNIVERSITÉ DU QUÉBEC À MONTRÉAL

LE RÔLE DU SYSTÈME BANCAIRE ET DES MARCHÉS FINANCIERS DANS LE DÉVELOPPEMENT ÉCONOMIQUE

THÈSE
PRÉSENTÉE
COMME EXIGENCE PARTIELLE
DU DOCTORAT EN ÉCONOMIQUE

PAR
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FÉVRIER 2015

REMERCIEMENTS

Mes remerciements vont à Dieu pour m'avoir accordé santé et force nécessaires pour mener à bien cette thèse. Je tiens à remercier chaleureusement mon directeur de recherche, Wilfried Koch, PhD. Il a été pour moi un soutien indéfectible durant le long processus d'élaboration de cette thèse tant sur le plan psychologique, éducatif que financier. Sa rigueur et sa méthodologie d'encadrement ont été les leçons de toute une vie. J'ai appris à ses côtés comment initier une recherche et surtout à développer les qualités d'un bon chercheur. Je le remercie de façon particulière pour la confiance et le soutien qu'il m'a généreusement offerts, et je lui suis infiniment reconnaissant de m'avoir poussé sans relâche dans la voie de la précision et du travail bien fait durant la rédaction de cette thèse. Mes sincères remerciements vont aux professeurs et membres du jury : Louis Phaneuf, Benoit Carmichael et Pavel Sevcik pour leurs commentaires pertinents qui m'ont permis d'augmenter la valeur ajoutée de la thèse.

Cette thèse a été également rendue à terme grâce au soutien de ma famille : ma mère, mon père, et mon épouse. Cette dernière a été constamment là pour m'encourager et me soutenir pendant les périodes difficiles. Mes pensées vont également à mon oncle Nasser qui a nous quitté en début d'année, ainsi que mes trois frères, Mouctar, Yacine et El. Hadj.

Je remercie tout le corps professoral du département des Sciences économiques. J'adresse, plus particulièrement, mes sincères remerciements aux professeurs Kristian Behrens, Claude Fluet, Steve Ambler, Douglas Hodgson, et Max Blouin.

Je remercie Mesdames : Martine Boisselle, Germain Francine, Julie Hudon, Lorraine Brisson, Josée Parenteau, et Jacinthe Lalonde pour leur disponibilité et leur aide durant mon doctorat. Merci également au CIRPÉE et au département des Sciences économiques pour le soutien financier dont j'ai pu bénéficier dès la premièrere année de mon doctorat.

En terminant, je ne manquerai pas de remercier mes amis Ndack Kane, Yorou Tchakando, Sêgnon Aguey, Ibrahima Berté, Salah Eddine El Omari et Thiémokho Diop pour tous les bons moments passés ensemble et les débats passionnants que nous avons eus durant toute la période doctorale, ainsi que mes amis Isabelle Harrisson, Jeffrey Malecki et Hassatou Diallo pour la relecture.

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RÉSUMÉ

Cette thèse étudie le rôle du système bancaire et des marchés financiers dans le développement économique. Elle est constituée de trois articles scientifiques :

Le premier article utilise un modèle de croissance endogène du type Schumpétérien et un marché bancaire évoluant dans un environnement de concurrence imparfaite à la Cournot. Nous montrons que la concentration bancaire a un effet négatif sur la croissance économique. De plus, cet effet est d'autant plus négatif pour les pays proches de la frontière technologique mondiale. Pour valider nos résultats théoriques nous utilisons des estimations économétriques avec des données en coupe transversale et en panel pour un ensemble de 125 pays sur la période 1980-2010. Nous montrons que la concentration bancaire diminue le taux de croissance annuel moyen du PIB par travailleur. Cet effet est d'autant plus négatif pour les pays proches de la frontière technologique mondiale. Nos résultats empiriques sont robustes à l'utilisation du taux de croissance annuel moyen du PIB par tête et à l'introduction de variables macroéconomiques (taux d'inflation, taux de croissance de la masse monétaire, balance budgétaire, dépenses gouvernementales, et commerce), éducation, crédits privés et origines légales comme contrôles.

Dans notre second article de thèse, nous endogéneisons le nombre de banques. Pour cela, nous utilisons un modèle bancaire en concurrence bancaire imparfaite avec différenciation horizontale à la Salop (1979). Ce modèle nous permet ensuite d'étudier les effets des réformes bancaires sur la croissance économique. Les réformes bancaires sont mesurées par les coûts de transports qui séparent une banque et un entrepreneur représentatif. À l'aide de la libre entrée dans le secteur bancaire, nous montrons que effets des réformes bancaires sur la croissance économique dépendent du niveau du développement économique. Plus spécifiquement, nous montrons à l'aide des institutions dites appropriées, qu'il existe un seuil de développement économique à partir duquel les réformes bancaires sont bénéfiques pour la croissance économique. Ainsi, les réformes bancaires ont un effet positif sur la croissance économique pour les pays proches de la frontière technologique mondiale. Pour valider nos prédictions théoriques, nous effectuons des études empiriques pour 78 pays sur la période 1980-2010. Nous montrons que les effets des réformes bancaires sur la croissance économique dépendent du niveau de développement technologique. De plus, les réformes bancaires ont un effet positif et significatif pour les pays proches de la frontière technologique mondiale. Ce résultat reste valide à l'introduction de variables de contrôle et à l'utilisation de différentes techniques d'estimation économétriques.

Le troisième article de cette thèse étudie empiriquement les effets positifs de l'efficience bancaire sur la croissance économique en temps de crise économique. En effet, nous utilisons la crise financière et économique de 2009 comme un choc du côté de l'offre de crédits et nous montrons par la suite que les pays avec des systèmes bancaires efficaces résistent mieux et croissent plus vite. Cette efficience bancaire relaxe les contraintes de crédits pour les industries qui ont le plus besoin de financement externe. Nous utilisons une méthode économétrique appelée Data Envelopment Analysis (DEA) pour mesurer l'efficience bancaire et des estimations économétriques en coupes pays et industries. Nos résultats montrent que l'efficacité bancaire a un effet positif et significatif sur le taux de croissance réel pour les industries qui ont le plus besoin de financement externe. Cela implique qu'un système bancaire efficace permet aux industries qui ont le plus besoin de financement externe d'avoir plus de crédits en période de crise économique. Nos résultats restent robustes à l'utilisation de différentes mesures de dépendance financière.

Mots clés : Croissance schumpétérienne, frontière technologique, concentration bancaire, réformes bancaires, institutions appropriées, efficience bancaire, dépendance financière, frictions financières.

ABSTRACT

In this thesis we study the role of the banking sector and financial markets on economic development. It consists of three scientific papers :

In the first paper, we investigate the relationship between economic growth and bank concentration. We introduce imperfect competition within the banking system according to the Schumpeterian growth paradigm, and we theoretically and empirically show that the effects of bank concentration on economic growth depend on proximity to the world technology frontier. The theory predicts that bank concentration has a negative and significant direct effect on economic growth, especially for countries close to the frontier. We empirically verify our theoretical predictions by using cross-country and panel data for 125 countries over the period 1980-2010.

In the second paper, we endogenize the number of banks and we theoretically and empirically analyze the effects of banking reforms on growth according to the level of technological development of a country. Using a Schumpeterian growth paradigm and monopolistic competition between differentiated products of the banking system, we show that there is a threshold of technological development from which banking reforms exert a positive effect on economic growth. To validate our theoretical predictions we use cross-country and panel estimates over the period 1980-2010 for 78 countries. We find that banking reforms enhance the average per-worker GDP growth for countries close to the world technology frontier.

In the last paper, we use the recent financial crisis as a shock to the supply of credit, and we analyze the effect of bank efficiency on value added growth of firms in industries that are most dependent on external finance. Our main results show that bank efficiency relaxed credit constraints and increased the growth rate for financially dependent industries during the crisis. This finding remains robust the introduction of control variables, namely financial development, bank concentration and competition, bank size and capitalization, bank supervision, net interest margin, overhead costs, banking crises, monetary policy, government intervention measures and macroeconomic variables interacted with external financial dependence. It also remains robust to the use of several measures of external financial dependence and econometric methods.

KEYWORDS : Schumpeterian growth, technological frontier, bank concentration, banking reforms, appropriate institutions, bank efficiency, financial dependence, financial frictions.

INTRODUCTION

Le débat entre développement financier et croissance économique ne date pas d'aujourd'hui, pour s'en rendre compte Schumpeter (1911) évoquait déjà ce lien. Il suggérait que le développement financier à travers un système bancaire efficace augmente la croissance économique. Puisque plus les banques sont efficaces, plus elles prêtent et financent les projets les plus rentables et novateurs. Cette situation augmente la productivité des entreprises et il s'ensuit une croissance économique élevée. Dans la foulée de cet article de Schumpeter, les études sur le rôle positif du développement financier sur la croissance n'ont cessé de croître. C'est le cas notamment de Goldmisth (1969) qui utilise pour la première fois des estimations empiriques. À l'aide des données en coupe transversale sur la période 1860-1963, il découvre que la croissance moyenne est positivement corrélée à la taille du secteur financier. Pour pallier les lacunes posées par les estimations de Goldsmith (1969), qui n'introduisait aucune variable de contrôle, les articles de King et Levine (1993a, 1993b) apportent un nouvel éclairage sur ce passionnant débat. Ainsi, à l'aide d'une régression de la croissance moyenne du PIB par tête sur plusieurs variables de l'indicateur du développement financier et des variables de contrôle (le revenu initial par tête, des mesures d'éducation, des indicateurs de stabilité politique et économique), ils démontrent que le développement financier est un bon indicateur prévisionnel du taux de croissance par tête. Ils mesurent le développement financier à l'aide de trois méthodes différentes, la première consistant à prendre le ratio entre les dettes liquides du système financier et le PIB, la seconde utilisant le ratio de crédit des banques de second rang sur les crédits bancaires plus les titres domestiques de la Banque Centrale, et enfin la dernière tenant compte du ratio des crédits accordés aux entreprises privées sur le PIB (Produit Intérieur Brut). Ils montrent ainsi que le développement financier est un bon indicateur pour mesurer l'accumulation du capital physique et du changement technologique pour un ensemble de 77 pays sur la période 1960-1980. Bencivenga et

Smith (1991) montrent que l'existence des banques fiables permet de bien gérer l'épargne des ménages et ainsi leur apporter un niveau de vie important grâce aux rendements bancaires significatifs. Plus récemment Levine (2005) dans le *Handbook of Economic Growth,* résume cette revue de littérature comme suit : Les pays dans lesquels le système financier fonctionne : à savoir les marchés et les intermédiaires financiers, possèdent des taux de croissance plus rapide, ces résultats restent consistants à l'introduction de biais de simultanéité. Il explique également qu'un bon fonctionnement du système financier desserre les contraintes de financement externes et permet aux firmes de pouvoir emprunter facilement et de produire plus. Aghion *et al.* (2005) dans leur article célèbre publié dans *Quaterly Journal of Economics* utilisent un modèle de croissance endogène du type schumpétérien et un modèle bancaire avec contraintes de crédit pour analyser la relation entre le développement financier et la croissance économique. Ils montrent que la contrainte de crédit est un facteur important pour expliquer la convergence ou la divergence entre les pays. Plus particulièrement, ils montrent, théoriquement et empiriquement , que le développement financier a un impact sur la croissance économique selon que le pays est proche ou est éloigné de la frontière technologique. Ils obtiennent des résultats qui classent les pays en trois catégories. La première catégorie concerne des pays qui convergent à long terme vers l'état stationnaire, il s'agit de pays qui ne subissent pas de contraintes de crédit et donc le développement financier n'a aucun impact ni sur la croissance ni sur le niveau du PIB à l'état stationnaire. La deuxième est une catégorie de pays dont le développement financier est moyen. Dans ces pays le développement financier n'a aucun impact sur la croissance, mais il affecte le niveau du PIB à l'état stationnaire. Pour la dernière catégorie, il s'agit de pays qui divergent à long terme. La contrainte de crédit dans ces pays est très forte et le développement financier est faible, il y a donc un effet négatif et significatif sur la croissance économique.

L'objectif principal de cette thèse est d'apporter une contribution scientifique pertinente à ce débat. Ainsi, nous étudions l'importance du développement financier et le rôle du système bancaire dans le développement économique en tenant compte de la structure microéconomique du marché bancaire. La thèse est constituée de trois articles scientifiques pertinents. En effet, dans le premier article, nous analysons théoriquement et empiriquement les effets de la concentration bancaire sur la croissance économique. Dans le second article, nous étudions à l'aide d'un modèle théorique et empirique les effets des réformes bancaires sur la croissance économique en fonction du niveau du développement technologique. Et enfin, dans le dernier article nous mesurons les effets positifs de l'efficience bancaire sur la croissance économique durant la crise économique de 2009.

L'intérêt démontré pour ces questions s'explique pour plusieurs raisons. Premièrement, plusieurs des études susmentionnées utilisent des estimations empiriques pour mesurer les effets du développement financier sur la croissance économique. Deuxièmement, ces études ne tiennent pas compte de la structure microéconomique du marché bancaire à savoir : la concentration, la concurrence et l'efficience bancaires. Troisièmement, la littérature existante sur le lien entre la croissance et la strucuture microéconomique du bancaire trouve des résultats contradictoires et ambigus. De plus, rares sont ces études qui utilisent des modèles théoriques pour analyser les effets de la structure du marché bancaire sur le développement économique. En effet, Ceterolli (2002) étudie empiriquement les effets de la concentration bancaire sur la croissance. Il utilise la méthode offerte par Rajan et Zingales (1998) avec des données en coupe pays-industries pour montrer que la concentration dans le secteur bancaire augmente le taux de croissance pour les industries qui ont le plus besoin de financement externe. Cependant, il trouve que cet effet est très faible pour les pays avec un niveau de développement financier faible. Beck *et al.* (2004) utilisent la même méthodologie et démontrent que la concentration dans le secteur bancaire augmente les contraintes de crédit pour les firmes. Deidda et Fattouh (2005) utilisent un modèle de croissance endogène du type AK et un marché bancaire en concurrence imparfaite, et montrent que la concentration bancaire exerce deux effets opposés sur la croissance économique. Pour les États-Unis, Goldberg *et al.* (2000) montrent que la concentration bancaire affecte positivement le niveau des crédits accordés aux petites et moyennes firmes dans les zones urbaines, mais négativement dans les zones rurales.

Le premier article de cette thèse utilise un modèle de croissance endogène du type schumpétérien et un marché bancaire évoluant dans un environnement de concurrence imparfaite à la Cournot. Le choix pour un modèle de croissance endogène du type schumpétérien s'explique par le fait que les modèles de croissance néoclassique et les modèles de croissance endogène à la Romer soulèvent plusieurs questions. Dans le cadre néoclassique, les modèles parlent d'un progrès technologique exogène qui explique la croissance sans pour autant justifier clairement l'origine de ce progrès technique. Dans les modèles à variétés de biens de Romer, c'est la possibilité de création de nouvelles variétés de biens intermédiaires par le canal de l'innovation qui augmente le PIB. Ces modèles ne tiennent pas compte de l'obsolence des inputs intermédiaires les plus anciens. De ce fait, une disparition de ceux-ci diminue automatiquement le PIB. Dans le modèle de croissance schumpétérienne que nous présentons, la qualité du bien a une importance cruciale pour la croissance économique. Les premières tentatives d'utilisation de ce type de modèles sont dues à Aghion et Howitt (1992) qui utilisent les outils de l'économie industrielle pour mesurer le degré de concurrence pour la productivité. La modélisation dans un cadre de concurrence imparfaite à la Cournot nous permet d'introduire les effets de la concentration bancaire mesurée par l'indice de Herfindahl sur la croissance économique.

Nos premiers résultats montrent que la concentration bancaire a un effet négatif sur la croissance économique. De plus, cet effet est d'autant plus négatif pour les pays proches de la frontière technologique mondiale. Ce résultat s'explique en partie par le fait que la concentration bancaire diminue les montants accordés aux entrepreneurs parce qu'elle augmente les taux d'intérêts des emprunts. Ainsi, il en résulte une baisse de l'innovation et donc de la croissance économique. Nous observons des opportunités d'innovation plus importantes pour les pays proches de la frontière technologique, une hausse de la concentration bancaire diminuant les montants alloués à l'innovation, il s'ensuit une baisse importante de la croissance économique pour ces pays. Pour valider nos résultats théoriques, nous utilisons des estimations économétriques avec des données en coupe transversale et en panel pour un ensemble de 125 pays sur la période 1980-

2010. Nous démontrons que la concentration bancaire diminue le taux de croissance annuel moyen du PIB par travailleur. Cet effet est d'autant plus négatif et significatif pour les pays proches de la frontière technologique mondiale. Nos résultats empiriques sont robustes à l'utilisation du taux de croissance annuel moyen du PIB par tête et à l'introduction de variables macroéconomiques (taux d'inflation, taux de croissance de la masse monétaire, balance budgétaire, dépenses gouvernementales, et commerce), éducation, crédits privés et origines légales comme contrôles et à l'utilisation de plusieurs techniques économétriques.

Dans notre second article, nous endogénéisons le nombre de banques qui est une donnée exogène dans le premier chapitre. Pour cela, nous utilisons un modèle bancaire en concurrence imparfaite avec différenciation horizontale à la Salop (1979). Ce modèle nous permet ensuite d'étudier les effets des réformes bancaires sur la croissance économique. Les réformes bancaires sont mesurées par les coûts fixes d'entrée. À l'aide de la libre entrée dans le secteur bancaire, nous montrons que les réformes bancaires affectent la croissance économique. Les intuitions de ce résultat s'expliquent par le fait que les réformes bancaires par la libre entrée facilitent l'accès aux crédits pour les innovateurs en diminuant les taux d'emprunts. Des réformes bancaires en profondeur, par exemple la libre entrée dans le secteur bancaire, permettent au pays de croître et d'avoir des taux de croissance élevés. Pour valider nos prédictions théoriques, nous effectuons des études empiriques pour 78 pays sur la période 1980-2010. Nous montrons que les réformes bancaires affectent sur la croissance économique selon le niveau du développement économique. De plus, les réformes bancaires ont un effet positif et significatif pour les pays proches de la frontière technologique mondiale. Ce résultat reste valide à l'introduction de variables de contrôle et à l'utilisation de différentes techniques d'estimation économétriques.

Le troisième article de notre thèse étudie empiriquement les effets positifs de l'efficience bancaire sur la croissance économique en temps de crise économique. Nous utilisons la crise financière et économique de 2009 comme un choc du côté de l'offre de crédits et nous montrons par la suite que les pays avec des systèmes bancaires efficients résistent mieux et croissent plus vite. Nous utilisons une méthode économétrique appelée Data Envelopment Analysis (DEA) pour mesurer l'efficience bancaire et des estimations économétriques en coupes pays et industries. Pour la première fois, nous analysons le lien entre le développement financier et la croissance économique en utilisant une vraie mesure de l'efficience bancaire ou du développement financier. Ceci nous permet de nous différencier de la littérature existante qui utilise le niveau de crédits privés sur le PIB comme mesure du développement financier. L'utilisation des données pays-industries nous permet entre autres de contrôler pour les variables omises et de traiter en profondeur la question liée à l'endogénéité. Notre échantillon final est composé de 37 pays et de 36 industries pour un total de 2611 observations. Nous utilisons ensuite la méthode de Rajan et Zingales (1998), en régressant le taux de croissance annuel en termes réels de la valeur ajoutée de l'industrie j et du pays k sur les variables muettes pays et industries, l'interaction entre la dépendance financière de l'industrie j et l'efficience bancaire du pays k et différents types de variables contrôle du pays k.

Nous montrons que l'efficience bancaire relaxe les contraintes de crédits pour les industries qui ont le plus besoin de financement externe. De plus nos résultats montrent que l'efficience bancaire a un effet positif et significatif sur le taux de croissance réel pour les industries qui ont le plus besoin de financement externe. Cela implique qu'un système bancaire efficient permet aux industries qui ont le plus besoin de financement externe d'avoir plus de crédits en période de crise économique. Pour dissocier les effets réels de notre mesure de l'efficience bancaire sur la croissance à d'autres variables, nous introduisons différents types de variables de contrôle. Nous contrôlons pour le développement financier du pays en introduisant l'interaction entre la capitalisation boursière, la capitalisation totale et la dépendance financière. Notre résultat reste valide, et montre que l'efficience bancaire facilite l'accès aux crédits pour les industries qui ont le plus besoin de financement externe. Nous contrôlons également pour la concentration et la concurrence bancaires, la supervision bancaire, le PIB réel, le commerce, l'inflation, le taux de change, la politique monétaire, les mesures gouvernementales annoncées pour contrer la crise économique (actifs annoncés, actifs utilisés, garanties bancaires, support en liquidités), la taille du marché bancaire, la capitalisation bancaire et les crises bancaires. Nos résultats restent également robustes à l'utilisation de différentes mesures de dépendance financière. Les prochaines sections présentent en détail les trois chapitres de la thèse.

Mots-clés : Croissance schumpétérienne, frontière technologique, concentration bancaire, réformes bancaires, institutions appropriées, efficience bancaire, dépendance financière, frictions financières.

CHAPTER I

BANK CONCENTRATION AND SCHUMPETERIAN GROWTH : THEORY AND INTERNATIONAL EVIDENCE

Abstract

This paper investigates the relationship between economic growth and bank concentration. We introduce imperfect competition within the banking system according to the Schumpeterian growth paradigm, and we theoretically and empirically show that the effects of bank concentration on economic growth depend on proximity to the world technology frontier. The theory predicts that bank concentration has a negative and significant direct effect on economic growth, especially for countries close to the frontier. We empirically verify our theoretical predictions by using cross-country and panel data for 125 countries over the period 1980-2010.

KEYWORDS : Schumpeterian growth, bank concentration, technological frontier.

JEL : O3, O16, C21, C23.

1.1 Introduction

The role of financial development in economic growth, first outlined by Schumpeter (1912) as allowing for better capital allocation, is now at the heart of economic growth literature. The first serious attempt to empirically estimate the relation, between financial development and economic growth dates back to Robert King and Ross Levine. Indeed, King and Levine (1993a) used a cross-country perspective and found that various measures of the level of financial development are strongly associated with real per capita GDP growth, the rate of physical capital accumulation, and improvements in the efficiency with which economies employ physical capital. King and Levine (1993b) show that the level of a country's financial development helps predict its rate of economic growth for the following 10 to 30 years. Since then, a large body of literature, exhaustively reviewed by Levine (2005), has estimated this relation using numerous robustness checks to corroborate the intuition of Schumpeter (1912).

In this paper, we propose to evaluate the effect of bank concentration on economic growth, both theoretically and empirically, using the Schumpeterian growth paradigm. The literature devoted to the effects of bank concentration on economic growth has led to different and ambiguous results. Our purpose in this article is to clarify this relation by answering the two following main questions : What are the effects of bank concentration on economic growth in a theoretical and empirical framework ? How do these effects evolve for a given country according to its proximity to the world technology frontier ? The answer to both of these questions allows us to take a position in the existing literature mainly to provide a better understanding of the effects of market power and bank concentration on economic growth through a theoretical model validated by empirical estimates. We use an endogenous growth model, namely the Schumpeterian growth paradigm inspired by Aghion *et al.* (2005), where the engine of growth is considered to be innovation. Another merit of this model is that it takes into account the effects of convergence and divergence between countries as opposed to neoclassical growth models and first generations of endogenous growth models such as AK or varieties of intermediate goods of Romer (1990). Final output technology combines labor and intermediate inputs, and these intermediate inputs are produced by innovators (entrepreneurs) who enjoy monopoly power because they operate the technology that is closest to the frontier. Endogenous growth and convergence to the frontier are driven by innovation in the intermediate sector, which is performed by entrepreneurs needing external finance. Innovators (entrepreneurs) face a cost (thus they borrow), which depends on the success probability and is proportional to the technological level of the frontier. If successful, they enjoy profits which are proportional to the frontier technology. Innovators do not take the interest rate as given but interact strategically with banks. Hence, expected profitability from R&D depends on the amount invested in three ways : negatively because it is a cost, positively because it increases the probability of entrepreneurial innovation, and it reduces the interest rate on loans. To measure the effects of bank concentration on innovation in our model, we use imperfect Cournot competition in the banking sector. The banking sector is composed of n identical banks, which collect deposits and offer loans to entrepreneurs. The deposits sector is assumed to be perfect competition, while the loans sector has evolved according to imperfect Cournot competition. This last assumption allows us to capture the effects of bank concentration measured by the Herfindahl index on economic growth.

The effects of bank concentration on economic growth have been studied by Deidda and Fattouh (2005) using an AK endogenous growth model. They find that reduction in the level of concentration in the banking industry exerts two opposite effects on economic growth. On the one hand, it induces economies of specialization, which enhances intermediation efficiency and thereby economic growth. On the other hand, it results in the duplication of fixed costs, which are detrimental to efficiency and growth. Our article does not explore the channel of capital accumulation as did Deidda and Fattouh (2005) or Badunenko and Romero-Avila (2013), who found that a substantial part of the productivity growth attributable to physical capital accumulation should be associated with the allocative efficiency role of financial development using nonparametric production frontier and adding financial development. Our empirical results are robust, through the use of bank efficiency (net interest margin and overhead costs), as suggested by Badunenko and Romero-Avila (2013) for financial efficiency, in columns (6) and (7) of Table 1.9. In this article, we demonstrate that the effect of bank concentration on economic growth is due to three channels. The first channel is captured by the loan rate through imperfect Cournot competition in the banking system ; the second channel is measured by the probability of entrepreneurial innovation through the Schumpeterian endogenous growth model ; and the last channel deals with the proximity to the world technology frontier to explain the effects of convergence among countries through bank concentration. Several empirical studies show that high bank concentration increases the cost of the credits, as suggested by Hannan (1991), who finds strong evidence that concentration is associated with higher interest rates across U.S. banking markets. Cetorelli (2002) explores the effect of the banking market structure on the market structure of industrial sectors. He finds that banking concentration enhances industry market concentration, especially in sectors highly dependent on external finance. However, these effects are weaker in countries characterized by higher overall financial development. Empirically, Beck *et al.* (2004) use a cross-country approach with firm-level data and investigate the effects of bank competition on firm financing constraints and access to credit. They show that bank concentration increases financing constraints and decreases the likelihood of receiving bank financing for small and medium-size firms, but not for large firms. Petersen and Rajan (1995) show that the competition in credit markets is important in determining the value of lending relationships, and they find empirical evidence that creditors are more likely to finance credit-constrained firms when credit markets are concentrated because it is easier for these creditors to internalize the benefits of assisting the firms. Goldberg *et al.* (2000) show across local U.S. banking markets that concentration affects small business lending positively in urban markets and negatively in rural markets. We add a novelty to these studies by theoretically testing the effects of bank concentration on the costs of credit ; our first theoretical results show that bank concentration increases the cost of credit for entrepreneurs and at the same time exerts a direct negative effect on economic growth through innovation.

We theoretically show that the probability of entrepreneurial innovation is a decreasing function of bank concentration as measured by the Herfindahl index. This result allows us to verify the empirical results obtained in the literature on the relationship between bank concentration and the creation of new firms. Some authors use empirical investigation to illustrate the effects of bank concentration on the formation of firms, such as Black and Strahan (2002), who find evidence across U.S. states that higher concentration results in less new firm formation, especially in states and periods with regulated banking markets. However, Cetorelli and Gambera (2001) study the empirical relevance of the banking market structure on growth and show that bank concentration promotes the growth of the industrial sectors that are more in need of external finance by facilitating credit access to younger firms. They also find a general depressing effect on growth associated with a concentrated banking industry, which impacts all sectors and firms indiscriminately.

In order to answer the second question of our article, we measure the effects of bank concentration on the probability of entrepreneurial innovation according to the proximity to the world technology frontier for a given country. We theoretically show that bank concentration has a significant, direct effect on economic growth and that this effect is even more negative and significant when the country is close to the world technology frontier. These results contradict those of Deidda and Fattouh (2005), who empirically find that bank concentration is negatively associated with industrial growth only in low-income countries, while there is no such association in high-income countries. Despite the negative effect of bank concentration on economic growth through financing constraints, Beck *et al.* (2004) found that the connection between bank concentration and financing constraints is reduced in countries with an efficient legal system, good poverty rights protection, less corruption, better developed credit registries, and a large market share of foreign banks, while a greater extent of public bank ownership exacerbates the relation. In addition, these results do not explore the effects of bank concentration on the convergence among countries in a theoretical framework, and the results are obtained using cross-country evidence. We include in our specifications banking regulation variables (activity restriction, required reserves, bank development, and official supervisory power) as in Beck *et al.* (2004). The results are presented in columns (2)-(5) of Table 1.9. We significantly expand on such findings using panel and cross-country data of 125 countries over the period 1980-2010 to show that bank concentration has a negative and significant direct effect on the average per worker GDP growth and that this effect is even more negative and significant when the country is close to the world technology frontier. These findings remain robust to the use of the average per capita GDP growth rate, as shown in Table 1.7. In addition, our results are robust due to the use of multiple measures of bank concentration, multiple measures of GDP growth (Penn World Table 7.1 and Penn World Table 8.0), and the introduction of several types of control variables : financial development, school, macroeconomic policies (money growth, inflation, budget balance, government consumption, and trade), bank regulation (activity restriction, required reserves, bank development, and official supervisory powers), bank efficiency (net interest margin and overhead costs), institutional policies (British, French, and German legal origins) and multiple econometric methods, such as ordinary least squares (OLS), Instrumental Variables (IV) and Arrellano-Bond generalized method of moments (GMM) estimation.

In summary, our paper introduces several crucial novelties to the existing literature. First, while most papers use empirical cross-country estimates to test the effects of bank concentration on economic growth, our paper uses a theoretical model to measure the effects of bank concentration according to the proximity to the world technology frontier for a given country, as well as empirical estimates to validate our theoretical model. Second, to our knowledge, our theoretical model and empirical estimates are the first in the literature to establish the link between bank concentration and economic growth according to a Schumpeterian growth paradigm. Finally, our sample includes developed, developing, and emerging countries. To test the robustness of our results, we use several estimation methods and several types of control variables. The remainder of the paper is organized as follows. Section 1.2 outlines the basic structure of the theoretical model, section 1.3 confronts the theoretical predictions by using empirical investigation, and section 1.4 summarizes the findings.

1.2 Theoretical framework

1.2.1 A simple Schumpeterian theoretical framework

We use the theoretical Schumpeterian growth paradigm developed over the past decade by Howitt and Mayer-Foulkes (2004), Aghion *et al.* (2005), and Acemoglu *et al.* (2006). Time is considered discrete, and there is a continuum of individuals in each country. There are J countries, indexed by $j = 1, ..., J$, which do not exchange goods and factors but are technologically interdependent in the sense that they use technological ideas developed elsewhere in the world. Each country has a fixed population, L, which we normalize to one $L \equiv 1$, so that aggregate and per capita quantities coincide. Each individual lives two periods and is endowed with two units of labor services in the first period and none in the second. The utility function is assumed to be linear in consumption, so that $U = c_1 + \beta c_2$, where c_1 and c_2 represent consumption in the first and second periods of life, respectively, and $\beta \in (0, 1)$ is the rate at which individuals discount the utility consumption in the second period relative to that in the first.

Production of final good. Consider a country j, where in that follow we drop country-index without loss of generality, where there is only one general good Y_t, taken as the numéraire, produced by specialized intermediate goods and labor as

$$Y_t = L^{1-\alpha} \int_0^1 A_t(\nu)^{1-\alpha} x_t(\nu)^{\alpha} d\nu \quad \text{with} \quad 0 < \alpha < 1 \tag{1.1}$$

where $x_t(\nu)$ is the country input of intermediate good ν such that $\nu \in [0, 1]$, and $A_t(\nu)$ is the technological productivity parameter associated with it. The final good is used for consumption, as an input into entrepreneurial innovation and the production of intermediate goods. Producers of the general good act as perfect competitors in all markets, so that the inverse demands for intermediate goods and labor are given by

$$\text{(FOC)} \quad \begin{cases} p_t(\nu) = \alpha x_t(\nu)^{\alpha-1} A_t(\nu)^{1-\alpha} & \text{for all sectors } \nu \in [0, 1] \\ w_t = (1-\alpha) Y_t \end{cases} \tag{1.2}$$

Production of intermediate goods. For each intermediate good ν, there is an innovator who enjoys a monopoly power in the production of this intermediate good and produces a unit of the intermediate good by using 1 unit of the final good. The firm maximizes its profits given by

$$\pi_t(\nu) = p_t(\nu)x_t(\nu) - x_t(\nu) = \alpha x_t(\nu)^\alpha A_t(\nu)^{\alpha-1} - x_t(\nu) \tag{1.3}$$

The first order condition allows us to find the equilibrium quantity of intermediate good ν of quality $A_t(\nu)$ given by $x_t(\nu) = \alpha^{\frac{2}{1-\alpha}} A_t(\nu)$. The equilibrium price of the intermediate good ν is given by : $p_t(\nu) = \alpha^{-1}$, so that the equilibrium profit of intermediate firm is written as

$$\pi_t(\nu) = (1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}} A_t(\nu) = \pi A_t(\nu) \tag{1.4}$$

where $\pi \equiv (1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}}$ so that the profit earned by the incumbent in any sector ν will be proportional to the productivity parameter in that sector.

Net output and growth rate. Substituting the equilibrium quantity $x_t(\nu)$ into the final good production function (1.1) shows that the equilibrium gross output of the general good is proportional to the average productivity parameter, defined as $A_t = \int_0^1 A_t(\nu)d\nu$, so that

$$Y_t = \alpha^{\frac{2\alpha}{1-\alpha}} A_t \tag{1.5}$$

as well as wages

$$w_t = (1-\alpha)\alpha^{\frac{2\alpha}{1-\alpha}} A_t \equiv \omega A_t \tag{1.6}$$

where $\omega \equiv (1-\alpha)\alpha^{\frac{2\alpha}{1-\alpha}}$. Finally, let Y_t^{net} represent the net output, defined as gross output minus the cost of intermediate goods, which enters in the production of the general good. Thus :

$$Y_t^{\text{net}} = Y_t - \int_0^1 x_t(\nu)d\nu = (1-\alpha)(1+\alpha)\alpha^{\frac{2\alpha}{1-\alpha}} A_t \tag{1.7}$$

Therefore, the growth rate of net output is the same for the average productivity parameter : $1+g_t \equiv \dfrac{A_t}{A_{t-1}}$. We focus on this last formula to determine the growth properties of a particular country.

Technological change. Following Aghion *et al.* (2005), in each intermediate good sector ν, a continuum of persons with an entrepreneurial idea is born in the period t capable of producing an innovation in the period $t+1$, and if successful becomes the ν^{th} incumbent at $t+1$. We denote $\mu_{t+1}(\nu)$ as the probability of entrepreneurial innovation, the level of technology of intermediate goods sector ν in the period $t+1$, $A_{t+1}(\nu)$ according to the following process :

$$A_{t+1}(\nu) = \begin{cases} \bar{A}_{t+1} & \text{with probability } \mu_{t+1}(\nu) \\ A_t(\nu) & \text{with probability } 1 - \mu_{t+1}(\nu) \end{cases}$$

where $\bar{A}_{t+1}$ denotes the world technology frontier, which grows at the constant rate $g > 0$. The expected level of productivity of sector ν thus evolves according to

$$A_{t+1}(\nu) = \mu_{t+1}(\nu)\bar{A}_{t+1} + (1 - \mu_{t+1}(\nu))A_t(\nu) \tag{1.8}$$

In equilibrium, as we show below, the probability of entrepreneurial innovation will be the same in each sector : $\mu_{t+1}(\nu) = \mu_{t+1}$. Replacing and integrating this equation on both sides, the average productivity becomes

$$A_{t+1} = \mu_{t+1}\bar{A}_{t+1} + (1 - \mu_{t+1})A_t \tag{1.9}$$

Let us denote $a_t \equiv \dfrac{A_t}{\bar{A}_t}$ as the proximity to the world technology frontier of the average productivity of a country. Its dynamics is given by the following law of motion :

$$a_{t+1} = \mu_{t+1} + \frac{1}{1+g}(1 - \mu_{t+1})a_t \tag{1.10}$$

Demand for loans. At the beginning of the second period, a household has the opportunity to become an entrepreneur (innovator) where the cost of innovation is given by [1]

$$\frac{Z_{t+1}(\nu)}{\bar{A}_{t+1}} = \psi\mu_{t+1}(\nu)^{\phi} \tag{1.11}$$

where $Z_{t+1}(\nu)$ is the total investment in terms of the final good, $\psi > 0$ is a parameter that affects the cost of innovation, and we assume that $\phi \geq 2$ in order to warrant the

1. For $\phi = 2$, the cost of innovation is : $\frac{Z_{t+1}(\nu)}{\bar{A}_{t+1}} = \frac{\psi}{2}\mu_{t+1}(\nu)^2$

existence of the equilibrium probability to innovate. The total investment is adjusted to the world technology frontier $\bar{A}_{t+1}$ to take into account that it becomes more expensive to maintain an innovation rate $\mu_{t+1}(\nu)$ as the technological frontier advances.

The households earn a wage at the end of the first period, w_t given by (1.6), which they save in the bank with a return rate $r_{D,t}$. They borrow the amount $(Z_{t+1}(\nu) - (1 + r_{D,t})w_t) = T_{t+1}(\nu)$ from the bank because the wage received is not sufficient to initiate an innovation. Therefore, in equilibrium, $\mu_{t+1}(\nu)$ will be chosen by the innovators so as to maximize the expected net profits as

$$\begin{aligned} & \max_{\{\mu_{t+1}(\nu)\}} \pi \bar{A}_{t+1}(\nu)\mu_{t+1}(\nu) - (1 + r_{t+1})\left[Z_{t+1}(\nu) - (1 + r_{D,t})w_t\right] - (1 + r_{D,t})w_t \\ = & \left[\mu_{t+1}(\nu)\pi - \psi(1 + r_{t+1})\mu_{t+1}(\nu)^{\phi}\right] \bar{A}_{t+1}(\nu) + r_{t+1}(1 + r_{D,t})w_t \end{aligned}$$

where r_{t+1} is the loan rate. So, in equilibrium, the probability of entrepreneurial innovation is the same in each sector :

$$\mu_{t+1} = \left[\frac{\pi}{\phi\psi(1 + r_{t+1})}\right]^{\frac{1}{\phi-1}} \tag{1.12}$$

Substituting equation (1.12) into equation (1.11) and using $Z_{t+1}(\nu) - (1 + r_{D,t})w_t = T_{t+1}(\nu)$ allows us to find the demand for loans for innovators, which decreases with the loan rate (r_{t+1}), and the innovation cost parameter (ψ), which increases with the world technology frontier $(\bar{A}_{t+1})$ and net profits (π). Denoting that the wage is proportional to local productivity such that $w_t = \omega A_t$, as displayed in equation (1.6), the demand for loans, identical in each sector, is given by

$$T_{t+1} = Z_{t+1} - (1 + r_{D,t})w_t = \psi\left[\frac{\pi}{\phi\psi(1 + r_{t+1})}\right]^{\frac{\phi}{\phi-1}} \bar{A}_{t+1} - (1 + r_{D,t})\omega A_t \tag{1.13}$$

1.2.2 Banking sector

We model the banking sector in the context of Cournot competition for loans, and we assume perfect competition for deposits, (as initially proposed by Monti (1972) and

Klein (1971) and reviewed in Freixas-Rochet (2008). The banking sector is composed of n identical banks indexed by $i = 1, ..., n$. Bank i pays linear transaction costs between loans and deposits $C(D_{t+1}(i), T_{t+1}(i)) = \gamma_D D_{t+1}(i) + \gamma_T T_{t+1}(i)$, where $\gamma_D, \gamma_T \in [0,1]$ are cost parameters associated with the deposits and loans activities, respectively. In the period $t+1$, the bank chooses $T_{t+1}(i)$ and $D_{t+1}(i)$ so as to maximize its profits given by

$$\Pi^B_{t+1}(i) = \left(r_{t+1}(i)\mu_{t+1} \sum_{k=1}^{n} T_{t+1}(k) - \gamma_T \right) T_{t+1}(i) - \tau B_{t+1}(i) - (r_{D,t+1} + \gamma_D) D_{t+1}(i) \tag{1.14}$$

and subject to the following constraints :

$$\begin{cases} T_{t+1}(i) = \psi \left[\frac{\pi}{\phi\psi(1+r_{t+1})} \right]^{\frac{\phi}{\phi-1}} \bar{A}_{t+1} - (1 + r_{D,t})\omega A_t \\ B_{t+1}(i) = R_{t+1}(i) + T_{t+1}(i) - D_{t+1}(i) \\ R_{t+1}(i) = \theta D_{t+1}(i) \end{cases} \tag{1.15}$$

In these constraints, $T_{t+1}(i)$ is the demand for loans of the bank i, and $B_{t+1}(i)$ is the net position of bank i on the interbank market according to the sum of the reserves $R_{t+1}(i)$ and loans, minus deposits. $R_{t+1}(i)$ is the reserves of bank i, equal to a proportion θ of deposits. The interbank rate (τ) and the coefficient of compulsory reserves (θ) may be used as policy instruments by which the Central Bank tries to influence monetary and credit policies, as noted by Freixas and Rochet (2007). Substituting the constraints, the problem becomes

$$\Pi^B_{t+1}(i) = \left(r_{t+1}(i)\mu_{t+1} \left(\sum_{k=1}^{n} T_{t+1}(k) \right) - \tau - \gamma_T \right) T_{t+1}(i) - (\tau(\theta - 1) + r_{D,t+1} + \gamma_D) D_{t+1}(i)$$

subject to

$$T_{t+1} = \psi \left[\frac{\pi}{\phi\psi(1 + r_{t+1})} \right]^{\frac{\phi}{\phi-1}} \bar{A}_{t+1} - (1 + r_{D,t})\omega A_t$$

The banks have the same linear cost function and the same demand for loans ; thus a unique equilibrium is given by $T_{t+1}(i) = \frac{T_{t+1}}{n}$, so that the first order conditions are

$$\text{(FOC)} \quad \begin{cases} r_{D,t+1} = r^*_D = \tau(1-\theta) - \gamma_D \\ r'_{t+1} T_{t+1} \mu_{t+1} H + r_{t+1}\mu_{t+1} = \tau + \gamma_T \end{cases} \tag{1.16}$$

The first condition shows that the deposits return rate is constant, and depends positively on the interbank rate (τ) but negatively on the coefficient of reserves (θ) and the deposits management costs (γ_D). The second condition allows us to find the loan rate according to the elasticity of the demand for loans :

$$\frac{r_{t+1}\mu_{t+1} - (\tau + \gamma_T)}{r_{t+1}\mu_{t+1}} = \frac{H}{\epsilon} \tag{1.17}$$

where $\frac{1}{\epsilon}$ is the inverse of the elasticity of the demand for loans, and H is the Herfindahl index. This condition shows the well-known Lerner index, which represents the market power of the bank. The inverse of the elasticity of the demand for loans is given by [2]

$$\frac{1}{\epsilon} = -\frac{T_{t+1}}{\frac{\partial T_{t+1}}{\partial r_{t+1}} r_{t+1}} = \frac{\psi(\phi-1)(1+r_{t+1})^2}{\pi r_{t+1}} - \frac{\bar{\omega}(\phi-1)(1+r_{D,t})(1+r_{t+1})^2}{\pi r_{t+1}\left[\frac{\pi}{\phi\psi(1+r_{t+1})}\right]^{\frac{1}{\phi-1}}} a_t \tag{1.18}$$

where $\bar{\omega} \equiv \frac{\omega}{1+g}$. We assume that $r_{t+1} < \{\bar{\omega}\left[\tau(1-\theta) + (1-\gamma_D)\right] a_t\}^{1-\phi} \left(\frac{1}{\psi}\right)^{2-\phi} \frac{\pi}{\phi} - 1$, [3] to ensure that the Lerner index is positive. Using equations (1.12), (1.17), and (1.18) allows us to find the implicit relation between the loan rate r_{t+1}, the proximity to the world technology frontier a_t, and the Herfindahl index H such that [4]

$$(\tau+\gamma_T)\left(\frac{\phi\psi}{\pi}\right)^{\frac{1}{\phi-1}} r_{t+1}^{\frac{2-\phi}{\phi-1}} - H\bar{\omega}(\phi-1)\left[\tau(1-\theta) + (1-\gamma_D)\right]\left(\frac{\phi\psi}{\pi^{\phi}}\right)^{\frac{1}{\phi-1}} a_t r_{t+1}^{\frac{\phi}{\phi-1}} - \left(1 - \frac{H(\phi-1)}{\phi}\right) = 0 \tag{1.19}$$

We derive, from this expression, the effect of the proximity to the world technology frontier on the loan rate r_{t+1}.

Proposition 1. *If $\phi \geq 2$, then the loan rate r_{t+1} is a decreasing function of the proximity to the world technology frontier a_t : $\frac{\partial r_{t+1}}{\partial a_t} < 0$.*

Proof See Appendix C. ∎

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2. See Appendix A.

3. See Appendix B.

4. See Appendix C.

If the cost of innovation is convex, and the Lerner index is positive, the implication for proposition 1 is that countries close to the world technology frontier have higher wages, implying that the entrepreneurs in the innovation sector are self-financing a significant amount of their project and therefore paying a smaller amount to the bank. Thus, the loan rate for innovators is reduced when the country is close to the technological frontier.

The following proposition establishes the link between loan rate and bank concentration. It shows theoretically that an increase in bank concentration increases the cost of credit for innovators.

Proposition 2. *If* $\phi \geq 2$ *and* $r_{t+1} < \{\bar{\omega}\left[\tau(1-\theta)+(1-\gamma_D)\right]a_t\}^{1-\phi}\left(\frac{1}{\psi}\right)^{2-\phi}\frac{\pi}{\phi}-1$, *then the loan rate* r_{t+1} *is an increasing function of bank concentration* H *measured by the Herfindahl index :* $\dfrac{\partial r_{t+1}}{\partial H} > 0$.

Proof See Appendix C. ■

The intuition of the proposition 2 is as follows. Under the convexity of the cost of innovation and the positivity of the Lerner index, an increase in the Herfindahl index increases the market power of banks and increases at the same time the loan rate for entrepreneurs.

Using equations (1.12), (1.17), (1.18), and the implicit relation (1.19), we derive the equilibrium probability of entrepreneurial innovation μ_{t+1} according to the loan rate r_{t+1}, the proximity to the world technology frontier a_t, and the Herfindahl index H, given by[5]

$$\mu_{t+1} = \begin{cases} \left\{\frac{\pi}{\phi\psi(\tau+\gamma_T)}\left[1-H\left(\frac{\phi-1}{\phi}-\bar{\omega}(\phi-1)\left[\tau(1-\theta)+(1-\gamma_D)\right]\left(\frac{\phi\psi}{\pi^{\phi}}\right)^{\frac{1}{\phi-1}}a_t r_{t+1}^{\frac{\phi}{\phi-1}}\right)\right]\right\}^{\frac{1}{\phi-2}} & \text{if } \phi > 2 \\ \left\{\frac{2\bar{\omega}\left[\tau(1-\theta)+(1-\gamma_D)\right]}{\psi\left[1-\frac{2}{H}\left(1-\frac{\psi(\tau+\gamma_z)}{\pi}\right)\right]}a_t\right\}^{\frac{1}{2}} & \text{if } \phi = 2 \end{cases} \tag{1.20}$$

5. See Appendix C.

The condition $\phi \geq 2$ ensures that the probability of entrepreneurial innovation is strictly positive ($\mu_{t+1} > 0$) and less than one ($\mu_{t+1} < 1$).[6] The following proposition shows that countries close to the world technology frontier have a higher probability to innovate.

Proposition 3. *If $\phi \geq 2$, the probability of entrepreneurial innovation μ_{t+1} is an increasing function of the proximity to the world technology frontier a_t :* $\dfrac{\partial \mu_{t+1}}{\partial a_t} > 0.$

Proof See Appendix C. ■

In proposition 1, we have shown that countries closer to the technology frontier have lower loan rates through higher wages. The decreased loan rates promote access to credit for innovators, increasing the probability of entrepreneurial innovation. An increase in the probability of entrepreneurial innovation has a positive and significant effect on the productivity of the economy.

The next proposition provides our first prediction; it implies that bank concentration has a negative direct effect on the probability of entrepreneurial innovation.

Proposition 4. *If $\phi \geq 2$ and $r_{t+1} < \{\bar{\omega}\left[\tau(1-\theta) + (1-\gamma_D)\right] a_t\}^{1-\phi} \left(\frac{1}{\psi}\right)^{2-\phi} \frac{\pi}{\phi} - 1$, the probability of entrepreneurial innovation is a decreasing function of the bank concentration H measured by the Herfindahl index :* $\dfrac{\partial \mu_{t+1}}{\partial H} < 0.$

Proof See Appendix C. ■

Proposition 4 is quite intuitive and comes from proposition 2. The market power of banks increases loan rates, which reduces the amounts of loans for innovation, thereby decreasing the probability of entrepreneurial innovation.

Finally, the following proposition is the most important prediction of our theoretical model. It shows that bank concentration has a negative and significant effect on

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6. See Appendix C.

the probability of entrepreneurial innovation, and that this effect is increasingly negative as the country approaches the world technology frontier. This result is validated by empirical estimates using cross-country and panel data, which we present in section 3 of the article.

Proposition 5. *If* $\phi \geq 2$ *and* $r_{t+1} < \{\bar{\omega}\left[\tau(1-\theta) + (1-\gamma_D)\right] a_t\}^{1-\phi} \left(\frac{1}{\psi}\right)^{2-\phi} \frac{\pi}{\phi} - 1$, *then the bank concentration has a negative effect on economic growth for countries close to the world technology frontier :* $\dfrac{\partial^2 \mu_{t+1}}{\partial H \partial a_t} < 0$.

Proof See Appendix C. ■

Combining propositions 3 and 4 gives us proposition 5. The intuition of proposition 5 is as follows. The market power of banks by increasing the Herfindahl index has a negative effect on the probability of entrepreneurial innovation for a country close to the frontier. To our knowledge, this theoretical result is the first in the literature to establish the negative effect of bank concentration on growth through innovation for countries close to the world technology frontier. The raison d'être of this finding is that countries close to the world technology frontier have more opportunities to innovate, which positively and increasingly affects economic growth. The increase of market power in the banking sector by the rise in bank concentration leads to the reduction of the amounts allocated to innovators, resulting in the reduction of economic growth for these countries.

1.2.3 Dynamics and bank concentration

Substituting the expression of the probability of entrepreneurial innovation into the equation (1.10) allows us to find the dynamics of the proximity to the world technology frontier :

$$a_{t+1} = \mu(a_t) + \frac{1}{1+g}(1-\mu(a_t))a_t = F(a_t) \tag{1.21}$$

where the equilibrium probability of entrepreneurial innovation is given by

$$\mu(a_t) = \begin{cases} \left\{ \frac{\pi}{\phi\psi(\tau+\gamma_T)} \left[1 - H\left(\frac{\phi-1}{\phi} - \bar{\omega}(\phi-1)\left[\tau(1-\theta)+(1-\gamma_D)\right] \left(\frac{\phi\psi}{\pi\phi}\right)^{\frac{1}{\phi-1}} a_t r_{t+1}^{\frac{\phi}{\phi-1}} \right) \right] \right\}^{\frac{1}{\phi-2}} & \text{if } \phi > 2 \\ \left\{ \frac{2\bar{\omega}[\tau(1-\theta)+(1-\gamma_D)]}{\psi\left[1-\frac{2}{H}\left(1-\frac{\psi(\tau+\gamma_z)}{\pi}\right)\right]} a_t \right\}^{\frac{1}{2}} \text{ if } \phi = 2 & \end{cases}$$

Proposition 6 shows that a given country reaches a unique and positive value of its proximity to the world technology frontier and that this equilibrium is stable. The steady state depends on the bank concentration of the country through the equilibrium probability to innovate as already suggested by propositions 4 and 5

Proposition 6. *If $\phi > 2$, then :*

1. *$F(a_t)$ is z-Lipschitzian and contracting, where $z \equiv \frac{H}{(\phi-2)(1+g)} \left[\frac{\pi}{\phi\psi(\tau+\gamma_T)}\right]^{2-\phi} < 1$.*
2. *The proximity to the world technology frontier of a given country converges in the long run to the unique steady-state value a^*, where a^* is given by*

$$a^* = \frac{(1+g)\mu^*}{\mu^*+g} < 1 \tag{1.22}$$

Proof See Appendix D. ■

Main predictions : Our theoretical model predicts two implications :

1. *Bank concentration has a negative effect on economic growth;*
2. *For countries close to the world technology frontier, bank concentration has a negative effect on economic growth.*

1.3 Bank concentration and convergence : Cross-country and panel evidence

1.3.1 Specification and data

In this section, we support our theoretical predictions with evidence. Our regression is specified as

$$\text{Growth}_{i,t} = \alpha + \delta_1 \text{CONC}_{i,t} + \delta_2 \text{CONC}_{i,t} \times \text{FRONT}_{i,t} + \sum_{k=1}^{K} \beta_k x_{k,i,t} + \xi_i + \zeta_t + \varepsilon_{i,t} \quad (1.23)$$

where i and t denote country and period ; α, ξ_i, and ζ_t denote respectively the intercept, country, and time fixed effects ; and $X_{i,t} = [x_{1,i,t}, ..., x_{K,i,t}]$ is a set of K control variables defined below. We therefore test the link between growth and bank concentration using panel data for 125 countries over the period 1980-2010 where data are averaged over five 5-year periods between 1980 and 2010.[7] $\text{Growth}_{i,t}$ is the average per worker GDP growth rate over each 5-year period using per worker GDP data from Penn World Table 7.1 (Aten *et al.*, 2012).[8] The proximity of the country i to the world technology frontier, defined as the maximum of initial per worker real GDP's at the beginning of each sub-period, subsumed as a_t in the theoretical model and denoted $\text{FRONT}_{i,t}$ in our econometric specification, is measured as the logarithm of the ratio of the initial per worker real GDP of country i over the 5-year period to the initial per worker real GDP of the United States.[9]

$\text{CONC}_{i,t}$ is the bank concentration, which is equal to the share of assets of the

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7. The first period covers the years 1980-1985 ; the second period covers the years 1986-1990 ; the third period covers the years 1991-1995 and so on. The last period covers the years 2006-2010.

8. We use RGDPWOK as a measure of real GDP. PWT 7.1 is publicly available at `https://pwt.sas.upenn.edu/`. Our results remain robust using RGDPCH, i.e. per capita GDP instead of per worker GDP. See Table 1.7 for more details. We also use the new Penn World Table 8 taken from Groningen Growth and Development Center, publicly available at `http://www.rug.nl/research/ggdc/data/penn-world-table`. For details see, Table 1.10 and 1.11.

9. We do not put the proximity to the worldwide technological frontier $\text{FRONT}_{i,t}$ in our econometric specifications because we find a strong correlation equals to 0.938 between the interaction term $\text{CONC}_{i,t} \times \text{FRONT}_{i,t}$ and the proximity to the world technology frontier $\text{FRONT}_{i,t}$, which leads to obvious multicollinearity problems. To treat this problem, we share our sample into two groups of countries, the first group is composed of countries above the median of the proximity to the world technology frontier, and the second group is composed of countries below. For details, see column (3) of Table 1.3.

three largest banks in total banking system assets. [10] Its value lies between 0 and 1, where 0 indicates a low bank concentration and 1 indicates a high bank concentration. Table 1.1 presents the summary of the statistics. The average of bank concentration is 0.737, while the minimum and maximum are 0.151 and 1, respectively. The countries with a high bank concentration over the period are Afghanistan, Angola, Albania, Burundi, Benin, Botswana, Bulgaria, Bahrain, Cape Verde, Cyprus, Egypt, Ethiopia, Estonia, Gabon, Guyana, Madagascar, and Kyrgyzstan. The countries with a low bank concentration over the period are : Guatemala, Luxembourg, Japan, Korea, Russia, Taiwan, and the United States. We use as robustness checks another measure of bank concentration (Herfindahl index), even if the sample size is much lower in Table 1.6.

Table 1.1 Descriptive statistics

Variables	Obs	Mean	Std. Dev.	Min.	Max.
Growth	547	0.019	0.031	-0.073	0.129
CONC	547	0.737	0.195	0.151	1
FRONT	547	-1.708	1.239	-4.606	0.441
M2	516	25.288	83.417	-26.669	1335.666
PRIVCRED	535	60.624	49.826	-61.054	306.973
INFL	511	26.816	134.947	-5.180	1667.207
SCHOOL	478	27.880	22.532	0.398	104.110
BUDBAL	340	-1.297	5.575	-64.939	19.755
GOVC	518	15.897	5.943	4.135	46.750
TRADE	539	84.271	51.310	16.061	412.116

Legal origin, which is a set of three dummy variables, introduced by Laporta *et al.* (1997, 1998, 2008), indicates the country i legal system (English, French, or German). [11]

10. Concentration measures, from Beck *et al.* (2010), are publicly available at `http://www.econ.brown.edu/fac/Ross_Levine/IndexLevine.htm`.

11. Legal origin dummies are from Laporta *et al.* (2008), and their dataset is publicly available at `http://mba.tuck.dartmouth.edu/pages/faculty/rafael.laporta/publications.html`. We also use

Other control variables, from the World Bank WDI,[12] are used in our estimations : school, private credit, macroeconomic policies (money growth, inflation rate, budget balance, government consumption, and trade). *School*, measured by the total enrollment in secondary education, regardless of age, is expressed as a percentage of the population of official secondary education age. *Private credit* provided by the banking sector includes all credit to various sectors on a gross basis, with the exception of credit to the central government, which is net. *Private credit* is our proxy for the financial development following Aghion *et al.* (2005) and Beck *et al.* (2000), who argue that private credit is a good measure of financial development. *Macroeconomic policies* include *money growth*, an average annual growth rate in money ; *inflation*, as measured by the consumer price index, reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly, where the Laspeyres formula is generally used[13] ; *budget balance as % of GDP* as cash surplus or deficit is revenue (including grants) minus expense, minus net acquisition of non financial assets (in the 1986 GFS manual, non-financial assets were included under revenue and expenditure in gross terms) ; *government consumption (% of GDP)* includes all current government expenditures for purchases of goods and services (including compensation of employees), and *trade*, calculated as the sum of exports (% of GDP) and imports (% of GDP).

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the legal origin as instrumental variables for the cross-country regressions.

12. The World Development Indicators are publicly available at `http://www.worldbank.org/`.

13. Our results are robust through the use of inflation, as measured by the annual growth rate of the GDP implicit deflator. For more information, see Table 1.8.

Table 1.2 Correlations Matrix

	Growth	CONC	FRONT	M2	PRIVCRED	INFL	SCHOOL	BUDBAL	GOVC	TRADE
Growth	1.000									
CONC	-0.095	1.000								
FRONT	-0.051	-0.083	1.000							
M2	0.019	0.004	-0.047	1.000						
PRIVCRED	-0.202	-0.159	0.617	-0.005	1.000					
INFL	-0.045	-0.002	-0.035	0.743	-0.032	1.000				
SCHOOL	0.104	-0.113	0.683	-0.067	0.491	-0.058	1.000			
BUDBAL	0.073	0.096	0.087	-0.002	-0.128	-0.024	0.116	1.000		
GOVC	-0.076	0.215	0.396	-0.015	0.234	-0.029	0.300	-0.169	1.000	
TRADE	0.051	0.144	0.235	-0.093	0.122	-0.108	0.106	0.072	0.196	1.000

Table 1.2 shows the correlations among the variables. The statistics demonstrate that there are some important correlations among the variables. The average per worker GDP growth rate and private credit are negatively correlated with bank concentration. This suggests that less bank concentration may be better in providing financing. There is also a negative correlation between bank concentration and the technological frontier, and we find that the average per worker GDP growth rate is negatively correlated with the frontier, which indicates the convergence effects. Bank concentration is negatively correlated with school but positively correlated with government consumption and trade.

1.3.2 Cross-country regression results

Table 1.3 presents the results of cross-country regressions. We first regress the average per worker GDP growth rate on bank concentration. Bank concentration has a negative and significant direct effect on the average per worker GDP growth rate at 5%, as per column (1). In column (2), we add the interaction variable equal to the product of bank concentration and the proximity to the world technology frontier, such that (CONC×FRONT) as suggested by our theoretical model. Bank concentration remains negative and significant at 1%, and the interaction variable is significant and negative at 10%. This result implies that bank concentration has a negative and significant effect on the average per worker GDP growth rate for countries close to the world technology frontier. In addition, we test the robustness of our results by addressing the issue of multicollinearity between the proximity to the world technology frontier (FRONT) and the interaction term (CONC×FRONT) in column (3). We divide our sample into two groups : countries above the median of proximity to the world technology frontier and those below. The first group represents countries closer to the world technology frontier, and the second represents countries farther away. Our goal is to eliminate the interaction variable in our regression ; we then regress the average per worker GDP growth rate on bank concentration for the two country groups. We find that countries above the median of proximity to the world technology frontier have a negative and significant coefficient, while countries below the median have a coefficient that is negative but insignificant.

Column (4) regresses the average per worker GDP growth rate on bank concentration, the interaction variable, and legal origin dummies. Bank concentration has a negative and significant direct effect on the average per worker GDP growth rate at 1%, and the interaction term (CONC×FRONT) is also negative and significant at 5%. Columns (5), (6), and (7), respectively, introduce the following control variables : financial development measured by private credit, school, and macroeconomic policies, which include money growth M2, inflation rate, budget balance, government consumption, and trade. Bank concentration has a negative and significant direct effect on the average per worker GDP growth rate at 1%, and the interaction term remains respectively negative and significant at 5% and 1%. These results confirm the theoretical predictions, namely that bank concentration has a negative and significant direct effect on growth, especially for countries close to the world technology frontier. Column (8) regresses the average per worker GDP growth rate on bank concentration, the interaction term, and all control variables listed above, showing that bank concentration and the interaction term remain negative and significant at 1%. To treat a possible endogeneity of bank concentration, we introduce an estimation with the instrumental variables in column (9). Following Aghion *et al.* (2005), we use English, French, and German legal origins as instrumental variables and instrumenting bank concentration, and we use legal origins interacted with the proximity to the world technology frontier (FRONT×LEGOR) to instrument the interaction term (CONC×FRONT). We also include the following control variables : financial development, school, and macroeconomic policies. We find that bank concentration remains negative and significant at 5%, and the interaction term is also negative and significant at 1%; these findings are consistent with the predictions of our theoretical model. However, Laporta *et al.* (2008) find that the legal origin is strongly correlated with so many economic variables, which are themselves strongly correlated with growth and therefore seem not to respect the exclusion restriction conditions. To remedy this deficiency, we present dynamic panel regressions based on the Arrellano-Bond GMM estimator (Arrellano and Bond, 1991) in the next section.

Table 1.3 Cross-country regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CONC	-0.017	-0.024		-0.028	-0.021	-0.025	-0.034	-0.034	-0.054
	(0.026)	(0.003)		(0.000)	(0.008)	(0.001)	(0.001)	(0.000)	(0.018)
CONC × FRONT		-0.002		-0.004	-0.005	-0.007	-0.003	-0.009	-0.011
		(0.067)		(0.012)	(0.018)	(0.001)	(0.040)	(0.001)	(0.000)
CONC1			-0.018						
			(0.042)						
CONC2			-0.178						
			(0.171)						
Observations	125	125	124	124	123	123	107	106	106
Legal Origins				yes				yes	yes
Financial Development					yes			yes	yes
School						yes		yes	yes
Macroeconomic Policies							yes	yes	yes

Notes : p−value are in parenthesis, all regressions include a constant. Depend variable is the average per worker GDP growth rate over the period 1980-2010, when available. The regression in column (1) is estimated using OLS. The regression in column (2) is also estimated using OLS and adds the interaction term between bank concentration and proximity to the worldwide technological frontier. Column (3) contains countries above and below the median of the proximity to the world technology frontier. The regressions in columns (4), (5), (6) and (7) add respectively the following controls : Legal Origins (British, French and German), Financial Development, School and Macroeconomic Policies (Inflation rate, Money growth, Trade, Government Consumption and Budget Balance). The regressions in columns (8) and (9) include all control variables, where OLS is used in column (7) and IV is used in column (9) with the instruments : (Legal origins and the variable : FRONT×LEGOR).

1.3.3 Panel results

In this section, we verify the predictions using panel data. The results are presented in Table 1.4 without control variables and in Table 1.5 with control variables. We therefore regress the average per worker GDP growth rate on bank concentration. Column (1) uses OLS, column (2) introduces the country fixed effects, and column (3) uses country and period fixed effects. Bank concentration has a negative sign but is not significant for all three methods listed above. These results are robust with the introduction of the control variables : financial development, school, and macroeconomic policies. In the second step, we introduce the interaction term between bank concentration and the proximity to the world technology frontier (CONC×FRONT). Using OLS in column (5), bank concentration has a negative and significant direct effect on the average per worker GDP growth GDP at 5%, but the interaction term remains negative and is not significant. In column (6), we use country fixed effects, and find that the variable bank concentration remains negative and significant at 1% and that the interaction term is also negative and significant at 1%. The country and period fixed effect are introduced in column (7), and bank concentration and the interaction term are negative and significant at 1%. These results confirm our theoretical predictions and empirical cross-country results. Bank concentration has a negative and significant direct effect on the average per worker GDP growth rate, and this effect is even more negative and significant when the country is close to the world technology frontier.

We introduce control variables in Table 1.5. In column (1), we regress the average per worker GDP growth rate on bank concentration and the interaction term, controlling for school. Using OLS in column (1), bank concentration has a negative and significant direct effect on the average per worker GDP growth rate at 5%, and the interaction term is negative and significant at 5%. In column (2), we introduce the country fixed effects, and see that bank concentration and the interaction term remain negative and significant at 1%. Column (3) introduces country and period fixed effects; bank concentration has a negative and significant direct effect on the average per worker GDP growth

Table 1.4 Panel regressions without control variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CONC	-0.009	-0.019	-0.017	0.008	-0.017	-0.060	-0.079	-0.083
	(0.179)	(0.135)	(0.230)	(0.694)	(0.030)	(0.001)	(0.000)	(0.001)
CONC × FRONT					-0.003	-0.020	-0.032	-0.053
					(0.101)	(0.003)	(0.000)	(0.000)
Observations	547	547	547	247	547	547	547	247
Country dummies		yes	yes			yes	yes	
Year dummies			yes				yes	

Notes : p—value are in parenthesis, all regressions include a constant. Depend variable is the average per worker GDP growth rate over the period 1980-2010, when available. The regressions in columns (1) and (5) are estimated using OLS, columns (2) and (6) include countries fixed effects, columns (3) and (7) include both countries and periods fixed effects and (4) and (8) are estimated with the Arrellano-Bond GMM estimator (Arrellano and Bond, 1991).

at 1%, and the interaction term remains negative and significant at 1%. Controlling for school, our empirical results are robust and at same time validate our theoretical predictions. The control variable financial development is introduced in columns (5), (6) and (7). We find that bank concentration is respectively negative and significant at 1% and 5%, using OLS, country fixed effects, and country and period fixed effect. The interaction term is negative and insignificant using OLS, but it is significant at 1% when we include country, and period fixed effects. In columns (9), (10), and (11), we control for macroeconomic policies, and bank concentration is negative and significant at 5%, but the interaction term is not significant using OLS. Column (10) introduces country fixed effects, and shows that bank concentration has a negative and significant direct effect on the average per worker GDP growth rate at 1%, and that the interaction term is negative and significant at 1%. The country and period fixed effects are introduced in column (11). We find that bank concentration and the interaction term are negative and significant at 1%. Therefore, our theoretical predictions are robust with the introduction of various control variables ; we show in the next section that results are also robust using other estimations methods, as well as some other measures of our interest variable, that is, bank concentration, other measures of inflation, and per capita GDP instead of per worker GDP in Tables 1.6, 1.7, and 1.8.

Table 1.5 Panel regressions with control variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
CONC	-0.018	-0.068	-0.084	-0.106	-0.016	-0.052	-0.070	-0.055	-0.022	-0.087	-0.090	-0.065
	(0.022)	(0.001)	(0.001)	(0.001)	(0.047)	(0.005)	(0.002)	(0.021)	(0.050)	(0.001)	(0.007)	(0.033)
CONC $\times$ FRONT	-0.005	-0.025	-0.037	-0.069	- 0.000	-0.013	-0.029	-0.034	-0.002	-0.037	-0.045	-0.050
	(0.019)	(0.003)	(0.000)	(0.000)	(0.897)	(0.060)	(0.000)	(0.001)	(0.331)	(0.003)	(0.002)	(0.001)
Observations	478	478	478	201	535	535	535	243	308	308	308	137
Country dummies		yes	yes			yes	yes			yes	yes	
Year dummies			yes				yes				yes	
Financial Development					yes	yes	yes	yes				
School	yes	yes	yes	yes								
Macroeconomic Policies									yes	yes	yes	yes

Notes : $p-$value are in parenthesis, all regressions include a constant. Depend variable is the average per worker GDP growth rate over the period 1980-2010, when available. The columns (1)-(4) include School with country and year dummies. The columns (5)-(8) include Financial development with country and period dummies. The columns (9)-(12) include the Macroeconomic policies variables (Inflation rate, Money growth, Trade, Government Consumption and Budget Balance) with country and year dummies. The columns (4), (8) and (12) use the Arrellano-Bond GMM estimator (Arrellano and Bond, 1991).

1.3.4 Robustness checks

To remedy the problems of the legal origin in the estimation by the IV method in the cross-country section, we use the Arrellano *et al.* (1991) GMM estimation method. The results are presented in columns (4) and (8) of Table 1.4 and in columns (4), (8), and (12) of Table 1.5. Regressing only the average per worker GDP growth rate on bank concentration, the Arrellano-Bond GMM method shows that bank concentration has a positive and insignificant effect on growth GDP rate, as shown in column (4) of Table 1.4. Column (8) introduces the interaction term; bank concentration and the interaction term are negative and significant at 1%, as shown in column (8) of Table 1.4. Controlling for school, financial development, and macroeconomic policies, we find that bank concentration exerts respectively a negative and significant direct effect on the average per worker GDP growth rate at 1% and 5%, and the interaction term remains negative and significant at 1%, as shown in columns (4), (8), and (12) of Table 1.5. In summary, bank concentration has a negative and significant direct effect on the average per worker GDP growth rate, and this effect is even more negative and significant when the country is close to the world technology frontier.

We also use another variable to measure bank concentration : the Herfindahl index as defined in the theoretical section of our model. However, the size of the sample is smaller than in the first case; we have 70 observations in the cross-country regression, and there is not enough variability within countries to use this measure in the panel regressions. The results are presented in Table 1.6. The first column (1) regresses the average per worker GDP growth rate on bank concentration with the OLS method, and bank concentration exerts a negative but insignificant effect on the average per worker GDP growth rate. In column (2), we add the interaction term between bank concentration and the proximity to the world technology frontier. The coefficient associated with bank concentration is negative and significant at 10%, while the interaction term remains negative and insignificant but becomes significant when we introduce control variables (legal origin, column (3); financial development, column (4); and school, column (5)). Bank concentration has a negative and significant direct effect at 5% on the average per worker growth GDP rate, and the interaction term has a negative and significant effect at 10% with legal origin, and financial development, and 5% with school. Column (7) regresses the average per worker GDP growth rate on bank concentration, the interaction term, and the set of all control variables. Bank concentration has a negative and significant direct effect at 1% on the average per worker GDP growth rate, and this effect is even more negative when the country is close to the world technology frontier because the interaction term is negative and significant at 5%. IV estimation is performed in column (8) and confirms the robustness of our main results, because bank concentration and the interaction term remain negative and significant at 1%.

Table 1.6 Cross-country regressions using Herfindahl Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HERF	-0.018	-0.032	-0.043	-0.031	-0.034	-0.049	-0.050	-0.107
	(0.152)	(0.066)	(0.022)	(0.049)	(0.020)	(0.014)	(0.006)	(0.005)
HERF × FRONT		-0.005	-0.008	-0.008	-0.012	-0.006	-0.016	-0.025
		(0.246)	(0.087)	(0.085)	(0.013)	(0.219)	(0.027)	(0.000)
Observations	70	70	70	70	69	63	62	62
Legal Origins			yes				yes	yes
Financial Development				yes			yes	yes
School					yes		yes	yes
Macroeconomic Policies						yes	yes	yes

Notes : $p-$value are in parenthesis, all regressions include a constant. Depend variable is the average per worker GDP growth rate over the period 1980-2010, when available. The regression in column (1) is estimated using OLS. The regression in column (2) is also estimated using OLS and adds the interaction between bank concentration and proximity to the worldwide technological frontier . The regressions in columns (3), (4), (5) and (6) add respectively the following controls : Legal Origins (British, French and German), Financial Development, School and Macroeconomic Policies (Inflation rate, Money growth, Trade, Government Consumption and Budget Balance). The regressions in columns (7) and (8) include all control variables, where OLS is used in column (7) and IV is used in column (8) with the instruments : (Legal origins and the variable : FRONT×LEGOR).

In Table 1.7, we test the robustness of our theoretical implications and empirical results using the average per capita GDP growth rate in panel data. Bank concentration exerts a negative and insignificant effect on the average per capita GDP growth rate, as shown in column (1) with OLS, column (2) uses country fixed effects, column (3) adds country, and period fixed effects, and column (4) uses Arrellano-Bond GMM estimation. The introduction of the interaction term implies that bank concentration has a negative and significant direct effect at 5% with OLS , and 1% with country fixed effects, country and period fixed effects and Arrellano-Bond GMM estimation. The interaction term remains negative and significant at 1% except for the OLS method, columns (5)-(8). Therefore, using the average per capita GDP growth rate, we confirm the results obtained using per worker GDP growth rate in Table 4 and at the same time our theoretical predictions.

Table 1.7 Panel regressions without control variables using the average per capita GDP growth rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CONC	-0.008	-0.017	-0.011	0.016	-0.020	-0.059	-0.076	-0.053
	(0.230)	(0.166)	(0.450)	(0.442)	(0.013)	(0.000)	(0.001)	(0.031)
CONC × FRONT					-0.004	-0.021	-0.027	-0.034
					(0.013)	(0.000)	(0.000)	(0.000)
Observations	548	548	548	248	548	548	548	248
Country dummies		yes	yes			yes	yes	
Year dummies			yes				yes	

Notes : p−value are in parenthesis, all regressions include a constant. Depend variable is the average per capita GDP growth rate over the period 1980-2010, when available. The regressions in columns (1) and (5) are estimated using OLS, columns (2) and (6) include countries fixed effects, columns (3) and (7) include both countries and periods fixed effects and (4) and (8) are estimated with the Arrellano-Bond GMM estimator (Arrellano and Bond, 1991).

We do this same exercise by changing the measure of inflation with the annual growth rate of the GDP implicit deflator. The cross-country results are presented in columns (1)-(3) of Table 1.8, and the panel results are given in columns (4)-(7) of Table

1.8. The regression of the average per worker GDP growth rate on bank concentration, the interaction term, and the control variables show that bank concentration has a negative and significant direct effect on the average per worker GDP growth rate and that this effect is even more negative and significant when the country is close to the world technology frontier.

Table 1.8 Cross-country and panel regressions using inflation measured by the annual growth rate of the GDP implicit deflator

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CONC	-0.032	-0.032	-0.042	-0.023	-0.098	-0.102	-0.080
	(0.002)	(0.001)	(0.073)	(0.032)	(0.000)	(0.002)	(0.012)
CONC × FRONT	-0.003	-0.008	-0.010	-0.002	-0.039	-0.047	-0.053
	(0.096)	(0.003)	(0.000)	(0.212)	(0.001)	(0.001)	(0.000)
Observations	108	107	107	321	321	321	145
Country dummies					yes	yes	
Year dummies						yes	
Legal Origins		yes	yes				
Financial Development		yes	yes				
School		yes	yes				
Macroeconomic Policies	yes	yes	yes	yes	yes	yes	yes

Notes : $p-$value are in parenthesis, all regressions include a constant. Depend variable is the average per worker GDP growth rate over the period 1980-2010, when available. The regression in column (1) is estimated using OLS and add Macroeconomic policies. The regression in column (2) is also estimated using OLS and adds respectively the following controls : Legal Origins (British, French and German), Financial Development, School and Macroeconomic Policies (Inflation rate, Monetary growth, Trade, Government Consumption and Budget Balance). The IV is used in column (3) with the instruments : (Legal origins and the variable : FRONT×LEGOR). The columns (4)-(5)-(6)-(7) include the Macroeconomic policies variables (Inflation rate, Money growth, Trade, Government Consumption and Budget Balance) with country and year dummies. The column (7) uses the Arrellano-Bond GMM estimator (Arrellano and Bond, 1991).

In our specifications , we include bank regulation variables (activity restriction, required reserves, bank development, and official supervisory power) [14] by following Beck *et al.* (2004). The results are presented in columns (2)-(5) of Table 1.9. The second column introduces entry into the banking requirements variable; the coefficients associated with bank concentration and the interaction variable is negative and significant at 5% and 10%, respectively. Column 3 controls for the interaction variable (CONC×REST), where REST is an indicator of a bank's ability to engage in business of securities underwriting, insurance underwriting and selling, and in real estate investment, management, and development. Bank concentration has a negative and significant direct effect on the average per worker GDP growth rate at 10% and the interaction variable (CONC×FRONT) is negative, and significant at 10%. The interaction variable (CONC×SUP), where SUP indicates official supervisory power, is introduced in column 4; bank concentration and the interaction variable (CONC×FRONT) are negative and significant at 5% and 10%,respectively. Column 5 regresses the average per worker GDP growth rate on bank concentration and the interaction variable (CONC×FRONT) and controlling for (CONC×BANKDEV), where BANKDEV indicates bank development and is measured as the ratio of bank credit to private firms as a share of GDP, bank concentration and the interaction term (CONC×FRONT); are respectively negative and significant at 1%, and 5%. We show that bank concentration has a negative and significant direct effect on the average per worker GDP growth rate and that this effect is even more negative when the country is close to the worldwide technological frontier after having controlled for bank restriction variables. Bank efficiency control variables are introduced in columns (6) and (7). Indeed, we use net interest margin as a fraction of total interest earning assets and overhead costs as a share of total assets. Adding overhead costs, bank concentration and the interaction term remain negative and significant at 5% and 1% respectively, as per column 6. Column 7 regresses the average per worker GDP growth rate on bank concentration and interaction term (CONC×FRONT); controlling for net interest margin, we find that bank concentration and the interac-

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14. Bank restriction and bank efficiency data, from Levine *et al.* (2007) and Levine *et al.* (2008), Survey of Bank Regulation and Supervision, publicly available at `econ.worldbank.org`

tion term exert a negative and significant effect on growth at 5%. Controlling for bank efficiency, our theoretical predictions and empirical results remain robust.

Table 1.9 Cross-country using bank control variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CONC	-0.026	-0.023	-0.023	-0.025	-0.031	-0.022	-0.023
	(0.002)	(0.035)	(0.084)	(0.027)	(0.009)	(0.015)	(0.021)
CONC × FRONT	-0.003	-0.004	-0.004	-0.005	-0.004	-0.006	-0.008
	(0.067)	(0.089)	(0.098)	(0.060)	(0.063)	(0.032)	(0.008)
Observations	125	69	68	68	66	64	64
Required reserves		yes					
Activity restrictions			yes				
Official Supervisory Power				yes			
Bank development					yes		
Overhead costs						yes	
Net interest margin							yes

Notes : $p-$value are in parenthesis, all regressions include a constant. Depend variable is the average per worker GDP growth rate over the period 1980-2010, when available. The regression in column (1) is estimated using OLS. The regression in column (2)-(3)-(4)-(5) is also estimated using OLS and adds respectively the following controls : Entry into banking requirements, (CONC×REST), (CONC×SUP) and (CONC×BANKDEV). Bank efficiency control variables are introduced in column (6) and (7). Column (6) adds overhead costs and column (7) adds net interest margin.

In Tables 1.10 and 1.11,[15] we perform our theoretical and empirical results by using the new Penn World Table (PWT 8.0) following Feenstra *et al.* (2013). They make three major changes to PWT. The first change measures relative prices of exports and imports. The second change depends on the estimation of PPPs, over time which has important implications on cross-country economic growth, and the third change

15. Our results remain robust when using the new Penn World Table 8.0 and including controls such as financial development, school, and macroeconomic policies (money growth, inflation rate, budget balance, government consumption, and trade). These additional results can be obtained from the authors upon request.

deals with the measures of capital stock and total factor productivity. These changes take into account the estimations of models that use the proximity (inverse measure of the distance) to the technological frontier. We regress the average per worker GDP growth rate on bank concentration in columns (1)-(3) using the OLS method, country dummies, and country and period fixed dummies, respectively. Bank concentration remains negative and significant. Columns (4)-(6) add the interaction term and use OLS, country dummies, and country and period fixed dummies; bank concentration exerts a negative and significant direct effect on the average per worker GDP growth rate while the interaction remains negative and significant.

Table 1.10 Panel regressions using Penn-World Table 8 and the average per worker GDP growth rate

	(1)	(2)	(3)	(4)	(5)	(6)
CONC	-0.020	-0.034	-0.034	-0.030	-0.071	-0.080
	(0.001)	(0.015)	(0.025)	(0.003)	(0.004)	(0.002)
CONC × FRONT				-0.004	-0.018	-0.026
				(0.022)	(0.033)	(0.009)
Observations	518	518	518	517	517	517
Country dummies		yes	yes		yes	yes
Year dummies			yes			yes

Notes : $p-$value are in parenthesis, all regressions include a constant. Depend variable is the average per worker GDP growth rate over the period 1980-2010, when available. The regressions in columns (1), (2), (3) show the results with the Panel data by using OLS method and adding countries fixed effects, and countries and period fixed effects, respectively. The regressions in columns (4), (5) and (6) include the interaction term of the Panel data.

We also use the average per capita GDP growth rate in Table 1.11. Bank concentration, the interaction term between bank concentration, and the proximity to the technology frontier remain negative and significant. By using the new Penn World Table 8.0, we show that bank concentration has a negative and significant direct effect on growth rate and that this effect is even more negative and significant for countries close to the world technology frontier. These findings confirm our theoretical and empirical results and validate at the same the robustness of our results.

Table 1.11 Panel regressions using Penn-World Table 8 and the average per capita GDP growth rate

	(1)	(2)	(3)	(4)	(5)	(6)
CONC	-0.016	-0.030	-0.024	-0.025	-0.068	-0.084
	(0.025)	(0.061)	(0.152)	(0.003)	(0.017)	(0.004)
CONC × FRONT				-0.003	-0.016	-0.031
				(0.040)	(0.036)	(0.003)
Observations	518	518	518	517	517	517
Country dummies		yes	yes		yes	yes
Year dummies			yes			yes

Notes : p−value are in parenthesis, all regressions include a constant. Depend variable is the average per capita GDP growth rate over the period 1980-2010, when available. The regressions in columns (1), (2), (3) show the results with the Panel data by using OLS method and adding countries fixed effects, and countries and period fixed effects, respectively. The regressions in columns (4), (5) and (6) include the interaction term of the Panel data.

1.4 Conclusion

The effects of bank concentration on economic development have previously been studied in the literature. However, these works focus on the empirical studies, and the results are ambiguous and unclear. In this article, we employed a theoretical and empirical framework to study the role played by the banking market structure in economic growth. Our theoretical model uses Schumpeterian endogenous growth following Aghion *et al.* (2005) and the Cournot imperfect banking competition.

We theoretically show that bank concentration exerts a direct negative effect on economic growth. For countries close to the world technology frontier, bank concentration has a negative effect on economic growth. To verify and validate our theoretical predictions, we use econometric specification regressing the average per worker GDP growth rate on bank concentration and the interaction term between bank concentration and the proximity to the world technology frontier using cross-country and panel data over the period 1980-2010 for 125 countries. Our empirical results show that bank concentration has a negative and significant direct effect on the average per worker GDP growth rate, which is even more negative and significant when the country is close to the worldwide technological frontier. These results are robust to the use of different measures of bank concentration, to the introduction of the following control variables : school, financial development, legal origins (British, French, and German), macroeconomic policies (money growth, inflation, budget balance, government consumption, and trade), bank regulation (activity restriction, required reserves, bank development and official supervisory power) and bank efficiency (net interest margin, and overhead costs), as well as, to the use of multiple estimation methods : OLS, IV, and Arrellano-Bond GMM estimation.

Appendix A : Demand for loans

Case of $\phi > 2$. The demand for loans is given by :

$$T_{t+1} = Z_{t+1} - (1 + r_{D,t})w_t = \psi \left(\frac{\pi}{\phi\psi r_{t+1}} \right)^{\frac{\phi}{\phi-1}} \bar{A}_{t+1} - (1 + r_{D,t})\omega A_t \tag{1.24}$$

Where T_{t+1} is the amount borrowed from the bank, Z_{t+1} is the total investment in terms of the final good, w_t is wages and $r_{D,t}$ the return rate. We first derive this demand for loans with respect to loan rate r_{t+1} :

$$\frac{\partial T_{t+1}}{\partial r_{t+1}} = -\frac{\pi}{(\phi - 1)r_{t+1}^2} \left(\frac{\pi}{\phi\psi r_{t+1}} \right)^{\frac{1}{\phi-1}} \bar{A}_{t+1} \tag{1.25}$$

then, multiplying by r_{t+1}, we obtain :

$$\frac{\partial T_{t+1}}{\partial r_{t+1}} r_{t+1} = -\frac{\pi}{(\phi - 1)r_{t+1}} \left(\frac{\pi}{\phi\psi r_{t+1}} \right)^{\frac{1}{\phi-1}} \bar{A}_{t+1} \tag{1.26}$$

and finally, we derive the inverse of the elasticity of the demand for loans as :

$$\frac{1}{\epsilon} = -\frac{T_{t+1}}{\frac{\partial T_{t+1}}{\partial r_{t+1}} r_{t+1}} = \frac{\phi - 1}{\phi} - \frac{\bar{\omega}(\phi - 1)(1 + r_{D,t})r_{t+1}}{\pi \left(\frac{\pi}{\phi\psi r_{t+1}} \right)^{\frac{1}{\phi-1}}} a_t \tag{1.27}$$

where $\bar{\omega} = \frac{\omega}{1+g}$. The inverse of the elasticity of the demand depends on ϕ, the parameter that captures the curvature of the cost of innovation; a share of wages and profits, $\bar{\omega}$ and π ; $r_{D,t}$, deposit rate; r_{t+1}, loan rate; and a_t, the proximity to the world technology frontier.

Case of $\phi = 2$. We derive the demand for loans with respect to loan r_{t+1} :

$$\frac{\partial T_{t+1}}{\partial r_{t+1}} = -\frac{\pi^2}{\psi r_{t+1}^3} \bar{A}_{t+1}$$

then, multiplying by r_{t+1}, we obtain :

$$\frac{\partial T_{t+1}}{\partial r_{t+1}} r_{t+1} = -\frac{\pi^2}{\psi r_{t+1}^2} \bar{A}_{t+1}$$

and finally, we derive the inverse of the elasticity of the demand for loans as :

$$\frac{1}{\epsilon} = -\frac{T_{t+1}}{\frac{\partial T_{t+1}}{\partial r_{t+1}} r_{t+1}} = \left(\frac{1}{2} - \frac{\left(\left[\tau(1-\theta) + (1-\gamma_D) \right] \omega\psi \right.}{\pi^2(1+g)} r_{t+1}^2 a_t \right) \tag{1.28}$$

Appendix B : Lerner Index

Case of $\phi > 2$. Recall that, first order conditions of a given bank is written as :

$$\text{(FOC)} \quad \begin{cases} H r'_{t+1} T_{t+1} \mu_{t+1} + r_{t+1} \mu_{t+1} = \tau + \gamma_T \\ r_{D,t+1} = r_D^* = \tau(1-\theta) - \gamma_D \end{cases} \tag{1.29}$$

The first line allows us to find the loan rate according to the elasticity of the demand for loans :

$$r_{t+1}\mu_{t+1} - (\tau + \gamma_T) = -H r'_{t+1} T_{t+1} \mu_{t+1}$$

so that dividing by $r_{t+1}\mu_{t+1}$, we obtain the Lerner index expression :

$$\frac{r_{t+1}\mu_{t+1} - (\tau + \gamma_T)}{r_{t+1}\mu_{t+1}} = \frac{H}{\epsilon} \tag{1.30}$$

where the inverse of the elasticity of the demand for loans is determined by :

$$\frac{1}{\epsilon} = \frac{\phi - 1}{\phi} - \frac{\bar{\omega}(\phi-1)(1+r_{D,t})r_{t+1}}{\pi \left(\frac{\pi}{\phi\psi r_{t+1}} \right)^{\frac{1}{\phi-1}}} a_t = \frac{\phi-1}{\phi} - \Gamma a_t r_{t+1}^{\frac{\phi}{\phi-1}} \tag{1.31}$$

with $\Gamma \equiv \frac{\bar{\omega}(\phi-1)(\tau(1-\theta)+(1-\gamma_D))}{\pi \left(\frac{\pi}{\phi\psi} \right)^{\frac{1}{\phi-1}}}$. Therefore, the Lerner index is positive if $\frac{\phi-1}{\phi} - \Gamma a_t r_{t+1}^{\frac{\phi}{\phi-1}} > 0$, i.e. $r_{t+1} < \left(\frac{\phi-1}{\phi \Gamma a_t} \right)^{\frac{\phi-1}{\phi}}$.

Case of $\phi = 2$. The Lerner index is given by :

$$1 - \frac{\psi(\tau + \gamma_T)}{\pi} = \frac{H}{\epsilon} \tag{1.32}$$

where the inverse of the elasticity of the demand for loans is determined by :

$$\frac{1}{\epsilon} = \frac{1}{2} - \frac{\left[\tau(1-\theta) + (1-\gamma_D) \right] \bar{\omega}\psi}{\pi^2} r_{t+1}^2 a_t \tag{1.33}$$

Appendix C : Proof of Propositions 1 to 4

Case of $\phi > 2$. In order to prove Propositions 1 to 4, we have to establish the implicit relation between the loan rate r_{t+1}, the proximity to the worldwide technological frontier a_t, Herfindahl index H and the probability to innovate μ_{t+1}. First, we rewrite the expression of $r_{t+1}\mu_{t+1}$ using equation (1.12) such that :

$$r_{t+1}\mu_{t+1} = \Omega r_{t+1}^{\frac{2-\phi}{1-\phi}} \tag{1.34}$$

where $\Omega \equiv \left(\frac{\pi}{\phi\psi}\right)^{\frac{1}{\phi-1}}$. Then, substituting equation (1.31) and equation (1.34) into the equation (1.30), we get :

$$1 - \frac{(\tau + \gamma_T)}{\Omega} r_{t+1}^{\frac{2-\phi}{\phi-1}} = H\left(\frac{\phi - 1}{\phi} - \Gamma a_t r_{t+1}^{\frac{\phi}{\phi-1}}\right) \tag{1.35}$$

Finally, rewriting equation (1.35) allows us to find the implicit relation between the loan rate r_{t+1} and the proximity to the worldwide technological frontier a_t :

$$G(r_{t+1}, a_t) = \chi r_{t+1}^{\frac{2-\phi}{\phi-1}} - H\Gamma a_t r_{t+1}^{\frac{\phi}{\phi-1}} - \rho = 0 \tag{1.36}$$

where $\rho \equiv 1 - \frac{H(\phi-1)}{\phi}$ and $\chi \equiv \frac{(\tau+\gamma_T)}{\Omega}$.

Case of $\phi = 2$. We rewrite the Lerner index substituting equation (1.33) into the equation (1.32).

$$1 - \frac{\psi(\tau + \gamma_T)}{\pi} = H\left(\frac{1}{2} - \frac{[\tau(1-\theta) + (1-\gamma_D)]\,\bar{\omega}\psi}{\pi^2} r_{t+1}^2 a_t\right)$$

and finally the equilibrium loan rate is obtained as :

$$r_{t+1} = \pi\sqrt{\frac{\left\{1 - \frac{2}{H}\left[1 - \frac{\psi(\tau+\gamma_z)}{\pi}\right]\right\}}{2\bar{\omega}\psi\left[\tau(1-\theta) + (1-\gamma_D)\right]a_t}} \tag{1.37}$$

Proof of Proposition 1. If the cost of innovation is convex, and the Lerner index is positive, the implication for proposition 1 is that countries close to the world technology frontier have higher wages, implying that the entrepreneurs in the innovation sector are self-financing a significant amount of their project and therefore paying a smaller amount to the bank.

Case of $\phi > 2$. The implicit function theorem implies directly that :

$$\frac{\partial r_{t+1}}{\partial a_t} = -\frac{\dfrac{\partial G(r_{t+1}, a_t)}{\partial a_t}}{\dfrac{\partial G(r_{t+1}, a_t)}{\partial r_{t+1}}} < 0 \tag{1.38}$$

since $\dfrac{\partial G(r_{t+1}, a_t)}{\partial a_t} = -H\Gamma r_{t+1}^{\frac{\phi}{\phi-1}} < 0$ and $\dfrac{\partial G(r_{t+1}, a_t)}{\partial r_{t+1}} = \left(\frac{2-\phi}{\phi-1}\chi r_{t+1}^{\frac{3-2\phi}{\phi-1}} - \frac{H\phi}{\phi-1}\Gamma a_t r_{t+1}^{\frac{1}{\phi-1}}\right) < 0$ if $\phi > 2$.

Case of $\phi = 2$. To prove Proposition 1 for $\phi = 2$, we differentiate the equilibrium loan rate given by equation (1.37) with respect to the proximity to the worldwide technological frontier a_t :

$$\frac{\partial r_{t+1}}{\partial a_t} = -\frac{\pi\left\{1 - \frac{2}{H}\left[1 - \frac{\psi(\tau+\gamma_z)}{\pi}\right]\right\}}{4\bar{\omega}\psi\left[\tau(1-\theta) + (1-\gamma_D)\right] a_t^2 \sqrt{\frac{\left\{1-\frac{2}{H}\left[1-\frac{\psi(\tau+\gamma_z)}{\pi}\right]\right\}}{2\bar{\omega}\psi[\tau(1-\theta)+(1-\gamma_D)]a_t}}} < 0 \tag{1.39}$$

■

Proof of Proposition 2. Under the convexity of the cost of innovation and the positivity of the Lerner index, an increase in the Herfindahl index increases the market power of banks and increases at the same time the loan rate for entrepreneurs.

Case of $\phi > 2$. The implicit function theorem implies directly that :

$$\frac{\partial r_{t+1}}{\partial H} = -\frac{\dfrac{\partial G(r_{t+1}, a_t)}{\partial H}}{\dfrac{\partial G(r_{t+1}, a_t)}{\partial r_{t+1}}} > 0 \tag{1.40}$$

since $\dfrac{\partial G(r_{t+1}, a_t)}{\partial H} = \left(\frac{\phi-1}{\phi} - \Gamma a_t r_{t+1}^{\frac{\phi}{\phi-1}}\right) > 0$ (by positivity of the Lerner index) and $\dfrac{\partial G(r_{t+1}, a_t)}{\partial r_{t+1}} = \left(\frac{2-\phi}{\phi-1}\chi r_{t+1}^{\frac{3-2\phi}{\phi-1}} - \frac{H\phi}{\phi-1}\Gamma a_t r_{t+1}^{\frac{1}{\phi-1}}\right) < 0$ if $\phi > 2$.

Case of $\phi = 2$. To prove the Proposition 1 for $\phi = 2$, we differentiate the equilibrium loan rate given by equation (1.37) with respect to the Herfindahl index H :

$$\frac{\partial r_{t+1}}{\partial H} = \frac{\pi\left[1 - \frac{\psi(\tau+\gamma_z)}{\pi}\right]}{\bar{\omega}\psi\left[\tau(1-\tau) + (1-\gamma_D)\right] a_t H^2 \sqrt{\frac{\left\{1-\frac{2}{H}\left[1-\frac{\psi(\tau+\gamma_z)}{\pi}\right]\right\}}{2\bar{\omega}\psi[\tau(1-\theta)+(1-\gamma_D)]a_t}}} > 0 \tag{1.41}$$

■

Proof of Proposition 3.

Case of $\phi > 2$. We first derive the expression of the equilibrium probability to innovate and establish its properties and give a proof of proposition 2. Substituting equation (1.31) into equation (1.30) we get the following expression for the loan rate :

$$r_{t+1} = \frac{(\tau + \gamma_T)}{\left[1 - H\left(\frac{\phi-1}{\phi} - \Gamma a_t r_{t+1}^{\frac{\phi}{\phi-1}}\right)\right]\mu_{t+1}} \tag{1.42}$$

which we substitute into equation (1.12) to obtain the equilibrium probability to innovate :

$$\mu_{t+1} = \left(\kappa\left[1 - H\left(\frac{\phi-1}{\phi} - \Gamma a_t r_{t+1}^{\frac{\phi}{\phi-1}}\right)\right]\right)^{\frac{1}{\phi-2}} \tag{1.43}$$

where $\kappa \equiv \frac{\pi}{\phi\psi(\tau+\gamma_T)}$.

The probability of entrepreneurial innovation is positive and less than one if $\phi > 2$, since $\frac{\phi-1}{\phi} > \Gamma a_t r_{t+1}^{\frac{\phi}{\phi-1}}$ (by positivity of the Lerner index) and since $\Gamma a_t r_{t+1}^{\frac{\phi}{\phi-1}} > \frac{\phi-1}{\phi} - \frac{1}{H}$.

In proposition 1, we have shown that countries closer to the technology frontier have lower loan rates through higher wages. The decreased loan rates promote access to credit for innovators, increasing the probability of entrepreneurial innovation. An increase in the probability of entrepreneurial innovation has a positive and significant effect on the productivity of the economy. In order to prove the Proposition 3, we differentiate equation (1.43) to obtain :

$$\frac{\partial \mu_{t+1}}{\partial a_t} = \frac{1}{\phi-2}\left(\kappa\left[1 - H\left(\frac{\phi-1}{\phi} - \Gamma a_t r_{t+1}^{\frac{\phi}{\phi-1}}\right)\right]\right)^{\frac{3-\phi}{\phi-2}}\left[H\kappa\Gamma\left(r_{t+1}^{\frac{\phi}{\phi-1}} + a_t\frac{\phi}{\phi-1}\frac{\partial r_{t+1}}{\partial a_t} r_{t+1}^{\frac{1}{\phi-1}}\right)\right] \tag{1.44}$$

Since we assume that $\phi > 2$ and $\mu_{t+1} > 0$, $\dfrac{\partial \mu_{t+1}}{\partial a_t} > 0$ if $\left(r_{t+1}^{\frac{\phi}{\phi-1}} + a_t \frac{\phi}{\phi-1} \dfrac{\partial r_{t+1}}{\partial a_t} r_{t+1}^{\frac{1}{\phi-1}} \right) > 0$.

Substituting the expression of $\dfrac{\partial r_{t+1}}{\partial a_t}$ given by (1.38), we get :

$$\left(r_{t+1}^{\frac{\phi}{\phi-1}} - a_t \frac{\phi}{\phi-1} \frac{H\Gamma r_{t+1}^{\frac{\phi}{\phi-1}}}{\left(\frac{\phi-2}{\phi-1} \chi r_{t+1}^{\frac{3-2\phi}{\phi-1}} + H \frac{\phi}{\phi-1} \Gamma a_t r_{t+1}^{\frac{1}{\phi-1}} \right)} r_{t+1}^{\frac{1}{\phi-1}} \right) = \frac{\phi-2}{\phi-1} \chi r_{t+1}^{\frac{3-\phi}{\phi-1}} > 0$$

Case of $\phi = 2$. We first derive the expression of the equilibrium probability to the entrepreneurial innovation. We substitute equation (1.37) into equation (1.12) to obtain the probability to innovate :

$$\mu_{t+1} = \sqrt{\frac{2\bar{\omega} \left[\tau(1-\theta) + (1-\gamma_D) \right]}{\psi \left\{ 1 - \frac{2}{H} \left(1 - \frac{\psi(\tau+\gamma_z)}{\pi} \right) \right\}} a_t} \tag{1.45}$$

To prove the Proposition 2 for $\phi = 2$ we differentiate equation (1.45) such that :

$$\frac{\partial \mu_{t+1}}{\partial a_t} = \frac{\bar{\omega} \left[\tau(1-\theta) + (1-\gamma_D) \right]}{\psi \left[1 - \frac{2}{H} \left(1 - \frac{\psi(\tau+\gamma_z)}{\pi} \right) \right] \left\{ \frac{2\bar{\omega}[\tau(1-\theta)+(1-\gamma_D)]}{\psi \left[1 - \frac{2}{H} \left(1 - \frac{\psi(\tau+\gamma_z)}{\pi} \right) \right]} a_t \right\}^{\frac{1}{2}}} > 0 \tag{1.46}$$

■

Proof of Proposition 4. It shows that the market power of banks increases loan rates, which reduces the amounts of loans for innovation, thereby decreasing the probability of entrepreneurial innovation.

Case of $\phi > 2$. To prove Proposition 3, we use the equilibrium probability of innovation, given by equation (1.43). Differentiating this equation with respect Herfindahl index H, we get :

$$\frac{\partial \mu_{t+1}}{\partial H} = -\frac{1}{\phi - 2} \left(\kappa \left[1 - H \left(\frac{\phi-1}{\phi} - \Gamma a_t r_{t+1}^{\frac{\phi}{\phi-1}} \right) \right] \right)^{\frac{3-\phi}{\phi-2}} \left[\kappa \left(\frac{\phi-1}{\phi} - \Gamma a_t r_{t+1}^{\frac{\phi}{\phi-1}} \right) \right] \tag{1.47}$$

Since we assume that $\phi > 2$ and $\mu_{t+1} > 0$, $\dfrac{\partial \mu_{t+1}}{\partial H} < 0$ if $\left(\frac{\phi-1}{\phi} - \Gamma a_t r_{t+1}^{\frac{\phi}{\phi-1}} \right) > 0$. This condition implies that : $r_{t+1} < \left(\frac{\phi-1}{\phi \Gamma a_t} \right)^{\frac{\phi-1}{\phi}}$ (positivity of the Lerner index).

Case of $\phi = 2$. To prove Proposition 3 for $\phi = 2$, we use the equilibrium probability to innovate given by (1.45). Differentiating this equation with respect to Herfindahl index H, we get :

$$\frac{\partial \mu_{t+1}}{\partial H} = -\frac{2\psi\bar{\omega}\left[\tau(1-\theta)+(1-\gamma_D)\right]\left(1-\frac{\psi(\tau+\gamma_T)}{\pi}\right)a_t}{H^2\sqrt{\frac{2\bar{\omega}[\tau(1-\theta)+(1-\gamma_D)]}{\psi\left\{1-\frac{2}{H}\left(1-\frac{\psi(\tau+\gamma_z)}{\pi}\right)\right\}}a_t}} < 0 \tag{1.48}$$

■

Proof of Proposition 5. The intuition of proposition 5 is as follows. The market power of banks by increasing the Herfindahl index has a negative effect on the probability of entrepreneurial innovation for a country close to the frontier. Since we assume that $\phi \geq 2$ and $\left(\frac{\phi-1}{\phi} - \Gamma a_t r_{t+1}^{\frac{\phi}{\phi-1}}\right) > 0$ (by positively of the Lerner index). Proposition 3 and Proposition 4 allows us to find Proposition 5 given by :

$$\frac{\partial^2 \mu_{t+1}}{\partial H \partial a_t} < 0$$

■

Appendix D : Dynamics studies

The technology gap is given by :

$$a_{t+1} = \mu(a_t) + \frac{1}{1+g}(1-\mu(a_t))a_t = F(a_t) \tag{1.49}$$

where

$$\mu(a_t) = \begin{cases} \left\{\kappa\left[1 - H\left(\frac{\phi-1}{\phi} - \Gamma a_t r_{t+1}^{\frac{\phi}{\phi-1}}\right)\right]\right\}^{\frac{1}{\phi-2}} & \text{if} \quad \phi > 2 \\ \left\{\frac{2\bar{\omega}[\tau(1-\theta)+(1-\gamma_D)]}{\psi\left[1-\frac{2}{H}\left(1-\frac{\psi(\tau+\gamma_z)}{\pi}\right)\right]}a_t\right\}^{\frac{1}{2}} & \text{if} \quad \phi = 2 \end{cases} \tag{1.50}$$

First of all, we evaluate the function F at the origin (i.e. $a_t = 0$) and at the worldwide technological frontier (i.e. $a_t = 1$). For $\phi = 2$, $F(0) = 0$, but $F(0) > 0$ if $\phi > 2$:

$$F(0) = \begin{cases} \mu(0) = \left[\frac{\pi}{\phi\psi(\tau+\gamma_T)}\left(1 - \frac{H(\phi-1)}{\phi}\right)\right]^{\frac{1}{\phi-2}} > 0 \quad \text{if } \phi > 2 \\ \mu(0) = 0 \quad \text{if } \phi = 2 \end{cases} \tag{1.51}$$

At the worldwide technological frontier, we have (recall that μ is a probability and therefore is between 0 and 1 as shown in the main text) :

$$F(1) = \mu(1) + \frac{1}{1+g}(1-\mu(1)) = \frac{g\mu(1)+1}{1+g} < 1 \tag{1.52}$$

where

$$\mu(1) = \begin{cases} \left\{ \frac{\pi}{\phi\psi(\tau+\gamma_T)} \left[1 - H\left(\frac{\phi-1}{\phi} - \bar{\omega}(\phi-1)\left[\tau(1-\theta)+(1-\gamma_D)\right] \left(\frac{\phi\psi}{\pi\phi}\right)^{\frac{1}{\phi-1}} r(1)^{\frac{\phi}{\phi-1}} \right) \right] \right\}^{\frac{1}{\phi-2}} & \text{if } \phi > 2 \\ \left\{ \frac{2\bar{\omega}[\tau(1-\theta)+(1-\gamma_D)]}{\psi\left[1-\frac{2}{H}\left(1-\frac{\psi(\tau+\gamma_z)}{\pi}\right)\right]} \right\}^{\frac{1}{2}} & \text{if } \phi = 2 \end{cases}$$

From Proposition 3, we already know that $F(a_t)$ is an increasing function of the proximity to the worldwide technological frontier a_t and $F(a_t)$ is concave because the probability of entrepreneurial innovation is concave as well. Finally, to assure convergence to a positive value of the steady state of the proximity to the worldwide technological frontier for the case $\phi = 2$, we show that the slope at the origin is greater than 1. Indeed, the value of the derivative of the function F at the origin is given by :

$$F'(0) = \mu'(0) + \frac{1}{1+g}(1-\mu(0)) \tag{1.53}$$

where equation (1.46), for the case $\phi = 2$, shows that the derivative of the equilibrium probability to innovate at the origin tends to infinity warranting that $F'(0) > 1$.

Proof of Proposition 6. At steady state $a^* = F(a^*)$, where $a^* \in [0,1]$. If $\phi > 2$, using the fixed point theorem, we show that :

1. $F(a)$ is z-Lipschitzian, therefore contracting, and
2. $F(a)$ converges to the unique steady state value a^*

$F(a)$ is contracting if : $\|F(1)-F(0)\| \leq z\|1-0\| = z$. Replacing the expressions of $F(1)$ and $F(0)$, we get :

$$\begin{aligned}
\|F(1)-F(0)\| &= \left\|\mu(1) + \frac{1}{1+g}(1-\mu(1)) - \mu(0)\right\| \\
&= \left\|\frac{g\mu(1)}{1+g} + \frac{1}{1+g} - \mu(0)\right\| \\
&= \frac{1}{1+g}\left\|g\mu(1) - (1+g)\mu(0) + 1\right\| \\
&= \frac{1}{1+g}\left\|g\left\{\kappa\left[1 - H\left(\frac{\phi-1}{\phi} - \Gamma r(1)^{\frac{\phi}{\phi-1}}\right)\right]\right\}^{\frac{1}{\phi-2}} - (1+g)\left[\kappa\left(1\frac{H(\phi-1)}{\phi}\right)\right]^{\frac{1}{\phi-2}} + 1\right\| \\
&\leq \frac{\kappa^{\frac{1}{\phi-2}}}{1+g}\left\|g\left\{\left[1 - \frac{H}{\phi-2}\left(\frac{\phi-1}{\phi} - \Gamma r(1)^{\frac{\phi}{\phi-1}}\right)\right]\right\} - (1+g)\left[\left(1 - \frac{H}{\phi-2}\frac{\phi-1}{\phi}\right)\right] + 1\right\| \\
&= \frac{H}{(\phi-2)(1+g)}\kappa^{\frac{1}{\phi-2}}\left\|g\Gamma r(1)^{\frac{\phi}{\phi-1}} - \frac{\phi-1}{\phi}\right\| \\
&\leq \frac{H}{(\phi-2)(1+g)}\kappa^{\frac{1}{\phi-2}}
\end{aligned} \tag{1.54}$$

where $\kappa \equiv \frac{\pi}{\phi\psi(\tau+\gamma z)}$. Therefore, because the Lerner index is positive, $F(a)$ is z-Lipschitzian, with $z \equiv \frac{H}{(\phi-2)(1+g)}\kappa^{\frac{1}{\phi-2}}$, and F is contracting and the steady state value a^* is unique.

■

CHAPTER II

BANKING REFORMS, DISTANCE TO FRONTIER AND GROWTH : THEORY AND EVIDENCE

Abstract

We theoretically and empirically analyze the effects of banking reforms on growth according to the level of technological development of a country. Using a Schumpeterian growth paradigm and monopolistic competition between differentiated products of the banking system, we show that there is a threshold of technological development from which banking reforms exert a positive effect on economic growth. To validate our theoretical predictions we use cross-country and panel estimates over the period 1980-2010 for 78 countries. We find that banking reforms enhance the average per-worker GDP growth for countries close to the world technology frontier.

KEYWORDS : Schumpeterian Growth, banking reforms, technological frontier, appropriate institutions.

JEL : O3, O16, G21, C21, C23.

2.1 Introduction

The effects of banking reforms on financial stability and economic growth have lately been the subject of numerous scientific studies. Since the mid-1980s, international organizations, namely the World Bank and the International Monetary Fund, have been encouraging emergent and developing countries to reform their banking systems to increase economic growth and reduce inequality. Empirically, the results obtained in studies measuring the connections between financial liberalization and economic growth have been disputed for many years among researchers (Henry (2007), Kose *et al.* (2009), among others). Townsend and Ueda (2010) analyze the welfare gains from financial liberalization using a tractable growth model with a financial sector and empirical simulations. They show that the gain in economic growth turns out to be small and not robust but there is a sizable welfare gains from financial liberalization. Levchenko *et al.* (2009) analyze the effects of financial liberalization on growth and volatility at the industry level in a large sample of countries. They find that financial liberalization have a positive and significant effect on both growth and volatility of production across industries. Bandiera *et al.* (2000) utilize empirical estimates for eight developing countries and find that financial liberalization does not increase private saving. Quinn and Toyoda (2008) empirically assess the effect of capital account liberalization on growth and find that the latter has a positive effect on growth for both developed and emerging countries. Rancière *et al.* (2008) empirically show that financial liberalization enhances economic growth in middle-income countries, but does not have the same effect in low-income economies. Ang (2011) shows that financial development has a beneficial effect on innovation, while the effect of financial liberalization is found to be negative in developing countries.

In this paper we study for the first time the effects of banking reforms on economic growth. To do this, we measure the impact of banking reforms on growth according to the level of economic development for a given country. This article is based on previous studies on the so-called "appropriate institutions". In *Economic Backwardness in His-*

torical Perspective (1962), Gerschenkron shows that relatively backward economies can quickly catch up with the developed countries by introducing "appropriate institutions" that enhance growth in the first stage of development, though these institutions may cease to improve growth in subsequent development. In other words, countries that have adopted the "appropriate institutions" may have high growth rates for a period, then slow down because such institutions later inhibit growth. More recently, Acemoglu *et al.* (2006) in their article entitled "Distance to frontier, selection and economic growth", using a Schumpeterian endogenous growth paradigm have linked the concepts of appropriate institution and distance to the frontier. To validate their theoretical results, they use estimates in cross-section and panel data over the period 1965-1995 for 42 countries. They split these countries into two groups according to the number of procedures required to start a new business as developed by Djankov *et al.* (2002). The first group consists of countries with low barriers to entry and the second countries with high barriers. The results suggest that economic growth does not suffer from high barriers to entry for countries far from the technology frontier, though growth does suffer as the country approaches the technology frontier.

In the same vein, we use an endogenous growth model, namely the Schumpeterian growth paradigm inspired by Aghion *et al.* (2005) where the engine of growth is considered to be innovation. Another merit of this model is that it takes into account the effects of convergence and divergence between countries, as opposed to neoclassical growth models and first-generation endogenous growth models, such that Ak or varieties of intermediate goods of Romer (1990). Final output technology combines labor and intermediate inputs and these intermediate inputs, are produced by innovators (entrepreneurs) who enjoy monopoly power since they employ technology that is closest to the frontier. Endogenous growth and convergence to the frontier are driven by innovation in the intermediate sector, which is performed by entrepreneurs needing external finance. Innovators (entrepreneurs) thus face costs (so they borrow), which are linear in terms of success probability and proportional to the technological frontier level. If successful, they also enjoy profits which are proportional to the frontier technology. Innovators do not take the interest rate as given, but interact strategically with banks. Hence, expected profitability from R&D depends on the amount invested in three ways : negatively because it is a cost, positively because it increases the probability of entrepreneurial innovation, and also because it reduces the interest rate on loans.

To measure the effects of banking reforms on growth in our model, we use monopolistic competition between differentiated products in the banking system, following Salop (1979) and Freixas and Rochet (2008). Commercial banks are located on a circle and compete for deposits from households (who are also entrepreneurs) uniformly distributed around a circle and who have a preference for closer banks. Banks use the deposits to lend to entrepreneurs and compete in the rate of return paid on deposits (deposit rate) and the interest rate charged on lending to entrepreneurs (loan rate). We use symmetric equilibrium in the banking sector, according to which banks pay the same deposit rate and loan rate. Banks also attract the same number of depositors and lend to the same number of entrepreneurs who are located closest to them. Banks have to pay a proportional transaction cost on lending, a proportional service cost on deposits, and an interbank interest rate on inter-bank borrowing. The number of banks are endogenously determined in equilibrium using a zero-profit condition. Monopolistic competition in the banking sector allows us to introduce the effects of banking reforms on innovation, and at the same time on growth. Moreover, when each borrower (entrepreneur) borrows money from a bank, he or she incurs a transportation cost λ proportional to the distance between the borrower's location and that of the bank. We use the fixed costs F as a proxy for the measure of banking reforms. The fixed costs F can be interpreted as a barrier to entry ; specifically, it may take the form of outright restrictions on the participation of foreign banks, restrictions on the scope of a bank's activities, restrictions on the geographic area where banks can operate, or excessively restrictive licensing requirements following Abiad *et al.* (2010). Reducing the value of F facilitates access to credit for innovators and at the same time increases the innovation rate ; we provide more details on this later on in the paper.

To best of our knowledge, this article is the first in the literature to theoretically and empirically examine the relationship between banking reforms, distance to the technology frontier and economic growth. By using the free entry in the banking sector we theoretically determine the number of banks and show that it depends positively on the strength of banking reforms F. The strength of banking reforms is measured by the transportation costs of entrepreneurs ; as we show above, these costs are proportional to the distance between a bank and a marginal entrepreneur. The equilibrium number of banks through free entry allows us to determine the equilibrium probability of entrepreneurial innovation. We then show that the probability of entrepreneurial innovation is an increasing function of the level of banking reforms for countries close to the world technology frontier. The assumption is that countries where the distance is small, or where banking reforms through free entry tend to reduce the distance, have a large number of banks. Banking reforms tend to favor the emergence of new banks in the economy and facilitate access to credit for entrepreneurs. This process increases innovation rates, which positively affects the overall productivity of the economy. This result is very important for our paper, as it shows that barriers to entry (low banking reforms) have limited costs when countries are far from the world technology frontier, but become much more costly closer to the technology frontier. More precisely, it suggests that there exists a level of technological development (distance to the technology frontier) such that, if an economy does not switch out of low banking reforms before this threshold, low banking reforms are detrimental to economic growth.

The interpretation of our findings is as follows. As the global technology frontier advances, the size of investment required in order to keep innovating is very high ; therefore, important banking reforms through free entry enable innovators to have more funds to innovate by reducing loan rates. More importantly, R&D and innovation become more important when an economy approaches the world technology frontier. However, for countries far from the technological frontier, problems of selection, moral hazard and agency costs are very high ; to reduce these problems that affect the amount allocated to entrepreneurs, market power in the banking sector can alleviate the negative effects of information asymmetries on innovation, and thereby on economic growth. In addition, our theoretical model shows that countries close to the world technology frontier have a higher number of banks. Our theoretical model shows that the steady-state technology gap is increasing at the level of banking reforms. Finally, we capture the effects of convergence between countries through banking reforms, whereby each country converges in the long run in relation to its own proximity to the technology frontier, and countries with high levels of banking reforms will converge to higher values. These theoretical findings are the first in the existing literature, to the best of our knowledge.

The following results are shown in our model. The increase in the number of banks through banking reforms increases the deposit rate, which then increases the loanable funds of banks. In our second step, banking reforms have the effect of reducing loan rates for innovators and thus increases the probability of entrepreneurial innovation, which positively affects the productivity of the economy. Besanko and Thakor (1992) examine the effects of lowering the entry barriers into banking and show that increased competition in the banking sector benefits savers and borrowers because loan rates decline and deposit rates rise. Boot and Thakor (2000) increase competition in their study, whether from the capital market or from other banks, and demonstrated an improvement in borrower welfare. Recently, Diallo and Koch (2013) theoretically and empirically study the effects of bank concentration on growth and show that bank concentration increases loan rates for innovators, and that the effects of bank concentration on economic growth depend on the level of technological development. Specifically, their results suggest that bank concentration is more harmful to growth for countries close to the world technology frontier.

In order to verify our theoretical predictions we use cross-country and panel data estimates. We split our sample into low-reform and high-reform countries according to the median of banking reforms measured by the index developed by Abiad *et al.* (2010). We give more details in the empirical section of this paper of the measurement of banking reforms. Dummy high reforms is equal to 1 for high-reform countries if the banking reform index for a country is greater or equal to the median of the index and into low-reform otherwise. This allows us to share our sample in 39 countries for high reforms and 39 countries for low reforms. The proximity to the frontier is defined as the ratio of the country's per-worker GDP to the U.S. per-worker GDP at the beginning of the sample in 1980. We then regress the average per-worker GDP growth rate over the period 1980-2010 on dummy high and low reforms, and the interactions between the proximity to the world frontier and high and low reforms, respectively, using White's consistent standards errors for statistical inference. However, our results remain robust to the use of the average per-capita GDP growth rate; we present these results in the robustness tests section. We show that the effects of banking reforms on economic growth depend on the level of technological development of countries. Specifically, our findings suggest that low-reform countries converge rapidly when they are far from the technology frontier but slow down significantly near the technological frontier. These results remain robust to the use of several control variables, namely private credit to measure the level of financial development, trade, and macroeconomic policies including inflation rate, money growth (M2), budget balance and government consumption. They also remain robust to the exclusion of OECD countries. To exploit the relevant information we use panel data averaged over five 5-year taking into account countries and year-fixed effects. Doing this, we regress the average per-worker GDP growth on the proximity to the world technology frontier, banking reforms and the interaction term between the proximity to the world technology frontier and banking reforms using clustering standards errors for statistical inference. The coefficient of the interaction term now captures the difference between the coefficients of the interaction between low-reform countries and the proximity to the world technology frontier, and the interaction between high-reform countries and the proximity to the world technology frontier in cross-sectional specifications. We find that low-reform countries slow down the closer they get to the technology frontier. More precisely, banking reforms have a positive and significant effect for countries close to the world technology frontier. Our results remain robust to the introduction of the control variables listed above.

Our paper introduces several crucial novelties to the existing literature. To the best of our knowledge, our paper is the first to theoretically and empirically measure the effects of banking reforms on innovation and economic growth according to the level of technological development. It also builds a bridge between appropriate institutions and growth, and banking reforms. The remainder of the paper is organized as follows. Section 2.2 outlines the basic structure of the theoretical model, section 2.3 confronts the theoretical predictions by using empirical investigation, and section 2.4 summarizes the findings.

2.2 Theoretical Framework

2.2.1 A simple Schumpeterian theoretical framework

In this paper, we use the theoretical Schumpeterian growth paradigm developed over the past decade by Howitt and Mayer-Foulkes (2004), Aghion *et al.* (2005) and Acemoglu *et al.* (2006), according to which time is considered discrete, and there is a continuum of individuals in each country. There are J countries, indexed by $j = 1, ..., J$, which do not exchange goods and factors, but are technologically interdependent in the sense that they use technological ideas developed elsewhere in the world. Each country has a fixed population, L, which we normalize to one $L \equiv 1$, so that aggregate and per capita quantities coincide. Each individual lives two periods and is endowed with two units of labor services in the first period and none in the second. The utility function is assumed to be linear in consumption, so that $U = c_1 + \beta c_2$, where c_1 and c_2 represent consumption in the first and second periods of life, respectively, and $\beta \in (0, 1)$ is the rate at which individuals discount the utility consumption in the second period relative to that in the first.

Production of final good Consider a country j, where we drop country-index without loss of generality, and where there is only one general good Y_t, taken as the numéraire, produced by specialized intermediate goods and labor as :

$$Y_t = L^{1-\alpha} \int_0^1 A_t(\nu)^{1-\alpha} x_t(\nu)^{\alpha} d\nu \quad \text{with} \quad 0 < \alpha < 1 \tag{2.1}$$

where $x_t(\nu)$ is the country input of intermediate good ν such that $\nu \in [0,1]$, and $A_t(\nu)$ is the technological productivity parameter associated with it. The final good is used for consumption, as an input into entrepreneurial innovation and the production of intermediate goods. Producers of the general good act as perfect competitors in all markets, so that the inverse demands for intermediate goods and labor are given by :

$$\text{(FOC)} \quad \begin{cases} p_t(\nu) = \alpha x_t(\nu)^{\alpha-1} A_t(\nu)^{1-\alpha} & \text{for all sectors } \nu \in [0,1] \\ w_t = (1-\alpha) Y_t \end{cases} \tag{2.2}$$

Production of intermediate goods For each intermediate good ν, there is an innovator who enjoys a monopoly power in the production of this intermediate good, and produces a unit of the intermediate good by using 1 unit of the final good. The firm maximizes its profits given by :

$$\pi_t(\nu) = p_t(\nu)x_t(\nu) - x_t(\nu) = \alpha x_t(\nu)^{\alpha} A_t(\nu)^{\alpha-1} - x_t(\nu) \tag{2.3}$$

The first order condition allows us to find the equilibrium quantity of intermediate good ν of quality $A_t(\nu)$ given by : $x_t(\nu) = \alpha^{\frac{2}{1-\alpha}} A_t(\nu)$. The equilibrium price of intermediate good ν is given by : $p_t(\nu) = \alpha^{-1}$, so that the equilibrium profit of intermediate firm is written as :

$$\pi_t(\nu) = (1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}} A_t(\nu) = \pi A_t(\nu) \tag{2.4}$$

where $\pi \equiv (1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}}$, so that the profit earned by the incumbent in any sector ν will be proportional to the productivity parameter in that sector.

GDP and growth rate Substituting the equilibrium quantity $x_t(\nu)$ into the final good production function (2.1) shows that the equilibrium output of the general good is proportional to the average productivity parameter defined as : $A_t = \int_0^1 A_t(\nu)d\nu$, so that :

$$Y_t = \alpha^{\frac{2\alpha}{1-\alpha}} A_t \tag{2.5}$$

as well as wages of country j :

$$w_t = (1-\alpha)\alpha^{\frac{2\alpha}{1-\alpha}} A_t = \omega A_t \tag{2.6}$$

where $\omega \equiv (1-\alpha)\alpha^{\frac{2\alpha}{1-\alpha}}$. Finally, the GDP of country j is equal to the sum of distributed revenues, profits and wages, to households :

$$\text{GDP}_t = w_t + \int_0^1 \pi_t(\nu)d\nu = (\pi + \omega)A_t \tag{2.7}$$

Therefore, the aggregate per capita GDP growth rate is the same as the average productivity parameter : $1 + g_{j,t} \equiv \dfrac{A_t}{A_{t-1}}$, and we focus on this last to determine the growth properties of country j.

Technological Change Following Aghion *et al.* (2005), in each intermediate good sector ν, a continuum of persons with an entrepreneurial idea is born in period t capable of producing an innovation in period $t+1$, and if successful becomes the ν^{th} incumbent at $t+1$. We denote $\mu_{t+1}(\nu)$ as the probability of entrepreneurial innovation, the level of technology of intermediate goods sector ν in the period $t+1$, $A_{t+1}(\nu)$ according to the following process :

$$A_{t+1}(\nu) = \begin{cases} \bar{A}_{t+1} & \text{with probability } \mu_{t+1}(\nu) \\ A_t(\nu) & \text{with probability } 1-\mu_{t+1}(\nu) \end{cases}$$

where $\bar{A}_{t+1}$ denotes the world technology frontier which grows at the constant rate $g > 0$. The average productivity thus evolves according to :

$$A_{t+1}(\nu) = \mu_{t+1}(\nu)\bar{A}_{t+1} + (1-\mu_{t+1}(\nu))A_t(\nu) \tag{2.8}$$

In equilibrium, as we show below, the probability of entrepreneurial innovation will be the same in each sector : $\mu_{t+1}(\nu) = \mu_{t+1}$. Replacing and integrating this equation on both sides, the average productivity becomes :

$$A_{t+1} = \mu_{t+1}\bar{A}_{t+1} + (1-\mu_{t+1})A_t \tag{2.9}$$

Let us denote $a_t \equiv \dfrac{A_t}{\bar{A}_t}$ the proximity to the world technology frontier of the average productivity of a country, its dynamics is given by the following law of motion :

$$a_{t+1} = \mu_{t+1} + \frac{1}{1+g}(1-\mu_{t+1})a_t \tag{2.10}$$

2.2.2 Banking Sector

Following Monti (1972), Klein (1971) and Salop (1979) (and reviewed in Freixas-Rochet (2008)), we model the banking sector in a context of monopolistic competition between differentiated products for loans and deposits. The banking sector is composed of n_{t+1} banks indexed $i = 1, .., n_{t+1}$. Bank i pays transaction linear costs between loans and deposits $C(D_{t+1}(i), T_{t+1}(i)) = \gamma_D D_{t+1}(i) + \gamma_T T_{t+1}(i)$, where $\gamma_D, \gamma_T \in [0, 1]$ are cost parameters associated with the deposit and loan activities, respectively. The banks offer multi-product services (deposits and loans), and there are two types of population (depositors and borrowers). We consider a continuum of depositors of mass one and a continuum of borrowers of mass one both uniformly distributed along a circle ; the n_{t+1} banks are located on the same circle. Moreover, when each depositor deposits money in a bank, he or she incurs a transportation cost θ proportional to the distance $\hat{h}(i)$ between the depositor's location and that of bank. To determine the demand for deposits $D_{t+1}(i)$ of bank i in this situation, it is necessary to compute the location of the marginal depositor who is indifferent about going to bank i or bank $i+1$. The distance $\hat{h}(i)$ between this marginal depositor and bank i is defined by :

$$r_{D,t+1}(i) - \theta\hat{h}(i) = r_{D,t+1}(i+1) - \theta\left(\frac{1}{n_{t+1}} - \hat{h}(i)\right) \tag{2.11}$$

We can find $\hat{h}(i)$ such that :

$$\hat{h}(i) = \frac{r_{D,t+1}(i) - r_{D,t+1}(i+1)}{2\theta} + \frac{1}{2n_{t+1}} \tag{2.12}$$

The demand for deposits of bank i is given by :

$$D_{t+1}(i) = 2\hat{h}(i) = \frac{r_{D,t+1}(i) - r_{D,t+1}(i+1)}{\theta} + \frac{1}{n_{t+1}} \tag{2.13}$$

When each borrower (entrepreneur) borrows money from a bank, he or she incurs a transportation cost λ proportional to the distance $\tilde{h}(j)$ between the borrower's location and that of the bank. To determine the supply of loans $T_{t+1}(i)$ of bank i in this situation, it is necessary to compute the location of the marginal borrower who is indifferent about going to bank i or bank $i+1$. The distance $\tilde{h}(i)$ between this marginal borrower and bank i is defined by :

$$r_{t+1}(i) + \lambda\tilde{h}(i) = r_{t+1}(i+1) + \lambda\left(\frac{1}{n_{t+1}} - \tilde{h}(i)\right) \tag{2.14}$$

We can find $\tilde{h}(i)$ such that :

$$\tilde{h}(i) = \frac{r_{t+1}(i+1) - r_{t+1}(i)}{2\lambda} + \frac{1}{2n_{t+1}} \tag{2.15}$$

The supply of loans of bank i is as follows :

$$T_t(i) = 2\tilde{h}(j) = \frac{r_{t+1}(i+1) - r_{t+1}(i)}{\lambda} + \frac{1}{n_{t+1}} \tag{2.16}$$

In the period $t+1$, the bank chooses $r_{t+1}(i)$ and $r_{D,t+1}(i)$ so as to maximize its profits given by :

$$\Pi^B_{t+1}(i) = (r_{t+1}(i)\mu_{t+1} - \gamma_T)\, T_{t+1}(i) - \tau B_{t+1}(i) - (r_{D,t+1} + \gamma_D)D_{t+1}(i) \tag{2.17}$$

subject to the following constraints :

$$\begin{cases} T_{t+1}(i) = \frac{r_{t+1}(i+1) - r_{t+1}(i)}{\lambda} + \frac{1}{n_{t+1}} \\ D_{t+1}(i) = \frac{r_{D,t+1}(i) - r_{D,t+1}(i+1)}{\theta} + \frac{1}{n_{t+1}} \\ B_{t+1}(i) = R_{t+1}(i) + T_{t+1}(i) - D_{t+1}(i) \\ R_{t+1}(i) = \rho D_{t+1}(i) \end{cases} \tag{2.18}$$

where $T_{t+1}(i)$ and $D_{t+1}(i)$ are, respectively, the supply of loans and demand for deposits of bank i, $R_{t+1}(i)$ is the reserves of bank i, which equal a proportion ρ of deposits. τ is the interbank rate and ρ the coefficient of compulsory reserves. τ and ρ may be used as a Central Bank instrument. $B_{t+1}(i)$ is the net position of bank i on the interbank market, and equals the sum of the reserves and loans minus deposits. Substituting the constraints, the problem becomes :

$$\Pi^B_{t+1}(i) = [r_{t+1}(i)\mu_{t+1} - \tau - \gamma_T]\, T_{t+1}(i) - [\tau(\rho - 1) + r_{D,t+1} + \gamma_D]\, D_{t+1}(i) \tag{2.19}$$

subject to :

$$\begin{cases} T_{t+1}(i) = \frac{r_{t+1}(i+1) - r_{t+1}(i)}{\lambda} + \frac{1}{n_{t+1}} \\ D_{t+1}(i) = \frac{r_{D,t+1}(i) - r_{D,t+1}(i+1)}{\theta} + \frac{1}{n_{t+1}} \end{cases} \tag{2.20}$$

The banks have same cost function taken linear, and the same supply of loans and demand for deposits; thus a unique equilibrium is given by : $r_{D,t+1}(i-1) = r_{D,t+1}(i) = r_{D,t+1}(i+1) = ... = r^*_{D,t+1}$ and $r_{t+1}(i-1) = r_{t+1}(i) = r_{t+1}(i+1) = ... = r^*_{t+1}$.

The deposit rate is independent of the probability of entrepreneurial innovation, and its expression is as follows :

$$r^*_{D,t+1} = \tau(1-\rho) - \gamma_D - \frac{\theta}{n_{t+1}} \tag{2.21}$$

Proposition 7 shows the relationship between deposit rate $r_{D,t+1}$ and the number of banks n_{t+1}.

Proposition 7. *The deposit rate $r_{D,t+1}$ depends positively on the number of banks n_{t+1}.*

Proof These properties follow directly from differentiating equation (2.21). ■

The loan rate depends on the number of banks, the probability of entrepreneurial innovation, borrowers' transportation costs, the interbank rate and bank management costs. Its expression is given by :

$$r^*_{t+1} = \frac{\lambda}{n_{t+1}} + \frac{\tau + \gamma_T}{\mu_{t+1}} \tag{2.22}$$

The following proposition establishes the link between loan rate r_{t+1} and the number of banks n_{t+1}. It implies that an increase in number of banks n_{t+1} reduces, the loan rate for entrepreneurs.

Proposition 8. *The loan rate r_{t+1} depends negatively on the number of banks n_{t+1}.*

Proof These properties follow directly from differentiating equation (2.22). ■

Proposition 7 and Proposition 8 are quite intuitive. First, an increase in the number of banks by banking reforms i.e. free entry in the banking sector increases the deposit rate, which allows banks to have more funds. Second, an increase in the number of banks also has the effect of reducing the loan rate. This would subsequently allow entrepreneurs in the innovation sector to borrow at a lower costs and thus increase the probability of entrepreneurial innovation, which in turn would have a positive and significant effect on productivity.

2.2.3 Innovation Sector

At the beginning of second period, a household has the opportunity to become an entrepreneur (innovator), and the cost of innovation is given by :

$$\frac{Z_{t+1}(\nu)}{\bar{A}_{t+1}} = \psi\mu_{t+1}(\nu) \tag{2.23}$$

where $Z_{t+1}(\nu)$ is the total investment in terms of the final good, and $\psi > 0$ is a parameter which affects the cost of innovation. The total investment is adjusted to the world technology frontier $\bar{A}_{t+1}$ to take into account the fact that it becomes more expensive to maintain an innovation rate of $\mu_{t+1}(\nu)$ as the technology frontier advances.

Households earn a wage at the end of the first period, w_t, given by (2.6), which they save at the bank with a return rate $r_{D,t+1}$. They borrow the amount $Z_{t+1}(\nu)-(1+r_{D,t+1})w_t = T_{t+1}(\nu)$ from the bank because the wage received is not sufficient to initiate an innovation. Therefore, in equilibrium, $\mu_{t+1}(\nu)$ will be chosen by the innovators so as to maximize the expected net profits :

$$\max_{\mu_{t+1}(\nu)} \pi\mu_{t+1}(\nu)\bar{A}_{t+1}(\nu) - (1+r_{t+1})\left[Z_{t+1}(\nu) - (1+r_{D,t+1})w_t\right] - (1+r_{D,t+1})w_t \tag{2.24}$$

subject to :

$$\begin{cases} \frac{Z_{t+1}(\nu)}{\bar{A}_{t+1}} = \psi\mu_{t+1}(\nu) \\ r_{t+1} = \frac{\lambda}{n_{t+1}} + \frac{\tau+\gamma_T}{\mu_{t+1}} \\ r_{D,t+1} = \tau(1-\rho) - \gamma_D - \frac{\theta}{n_{t+1}} \end{cases} \tag{2.25}$$

The FOC allows us to find the expression of the probability of entrepreneurial innovation μ_{t+1} according to the number of banks n_{t+1} and the proximity to the world technology frontier a_t.[1]

$$\mu_{t+1} = \sqrt{\frac{(\tau + \gamma_T)(\kappa - \frac{\theta}{n_{t+1}})\bar{\omega} a_t}{\pi - \frac{\lambda\psi}{n_{t+1}} - \psi}} \tag{2.26}$$

where $\kappa \equiv \tau(1-\rho)+(1-\gamma_D)$ and $\bar{\omega} \equiv \frac{\omega}{1+g}$. Equation (2.26) allows us to study the effect of the proximity to the world technology frontier a_t on the probability of entrepreneurial innovation μ_{t+1}. The following proposition states that if profits are to be positive, that is, if innovation is viable, then the probability of entrepreneurial innovation increases with the number of banks in the economy.

Proposition 9. *If $\pi > \frac{\lambda\psi\kappa}{\theta+\psi}$, then the probability of entrepreneurial innovation μ_{t+1} is an increasing function of the number of banks n_{t+1}, $\dfrac{\partial\mu_{t+1}}{\partial n_{t+1}} > 0$.*

Proof These properties follow directly from differentiating equation (2.26). ■

2.2.4 Equilibrium and the number of banks with free entry

Since there are no entry restrictions, the equilibrium number of banks will be obtained when the profit is equal to fixed costs F, which gives :

$$\Pi^B_{t+1} = (\mu_{t+1}r_{t+1} - \tau - \gamma_T)\frac{1}{n_{t+1}} - (\tau(\rho-1) + \gamma_D + r_{D,t+1})\frac{1}{n_{t+1}} = F \tag{2.27}$$

Substituting the expressions of loan rate, and deposit rate given by equations (2.21) and (2.22), respectively, and the expression of the probability of the entrepreneurial innovation given by equation (2.26), allows us to find the following equation :[2]

$$\begin{gathered} F^2(\pi-\psi)n^5_{t+1} - F^2\lambda\psi n^4_{t+1} - 2F\theta(\pi-\psi)n^3_{t+1} + 2F\theta\lambda\psi n^2_{t+1} + \\ \left[\theta^2(\pi-\psi) - \lambda^2(\tau+\gamma_T)\bar{\omega}\kappa a_t\right] n_{t+1} + \lambda^2(\tau+\gamma_T)\theta\bar{\omega} a_t - \lambda\psi\theta^2 = 0 \end{gathered}$$

where $\pi \equiv (1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}}$, $\kappa \equiv \tau(1-\rho)+(1-\gamma_D)$ and $\bar{\omega} \equiv \frac{(1-\alpha)\alpha^{\frac{2\alpha}{1-\alpha}}}{1+g}$.. The parameter F in our model measures the strength of banking reforms. The fixed costs λ can be interpreted

1. See Appendix A.

2. See Appendix A.

as a barrier to entry; specifically, it may take the form of outright restrictions on the participation of foreign banks, restrictions on the scope of a bank's activities, restrictions on the geographic area where banks can operate, or. excessively restrictive licensing requirements. Reducing the value of F facilitates access to credit for innovators and at the same time increases the innovation rate. The following proposition numerically shows that the equilibrium number of banks n^*_{t+1} increases with the level of banking reforms λ and F, which can be interpreted as barriers to entry. Specifically it may take the form of outright restrictions on the participation of foreign banks; restrictions on the scope of bank's activities; restrictions on the geographic area where banks can operate; or excessively restrictive licensing requirements.

Proposition 10. *The equilibrium number of banks n^*_{t+1} is an increasing function of the level of banking reforms F;* $\dfrac{\partial n^*_{t+1}}{\partial F} < 0$.

Proof See Appendix A. ■

Free entry into the banking sector increases the number of banks in the economy; in our model the main component that promotes the entry of banks is the strength of banking reforms. In order to measure the level of banking reforms we use the fixed costs, noted by F. A high value of F corresponds to weak banking reforms, and a low value corresponds to strong banking reforms. When the level of banking reforms is weak there are fewer banks and therefore more it is difficult for entrepreneurs to borrow funds for innovation. However, when the level of banking reforms is strong there are more banks, and consequently it is easier for entrepreneurs to borrow funds. The next proposition is the most important result of our paper. It shows that the probability of entrepreneurial innovation increases with the level of banking reforms.

Proposition 11. *The equilibrium probability of entrepreneurial innovation μ^*_{t+1} is an increasing function of the level of banking reforms F;* $\dfrac{\partial \mu^*_{t+1}}{\partial F} < 0$.

Proof See Appendix A. ■

Proposition 11 comes from Propositions 9 and 10. It intuition is as follows. If the distance between entrepreneurs' location and the bank is low through high banking reforms i.e. free entry then countries have a higher probability of success in innovation. From Propositions 9 and 10, the probability of entrepreneurial innovation increases with the number of banks, which also increases with the level of banking reforms. Strong banking reforms encourage the introduction of new banks through free entry, which facilitates access to credit for innovators. This allows entrepreneurs to borrow with lower loan rates and at the same time increases the amount allocated to innovators, which promotes innovation by increasing the rate of success. This augmentation of the probability of innovation increases the productivity. The channel through which banking reforms affect the probability of entrepreneurial innovation is the free entry into the banking sector. As we showed above, stronger banking reforms increase the number of banks, and this process facilitates access to credit for innovators, which in turn positively affects the probability of entrepreneurial innovation. Innovation and R&D are important factors for economic growth in our model. Thus, deep banking reforms allow countries to facilitate access to credit for entrepreneurs and thus increase the innovation that positively affects economic growth.

2.2.5 Dynamics and banking reforms

The dynamics of the proximity to the world technological frontier evolve according to :

$$a_{t+1} = \mu(a_t) + \frac{1}{1+g}(1 - \mu(a_t))a_t = F(a_t) \tag{2.28}$$

where the equilibrium probability of entrepreneurial innovation is given by equation (2.26). The following proposition establishes the relationship between the dynamics of the proximity to the world technology frontier and convergence through banking reforms through free entry. This implies that countries converge in the long run to the steady state a^*.

2.3 Methodology and Empirical Evidence

2.3.1 Data

Our dependent variable is the average per-worker GDP growth rate over the period 1980-2010 taken from the Penn World Table 7.1 (Aten *et al.*, 2012). However, our results remain also robust to the use of the average per capita GDP growth rate. We present these results in the robustness tests section.

Banking Reforms The data on banking reforms are taken from Abiad *et al.* (2010), who use seven aggregate variables : credit controls and excessively high reserve requirements (0-4), aggregate credit ceilings (0-1), interest rate controls (0-4), entry barriers (0-5), capital account restrictions (0-3), privatization (0-3), securities market policy (0-5), and prudential regulations and supervision of the banking sector (0-6). In general, 0 indicates fully repressed and the higher value fully liberalized. Note that for banking regulation and supervision a high score indicates high regulation, which implies that the country has reformed its banking sector, while a low score indicates an unregulated banking sector.

Other control variables, from the World Bank WDI, [3] are used in our estimations : school, private credit, macroeconomic policies (money growth, inflation rate, budget balance, government consumption and trade). *School*, measured by the total enrollment in secondary education, regardless of age, is expressed as a percentage of the population of official secondary education age. *Private credit* provided by the banking sector includes all credit to various sectors on a gross basis, with the exception of credit to the central government, which is net. *Private credit* is our proxy for financial development, following Aghion *et al.* (2005) and Beck *et al.* (2000), who argue that private credit is a good measure of financial development. *Macroeconomic policies* include : *money growth* is an average annual growth rate in money; *inflation, consumer price*

3. The World Development Indicators are publicly available at `http://www.worldbank.org/`.

index, as measured by the consumer price index, reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly, (the Laspeyres formula is generally used) ; *budget Balance as % of GDP* is cash surplus or deficit revenue (including grants) minus expenses, and net acquisition of non-financial assets. In the 1986 GFS manual, non-financial assets were included under revenue and expenditure in gross terms ; *government consumption (% of GDP)* includes all current government expenditures for purchases of goods and services (including compensation of employees) and *trade* calculated as the sum of exports (% of GDP) and imports (% of GDP). The data on population growth are taken from the Penn World Table 7.1. Table 2.1 presents the summary statistics of variables.

Table 2.1 Descriptive statistics

Variables	Obs	Mean	Std. Dev.	Min.	Max.
Growth	411	0.014	0.031	-0.109	0.112
Reforms	411	11.796	5.933	0	21
log(Front)	411	-1.789	1.238	-4.823	0.119
Money growth (M2)	377	53.415	288.418	-4.782	4733.971
Inflation	404	52.449	306.840	-5.111	4828.7
School	371	25.439	20.749	0.094	92.458
Govern. consump.	390	15.295	5.610	4.135	38.274
Trade	405	68.625	49.329	13.950	390.535
Private credit	399	65.320	46.962	5.061	306.973

Table 2.2 shows the correlations among the variables. We find that the average per-worker GDP growth rate is positively and significantly correlated with banking reforms, school and trade at the 1% level. This suggests that banking reforms, school and trade exert a positive and significant effect on growth. The correlation between the average per-worker GDP growth rate and money growth, inflation and government consumption is negative and significant. However, the measure of banking reforms is positively and significantly correlated with the proximity to the world technology frontier

at the 1% level, which suggests that banking reforms increase with the proximity to the world technology frontier. Banking reforms is also positively and significantly correlated with school, government consumption and trade at the 1% level. Finally, the proximity to the world technology frontier is positively and significantly correlated with school, government consumption and trade at the 1% level, but negatively significant at 10%.

Table 2.2 Correlations Matrix

	Growth	Reforms	log(Front)	M2	Infl	School	Gov. cons.	Trade
Growth	1.000							
Reforms	0.246	1.000						
	(0.000)							
log(Front)	0.0457	0.5673	1.000					
	(0.3556)	(0.000)						
M2	-0.2855	-0.181	-0.009	1.000				
	(0.000)	(0.000)	(0.858)					
Infl.	-0.316	-0.196	-0.024	0.979	1.000			
	(0.000)	(0.000)	(0.622)	(0.000)				
School	0.195	0.685	0.732	-0.058	-0.059	1.000		
	(0.000)	(0.000)	(0.000)	(0.279)	(0.255)			
Gov. consump.	-0.051	0.269	0.423	0.119	0.098	0.421	1.000	
	(0.307)	(0.000)	(0.000)	(0.022)	(0.052)	(0.000)		
Trade	0.224	0.340	0.272	-0.064	-0.065	0.202	0.058	1.000
	(0.000)	(0.000)	(0.000)	(0.210)	(0.189)	(0.000)	(0.252)	

2.3.2 Cross-country Evidence

The econometric specification is as follows :

$$\text{Growth}_i = \delta_{1,HR}\text{HR}_i + \delta_{2,LR}\text{LR}_i + \delta_3\text{Front}_i \times \text{HR}_i + \delta_4\text{Front}_i \times \text{LR}_i + \sum_{k=1}^{K} \delta_k x_{k,i} + \xi_i \quad (2.29)$$

where i denotes country and $X_i = [x_{1,i}, ..., x_{K,i}]$ is a set of K control variables defined below, and ξ_i is the error term. We test the link between growth, distance to frontier and banking reforms using cross-country data from 78 countries over the period 1980-2010. Growth_i is the average per-worker GDP growth rate over the period 1980-2010 using per-worker GDP data from the Penn World Table 7.1 (Aten *et al.*, 2012).[4] The proximity to the technology frontier is denoted by Front_i in our econometric specification and is defined as $\frac{Y_{i,1980}}{Y_{USA,1980}}$, where $Y_{i,1980}$ is per-worker GDP in country i in 1980 and $Y_{USA,1980}$ is per-worker GDP in the United States in 1980. We split our sample into low-reform (LR) and high-reform (HR) countries according to the median of banking reforms. We then define two dummy variables noted by HR and LR for high reforms and low reforms, respectively. HR is equal to 1 for high-reform countries, and LR takes the value 1 for the low-reform countries. Countries are classified into the high-reform if the measure of banking reforms is greater or equal to the median of banking reforms, and into the low-reform group otherwise. This implies that 39 countries are classified as high reforms and 39 as low reforms. For control our results for sub-Saharan African countries (SA) using a dummy variable that equal to 1 if country is a SA et 0 if not.

Table 2.3 shows the results of specifications. To treat heteroskedasticity problems, we use White's consistent standard errors for statistical inference. The specifications are estimated using ordinary least squares (OLS). The dependent variable is the average per-worker GDP growth rate over the period 1980-2010. In column (1) we regress the growth rate on high and low reform countries, the interaction term between high-reform

4. We use RGDPWOK as a measure of real GDP and PWT 7.1 is publicly available at `https://pwt.sas.upenn.edu/`

and the proximity to the world technology frontier, the interaction term between low-reform and the proximity to the world technology frontier and the dummy Sub-Saharan African value. The coefficient associated with high reform enters positively and significantly different from zero at the 1% level. This suggests that high banking reforms have a positive and significant effect on the average per-worker GDP growth rate. The interaction between high-reform and the proximity to the technology frontier enters negatively but insignificantly, while the interaction between low-reform and the proximity to the world technology frontier enters negatively and statistically significant at the 1% level. This result implies that low-reform countries converge rapidly when they are far from the technology frontier but slow down significantly close the frontier. This suggests that low banking reforms are detrimental to economic growth for countries close to the world technology frontier. The difference between the coefficients of the two interactions terms is statistically significant at the 5% level. In column (2) we control for school, and the coefficient of the interaction between low-reform and the proximity to the world technology frontier is negative and significant at the 1% level. There is a strong negative correlation between the average per-worker GDP growth rate and the proximity to the world technology frontier for countries with low banking reforms. This suggests that closer to the world technology frontier, countries with low banking reforms have a negative and significant effect on the average per-worker GDP growth rate, even though we cannot reject the hypothesis that these two coefficients are equal (p-value = 0.305). School is positively and significantly related to growth at the 1% level, a finding consistent with the results of Barro and Sala-I-Martin (1997), Hanushek and Woessmann (2007) and Vandenbussche *et al.* (2006). In column (3) we control for the dummy Sub-Saharan Africa and school. Our results remain robust and show that countries with low banking reforms slow down more significantly when they approach the technology frontier. The difference between the coefficients of the interactions enters statistically significant at the 10% level. Private credit is introduced in column (4) to take into account the level of financial development of countries. High-reform interacted with the proximity to the world technology frontier remains negative but insignificant, while the interaction between low-reform and the proximity to the frontier is negative and significant at the 1% level. The difference between these two coefficients is also statistically significant at the 10% level. We control for the degree of openness measured by trade of a country in column (5). The interaction between low-reform and the proximity to the world technology frontier remains negative and significant at the 1% level, which suggests that low-reform countries do relatively well when they are far from the technology frontier but slow down significantly closer to the technology frontier. We also find that the difference between the coefficients of interactions terms is statistically significant at the 5% level. The coefficient associated with trade enters positively and significantly different from zero at the 1% level. This suggests that trade enhances the average per-worker GDP growth rate. Columns (6) and (7) add macroeconomic variables (inflation rate, money growth (M2), budget balance and government consumption), and legal origin (British, French and German), respectively. Low-reform interacted with the proximity to the world technology frontier remains negative and significant at the 1% level. We show that the effects of banking reforms on growth depends on the level of economic development of country. This confirms our theoretical implications and empirical estimates. In addition, the coefficient associated with the french legal origin enters negatively and statistically significant at the 1% level. This suggests that french legal origin countries have lower levels of economic growth, a finding consistent with the literature.

Table 2.3 Banking Reforms, Distance to Frontier and Growth using Cross-country analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Front × dummy low reforms	-0.011***	-0.008***	-0.012***	-0.011***	-0.011***	-0.011***	-0.011***
	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Front × dummy high reforms	-0.002	-0.004	-0.004	-0.003	-0.001	-0.005	-0.005*
	(0.415)	(0.147)	(0.247)	(0.282)	(0.587)	(0.120)	(0.051)
Dummy high reforms	0.079***	-0.066	0.006	0.046	0.046***	0.086**	0.099***
	(0.000)	(0.182)	(0.888)	(0.229)	(0.001)	(0.045)	(0.000)
Dummy low reforms	-0.059	-0.180*	-0.140*	-0.105	-0.123*	-0.039	0.047
	(0.348)	(0.051)	(0.062)	(0.110)	(0.052)	(0.654)	(0.412)
School		0.049***	0.023				
		(0.004)	(0.142)				
Private credit				0.004			
				(0.330)			
Number of observations	78	76	76	77	77	70	78
Sub-Saharan Africa	Yes	No	Yes	Yes	Yes	Yes	Yes
Macroeconomic policies	No	No	No	No	No	Yes	No
Legal origin	No	No	No	No	No	No	Yes
p-value difference interaction coeffs.	0.044	0.305	0.056	0.056	0.021	0.237	0.102
R^2	0.594	0.520	0.625	0.617	0.633	0.662	0.684

Note that (***, ** and *) indicate significance at 1%, 5% and 10%, respectively. The dependent variable is the average per-worker GDP growth rate. *P*-value, are presented below the corresponding coefficients. Column 1 regresses the average per worker GDP growth rate on the interactions between low-reform and the proximity to the world technology frontier and high-reform and the proximity to the world technology frontier, dummies low-reform and high-reform. Column (2) controls for school. Column (3) adds school and dummy sub-Saharan Africa while columns (4)-(7) control for private credit, trade, macroeconomic policies (inflation rate, money growth, budget balance and government consumption), and legal origin (British, French and German), respectively.

2.3.3 Panel Evidence

We now estimate the panel specifications using the following equation :

$$\text{Growth}_{i,t} = \alpha + \delta_1 \text{Front}_{i,t} + \delta_2 \text{Reforms}_{i,t} + \delta_3 \text{Front}_{i,t} \times \text{Reforms}_{i,t} + \sum_{k=1}^{K} \delta_k x_{k,i,t} + \xi_i + \zeta_t + \varepsilon_{i,t} \tag{2.30}$$

where i and t denote country and period ; α, ξ_i, and ζ_t denote the intercept, country, and time fixed effects, respectively and $X_{i,t} = [x_{1,i,t}, ..., x_{K,i,t}]$ is a set of K control variables defined below. We therefore test the link between growth and banking reforms using panel data for 90 countries over the period 1980-2010 where data are averaged over five 5-year periods between 1980 and 2010.[5] The proximity of country i to the world technology frontier, defined as the maximum of initial per-worker real GDP' at the beginning of each sub-period, and subsumed as a_t in the theoretical model and denoted $\text{Front}_{i,t}$ in our econometric specification, is measured as the logarithm of the ratio of the initial per-worker real GDP of country i over the 5-year period to the initial per-worker real GDP of the United States. $\text{Reforms}_{i,t}$ is a measure of banking reforms of the country i in period t. To treat heteroskedasticity and autocorrelation problems in our specifications, we use clustering standard errors for statistical inference. Note that δ_3 now captures the difference between $\delta_{1,HR}$ and $\delta_{2,LR}$ in our cross-country specification.

The results are shown in Tables 2.4 and 2.5. We first regress the average per capita GDP growth rate on the proximity to the technology frontier, banking reforms and the interaction between these two variables using OLS standard, country dummies, country and year dummies and the Arrellano-Bond GMM estimation, respectively. As we can see, the proximity to the world technology is negatively and statistically related to growth at the 1% level, which suggests that there is convergence among countries and that banking reforms enhances the average per capita GDP growth rate using OLS standard, column

5. The first period covers the years 1980-1985 ; the second period covers the years 1986-1990 ; the third period covers the years 1991-1995 and so on. The last period covers the years 2006-2010.

(1). Columns (2) and (3) introduce country dummies and country and year dummies. The proximity to the world technology frontier remains negative and significant at the 1% level, while the coefficient associated with banking reforms enters positively and significantly different from zero at the 1% level. To treat a possible endogeneity, we then introduce the Arrellano-Bond GMM estimation in column (4). The coefficients associated with the proximity to the frontier and banking reforms remain negative and significant and positive and significant, respectively at the 1% level. Our main results are presented in columns (5)-(8). School as a control and the interaction between the proximity to the world technology frontier and banking reforms, and country dummies are introduced in column (5). The proximity to the world technology frontier enters negatively and statistically significant at the 1% level. Banking reforms remain positive but insignificant, while the interaction term enters negatively and significantly different from zero at the 5% level. This result is very important in the sense that it confirms our predictions and estimations using cross-sectional estimates. Banking reforms positively and significantly affect economic growth for countries close to the world technology frontier. School increases the average per capita GDP growth. These findings confirm the results obtained above and at the same time validate our theoretical predictions. Column (6) adds country dummies and year dummies after controlling for school. The proximity to the world technology frontier remains negative and significant at the 1% level, while banking reforms remain positive but insiginificant. However, the interaction term enters negatively and significantly at the 5% level. In column (7), we control for trade using country dummies. The interaction term between the proximity to the world technology frontier and banking reforms remain negative and significant at the 10% level. This suggests that the measure of banking reform has a positive and significant effect on growth for countries close to the world technology frontier. Column (8) adds country dummies and year dummies. The proximity to the world technology frontier and the interaction remain negative and significant at the 1% and 10% levels, respectively. This suggests that, controlling for trade, banking reforms have an effect on economic growth for countries close to the world technology frontier. Trade is positively and significantly related to the average per-worker GDP growth rate at the 1% level.

Table 2.4 Banking reforms, Distance to Frontier and Growth using panel specifications with control variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Front	-0.007***	-0.051***	-0.056***	-0.087***	-0.061***	-0.063***	-0.067***	-0.068***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Reforms	0.200***	0.249***	0.196***	0.241***	0.039	0.057	0.038	0.093
	(0.000)	(0.000)	(0.006)	(0.000)	(0.569)	(0.528)	(0.595)	(0.332)
Front × Reforms					-0.070**	-0.062**	-0.057*	-0.056*
					(0.017)	(0.040)	(0.068)	(0.088)
School					0.074***	0.061**	0.066***	0.065***
					(0.000)	(0.011)	(0.001)	(0.009)
Trade							0.030***	0.032***
							(0.001)	(0.001)
Number of obs	411	411	411	231	371	371	370	370
Number of groups	90	90	90	82	88	88	88	88
Country dummies	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Year dummies	No	No	Yes	No	No	Yes	No	Yes

Notes : $p-$value are in parenthesis, all regressions include a constant. The dependent variable is the average per-worker GDP growth rate over the period 1980-2010, when available. The regressions in columns (1) and (4) regress the average per-worker GDP growth rate on the proximity to the world technology frontier and banking reforms measure using OLS, countries fixed effects, countries and periods fixed effects and the Arrellano-Bond GMM estimator (Arrellano and Bond, 1991), respectively. Columns (5) and (6) control for school and countries fixed effects and periods fixed effects, respectively. Columns (7) and (8) add trade to take into account the degree of openness of a country using countries and periods fixed effects, respectively.

The results of the control variables, namely money growth (M2), inflation rate, government consumption and population growth, are shown in Table 2.5. Note that in all specifications the coefficient associated with the proximity to the world technology frontier is negative and significant at the 1% level. This suggests a convergence effect among countries. In column (1) we use country dummies, and banking reforms is positively related to growth even though insignificant. The interaction term enters negatively and significantly different from zero at the 10% level. Column (2) adds country and year dummies, and the interaction term remains negative and significant at the 10% level. This suggests that banking reforms increase the average per capita GDP growth rate for countries close to the world technology frontier. Money growth (M2) is negatively and statistically related to growth at the 1% level. We introduce country and year dummies in column (2). The interaction term remains negative and significant at the 10% level. Inflation rate as a control is used in columns (3) and (4). Banking reforms remain positive but insignificant, while the interaction term between the proximity to the world technology frontier and banking reforms has a negative and significant effect on the average per-worker GDP growth rate at the 5% level. This suggests that for countries close to the world technology frontier, banking reforms is positively and significantly related to economic growth. However, inflation exerts a negative and significant effect on growth at the 1% level, a finding consistent with the large body of literature that studies the relationship between growth and inflation. Using country and year dummies in column (4) the interaction term remains negative and significant at the 10% level. In columns (7) and (8) we control for population growth. The interaction term enters negatively and statistically significant different from zero at the 5% level using country and year dummies. This suggests that banking reforms positively and significantly affect the average per-worker GDP growth rate for countries close to the world technology frontier. In columns (9) and (10) we control for the sum of population growth and investment rate as in Solow (1956) using countries and period fixed effects, respectively. The interaction term between banking reforms and the proximity to the world technology frontier remains negative and significant at the 5% and 10% levels, respectively. This confirms the fact that banking reforms is positively and significantly related to economic growth for countries close to the world technology frontier. The coefficient associated with the Solow model enters positively and statistically different from zero at the 1% level.

Table 2.5 Banking reforms, Distance to Frontier and Growth using panel specifications with control variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Front	-0.057***	-0.059***	-0.056***	-0.057***	-0.062***	-0.064***	-0.061***	-0.063***	-0.050***	-0.052***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Reforms	0.041	0.051	0.017	-0.002	0.053	0.078	0.032	0.057	0.029	0.072
	(0.579)	(0.601)	(0.787)	(0.972)	(0.465)	(0.413)	(0.667)	(0.531)	(0.661)	(0.416)
Front × Reforms	-0.053*	-0.050*	-0.063**	-0.055*	-0.056*	-0.048	-0.068**	-0.062**	-0.061**	-0.048*
	(0.068)	(0.096)	(0.039)	(0.085)	(0.086)	(0.154)	(0.019)	(0.046)	(0.034)	(0.099)
Money growth (M2)	-0.001***	-0.001***								
	(0.000)	(0.000)								
Inflation rate			-0.001***	-0.002***						
			(0.000)	(0.000)						
Gov. consump.					-0.001**	-0.001**				
					(0.038)	(0.037)				
Pop. growth							-0.258	-0.197		
							(0.562)	(0.666)		
Pop. growth + investment rate									0.131***	0.135***
									(0.001)	(0.001)
Number of obs	345	345	369	369	356	356	371	371	371	371
Number of groups	87	87	88	88	85	85	88	88	88	88
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

Notes : $p-$value are in parenthesis, all regressions include a constant. The dependent variable is the average per worker GDP growth rate over the period 1980-2010, when available. Columns (1) and (2) control for money growth (M2), countries fixed effects and periods fixed effects, respectively. Columns (3) and (4) add inflation rate using countries and periods fixed effects, respectively. In columns (5) and (6) we use government consumption as a control using countries and periods fixed effects, respectively. Population as a control is added in columns (7) and (8). Columns (9) and (10) control for the sum of population growth and investment rate as in Solow model.

From the above, we can propose some solutions to improve productivity and economic growth in developing countries. Our model theoretically and empirically suggests that banking reforms have a positive and significant direct on the average per-worker GDP growth rate for countries close to the world technology frontier. We calculated a threshold for technological development in order to explain the positive effects of banking reforms on growth. With our standard panel estimations, the value of technological development will be greater or equal to 0.56. Countries where technological development reached or exceeded 0.56 should automatically switch policies by liberalizing their banking sectors in order to converge towards the world technology frontier. An increase also of the quality of banking reforms increases with the number of banks with free entry, which in turn encourages innovation and enhances growth. Combining the first effect with enhancements of human capital by investing in education, promoting trade and reducing public deficits can help these countries obtain growth and prosperity

2.3.4 Robustness checks

In order to test the robustness of the results shown above, we conduct some robustness tests. We present the results of cross-country specifications in Table 2.6. We first exclude OECD countries in our regressions, which reduces our sample to 57 countries. In column (1), controlling for dummy sub-Saharan African countries, we regress the average per-worker GDP growth rate on the interactions between low-reform countries and the proximity to the world technology frontier, and the high-reform countries and the proximity to the world technology frontier, high reform and low reform countries, respectively. Low reform interacted with the proximity to the frontier remains negative and significant at the 1% level, while the interaction between high reform and the proximity to the frontier is negative but insignificant. This result implies that close to the world technology frontier, a given country with a low banking reforms grows less than its usual growth rate. The difference between the coefficients of the two interactions is statistically significant at the 5% level. Column (2) controls for school and shows that there is a strong negative relationship between low reform interacted with the proximity to the world technology frontier and the average per-worker GDP growth rate. We add private credit and trade in columns (4) and (5). The interaction term between low reform and the proximity to the world technology frontier remains highly negative and significant at the 1% level. This suggests that low reform countries do relatively well when they are far from the world technology frontier but slow down significantly closer to the world technology frontier. There is also a negative relationship between low reform and the growth rate. In columns (6) and (7) we control for macroeconomic policies and legal origin, respectively. Low reform interacted with the proximity to the world technology frontier again enters negatively and significantly different from zero at the 1% level. The difference between the coefficients of the two interactions is statistically significant at the 10% and 5% levels, respectively. Our results remain robust through the exclusion of OECD countries, and we can conclude that low-reform countries slow down more when they are close to the world technology frontier.

Table 2.6 Banking Reforms, Distance to Frontier and Growth using Cross-country analysis excluding OECD countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Front × dummy low reforms	-0.011***	-0.009***	-0.012***	-0.011***	-0.011***	-0.012***	-0.012***
	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Front × dummy high reforms	0.002	-0.001	-0.000	0.000	-0.001	0.000	-0.000
	(0.705)	(0.987)	(0.994)	(0.982)	(0.715)	(0.955)	(0.837)
Dummy high reforms	0.125**	-0.074	0.014	0.051	0.027	0.157**	0.183**
	(0.015)	(0.354)	(0.823)	(0.558)	(0.688)	(0.014)	(0.048)
Dummy low reforms	-0.060	-0.236**	-0.166*	-0.130*	-0.132**	-0.029	0.115
	(0.352)	(0.026)	(0.070)	(0.093)	(0.049)	(0.758)	(0.255)
School		0.07***	0.035				
		(0.002)	(0.164)				
Private credit				0.001			
				(0.209)			
Number of observations	57	55	55	56	56	51	57
Sub-Saharan Africa	Yes	No	Yes	Yes	Yes	Yes	Yes
Macroeconomic policies	No	No	No	No	No	Yes	No
Legal origin	No	No	No	No	No	No	Yes
p-value difference interaction coeffs.	0.033	0.200	0.071	0.093	0.142	0.075	0.037
R^2	0.564	0.495	0.593	0.599	0.605	0.644	0.683

Note that (***, ** and *) indicate significant at 1%, 5% and 10%, respectively. The dependent variable is the average per worker GDP growth rate. P-value are presented below the corresponding coefficients. Column 1 regresses the average per worker GDP growth rate on the interactions between low-reform and the proximity to the world technology frontier and high-reform and the proximity to the world technology frontier, dummies low-reform and high-reform. Column (2) controls for school. Column (3) adds school and dummy sub-Saharan Africa while columns (4)-(7) control for private credit, trade, macroeconomic policies (inflation rate, money growth, budget balance and government consumption), and legal origin (British, French and German), respectively.

The results of panel specifications excluding OECD countries are presented in Table 2.7. Columns (1)-(4) regress the average per-worker GDP growth rate on the proximity to the world technology frontier and banking reforms using OLS standard, fixed effects and fixed and period effects, and the Arrellano-Bond GMM estimation, respectively. As we can see, the coefficient associated with the proximity to the world technology frontier is negatively and significantly related to growth at the 1% level, while banking reforms enter positively and statistically significant at the 1% level. These findings suggest that banking reforms enhance the growth rate. In order to take into account the effects of banking reforms on growth depending on the level of development of a country, we run specifications introducing the interaction term between the proximity to the world technology frontier and banking reforms. We then show the results in columns (5)-(8). The introduction of the interaction term and school (a control) and the use of the countries, effects allows us to show that the proximity to world technology frontier remains negative and significant at the 1% level. The coefficient associated with banking reforms remains positive but insignificant. However, the interaction term enters negatively and significantly at the 10% level. This suggests that banking reforms have a positive and significant effect on growth for countries close to the world technology frontier. In column (6) we use country and year dummies after controlling for school. The interaction term between banking reforms and the proximity to the world technology frontier remains negative and significant at the 10% level. There is also a strong positive relationship between school and the average per-worker GDP growth rate at the 1% level. This suggests that school increases the growth rate. We control for money growth (M2) and population growth in columns (7) and (8). The proximity to the world technology frontier remains negative and significant at the 1% level. The interaction term is negatively and significantly related to growth. This suggests that closer to the frontier countries with low reform slow down more and banking reforms increase the average per-worker GDP growth rate for countries close to the world technology frontier.

Table 2.7 Banking Reforms, Distance to Frontier and Growth using panel data and excluding OECD countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Front	-0.007**	-0.051***	-0.053***	-0.090***	-0.065***	-0.065***	-0.061***	-0.065***
	(0.016)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Reforms	0.225***	0.259***	0.273**	0.251***	0.006	0.095	-0.009	0.000
	(0.000)	(0.000)	(0.010)	(0.000)	(0.950)	(0.509)	(0.920)	(1.000)
Front × Reforms					-0.076*	-0.068*	-0.066*	-0.076*
					(0.057)	(0.095)	(0.069)	(0.064)
School					0.001***	0.091**		
					(0.004)	(0.033)		
Money growth (M2)							-0.001***	
							(0.000)	
Pop. growth								-0.128
								(0.818)
Number of obs	306	306	306	168	270	270	264	270
Number of groups	69	69	69	61	67	67	66	67
Country dummies	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Year dummies	No	No	Yes	No	No	Yes	No	No

Notes : $p-$value are in parenthesis, all regressions include a constant. The dependent variable is the average per-worker GDP growth rate over the period 1980-2010, when available. The regressions in columns (1) and (4) regress the average per-worker GDP growth rate on the proximity to the world technology frontier and banking reforms measure using OLS, countries fixed effects, countries and periods fixed effects and the Arrellano-Bond GMM estimator (Arrellano and Bond, 1991), respectively. Columns (5) and (6) control for school and countries fixed effects and periods fixed effects, respectively. Columns (7) adds money growth (M2) using countries and fixed effects. Population growth as a control is introduced in column (8) using country fixed effects.

We test the robustness of our findings using per-capita GDP growth rateinstead of per-worker GDP. Table 2.8 shows the results. In all specifications the interaction between the proximity to the world technology frontier and low reform enters negatively and significantly different from zero at the 1% level. This suggests that low-reform countries converge rapidly when they are far from the world technology frontier but slow down significantly close to the technology frontier. This also implies that low banking reforms are more harmful for countries close to the world technology frontier. By controlling for sub-Saharan Africa, private credit, trade and legal origin, we find that the difference between the coefficients of the two interactions is statistically significant at the 5% level.

Table 2.8 Banking Reforms, Distance to Frontier and Growth using Cross-country analysis using GDP per capita

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Front × dummy low reforms	-0.010***	-0.008***	-0.011***	-0.010***	-0.010***	-0.010***	-0.010***
	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Front × dummy high reforms	- 0.002	-0.004*	-0.003	-0.003	-0.001	0.005*	-0.004*
	(0.302)	(0.098)	(0.167)	(0.200)	(0.427)	(0.085)	(0.073)
Dummy high reforms	0.098***	-0.056	0.024	0.057	0.065***	0.100**	0.084***
	(0.000)	(0.325)	(0.674)	(0.194)	(0.000)	(0.023)	(0.000)
Dummy low reforms	-0.096	-0.207*	-0.178**	-0.143*	-0.162**	-0.072	-0.035
	(0.238)	(0.073)	(0.047)	(0.072)	(0.039)	(0.483)	(0.606)
School		0.049***	0.022				
		(0.005)	(0.193)				
Private credit				0.005			
				(0.279)			
Number of observations	78	76	76	77	77	70	78
Sub-Saharan Africa	Yes	No	Yes	Yes	Yes	Yes	Yes
Macroeconomic policies	No	No	No	No	No	Yes	No
Legal origin	No	No	No	No	No	No	Yes
p-value difference interaction coeffs.	0.028	0.215	0.037	0.034	0.015	0.176	0.078
R^2	0.727	0.666	0.756	0.751	0.764	0.774	0.776

Note that (***, ** and *) indicate significant at 1%, 5% and 10%, respectively. The dependent variable is the average per capita GDP growth rate. P-value are presented below the corresponding coefficients. Column 1 regresses the average per worker GDP growth rate on the interactions between low-reform and the proximity to the world technology frontier and high-reform and the proximity to the world technology frontier, dummies low-reform and high-reform. Column (2) controls for school. Column (3) adds school and dummy sub-Saharan Africa while columns (4)-(7) control for private credit, trade, macroeconomic policies (inflation rate, money growth, budget balance and government consumption), and legal origin (British, French and German), respectively.

2.4 Conclusion

This paper aims to model and empirically test the effects of banking reforms using a Schumpeterian growth model according to the technological development of a country. To do this, we first expand the theoretical framework of the Schumpeterian growth paradigm with a Salop model of monopolistic competition in the banking sector and subsequently test the predictions of our model using cross-country, panel data. We empirically use the index of Abiad *et al.* (2010) to measure banking reforms, and theoretically show that banking reforms exerts a positive effect on growth for countries close to the world technology frontier. Empirically, we regress the average per-worker GDP growth rate on banking reforms, the interaction between the proximity to world technology frontier and banking reforms using cross-country estimates, country and fixed effects. Our results show that banking reforms enhance the average per-worker GDP growth rate. Our results remain robust by introducing school, private credit as a measure of financial development, and macroeconomic policies (money growth, budget balance and trade) as controls. Our theoretical and empirical findings also confirm the importance of banking reforms in terms of enhancing innovation and productivity. We also give some recommendations to policymakers to improve innovation, productivity and economic growth.

Appendix A : Proof of Propositions

We first calculate the expression of the probability to innovate μ_{t+1} according to the proximity to the worldwide technological frontier a_t and the number of banks n_{t+1} using FOC. We then rewrite the expression of expected net profits in the innovation sector using equations (2.24) and (2.25), such that :

$$\max_{\mu_{t+1}(\nu)} \pi\mu_{t+1}(\nu)\bar{A}_{t+1}(\nu)-\left(\frac{\lambda}{n_{t+1}}+\frac{\tau+\gamma_T}{\mu_{t+1}}+1\right)\left[\psi\mu_{t+1}(\nu)\bar{A}_{t+1}(\nu)-(1+r_{D,t+1})w_t\right]-(1+r_{D,t+1})w_t \tag{2.31}$$

Developping equation (2.31), we get :

$$\max_{\mu_{t+1}(\nu)} \pi\mu_{t+1}(\nu)\bar{A}_{t+1}(\nu)-\tfrac{\lambda}{n_{t+1}}\psi\mu_{t+1}(\nu)\bar{A}_{t+1}(\nu)-(\tau+\gamma_T)\psi\bar{A}_{t+1}(\nu)+\tfrac{\tau+\gamma_T}{\mu_{t+1}(\nu)}(1+r_{D,t+1})w_t\bar{A}_{t+1}(\nu)+(1+r_{D,t+1})w_t(\tfrac{\lambda}{n_{t+1}}-1)$$

Using FOC, we find the expression of the probability of entrepreneurial innovation μ_{t+1} according to the proximity to worldwide technological frontier a_t and number of banks n_{t+1}.

$$\mu_{t+1}=\sqrt{\frac{(\tau+\gamma_T)(\kappa-\frac{\theta}{n_{t+1}})\bar{\omega}a_t}{\pi-\frac{\lambda\psi}{n_{t+1}}-\psi}} \tag{2.32}$$

where $\kappa\equiv\tau(1-\rho)+(1-\gamma_D)$ and $\bar{\omega}\equiv\frac{\omega}{1+g}$.

In order to prove Proposition 9 to Proposition 12, we determinate the equilibrium number of banks according to the proximity to the world technology frontier a_t, depositors' and borrowers' transportation costs, bank management costs, the cost of innovation, the interbank rate and the parameter of reserves. First, we rewrite the expression of banking net profits with free entry, using equation (2.27), such that :

$$\Pi^B_{t+1}=(\mu_{t+1}r_{t+1}-\tau-\gamma_T)\frac{1}{n_{t+1}}-(\tau(\rho-1)+\gamma_D+r_{D,t+1})\frac{1}{n_{t+1}}=F \tag{2.33}$$

We substitute the expressions of loan rate and deposit rate given by (2.21) and (2.22) and using equation (2.26) find the expression of equilibrium number of banks n^*_{t+1} as follows :

$$\sqrt{\frac{(\tau+\gamma_T)(\kappa-\frac{\theta}{n_{t+1}})\bar{\omega}a_t}{\pi-\frac{\lambda\psi}{n_{t+1}}-\psi}}=\frac{Fn^2_{t+1}-\theta}{\lambda} \tag{2.34}$$

Thus the equilibrium number of banks n^*_{t+1} is given by the solution of the following equation :

$$F^2(\pi-\psi)n^5_{t+1}-F^2\lambda\psi n^4_{t+1}-2F\theta(\pi-\psi)n^3_{t+1}+2F\theta\lambda\psi n^2_{t+1}+$$
$$\left[\theta^2(\pi-\psi)-\lambda^2(\tau+\gamma_T)\bar{\omega}\kappa a_t\right]n_{t+1}+\lambda^2(\tau+\gamma_T)\theta\bar{\omega}a_t-\lambda\psi\theta^2=0$$

where $\pi\equiv(1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}}$, $\kappa\equiv\tau(1-\rho)+(1-\gamma_D)$ and $\bar{\omega}\equiv\frac{(1-\alpha)\alpha^{\frac{2\alpha}{1-\alpha}}}{1+g}$.

Proof of Proposition 10. In order to prove Proposition we numerically solve the following equation :

$$F^2(\pi-\psi)n^5_{t+1}-F^2\lambda\psi n^4_{t+1}-2F\theta(\pi-\psi)n^3_{t+1}+2F\theta\lambda\psi n^2_{t+1}+$$
$$\left[\theta^2(\pi-\psi)-\lambda^2(\tau+\gamma_T)\bar{\omega}\kappa a_t\right]n_{t+1}+\lambda^2(\tau+\gamma_T)\theta\bar{\omega}a_t-\lambda\psi\theta^2=0$$

Table 2.9 Numerical solutions

Fixed costs	$\mathbf{n_1}$	$\mathbf{n_2}$	$\mathbf{n_3}$
$F=0.01$	0.04	2.98	3.32
$F=0.05$	0.04	1.33	1.48
$F=0.1$	0.04	0.94	1.05

CHAPTER III

FINANCIAL DEPENDENCE AND GROWTH DURING CRISES : WHEN DOES BANK EFFICIENCY REALLY MATTER ?

Abstract

We use the recent financial crisis as a shock to the supply of credit, and we analyze the effect of bank efficiency on value added growth of firms in industries that are most dependent on external finance. Our main results show that bank efficiency relaxed credit constraints and increased the growth rate for financially dependent industries during the crisis. This finding remains robust the introduction of control variables, namely financial development, bank concentration and competition, bank size and capitalization, bank supervision, net interest margin, overhead costs, banking crises, monetary policy, government intervention measures and macroeconomic variables interacted with external financial dependence. It also remains robust to the use of several measures of external financial dependence and econometric methods.

KEYWORDS : Bank efficiency, financial dependence, growth, financial frictions, banking crises.

JEL : G21, O16, F21, F23.

3.1 Introduction

The subprime crisis of 2009 reminds us how the banking sector plays an important role in the real economy. In this paper, we consider the crisis as a shock that affected the supply of credit of banks, and we particularly investigate how bank efficiency alleviates the effects of financial frictions on economic growth. More specifically, we analyze the substantial decrease in banking lending and we investigate the effect of bank efficiency in terms of the extent to which countries are able to weather the financial crisis.

We use the method offered by Rajan and Zingales (1998) to measure the impact of bank efficiency on growth for financially dependent industries. Indeed, the reasoning behind of paper is as follows. The channel through which bank efficiency affects growth is the "credit-channel." Bank efficiency positively affects the supply of credit granted to firms, which in turn increases the growth rate in real value added for industries most dependent on external financing. To measure bank efficiency in financial systems, we use Data Envelopment Analysis (DEA). We give more details about the dataset and this method in section 2 and Appendix A, respectively. Growth is the annual growth rate in real value added across firms and countries during the period 2009, during which the crisis spread from the U.S. to other countries. Financial dependence is computed at the industry level using data on industrial U.S. firms. Our final sample covers 37 countries for a total of 2611 country-industry observations. Our first result shows that bank efficiency relaxed credit constraints, permitting externally dependent industries to grow faster during the crisis. More precisely, if we take one industry at the 75th percentile of external financial dependence and another industry at the 25th percentile of external financial dependence, we find that the difference in growth rate between these two industries is 2.41 percentage points higher in a country at the 75th percentile of bank efficiency than in a country at the 25th percentile. This effect is large relative to mean annual industry value-added growth in our sample (-4.559%). This confirms that a more efficient banking system provided external financially dependent firms with more and better access to financing and allowing them to grow rapidly during the crisis.

Bank efficiency had a higher profitability in terms of growth for financially dependent industries during the crisis.

In order to disentangle the impact of bank efficiency from other factors that might be correlated with our measure of bank efficiency, we control for other interactions of external financial dependence with measures of financial development, bank concentration and competition, bank size, bank capitalization, net interest margin, overhead costs, banking crises measures, bank supervision, and other government policy intervention measures during the crisis. Our results continue to hold, and remain robust to the use of several measures of external financial dependence, the introduction of control variables, namely trade, real GDP monetary policy, exchange rate and inflation rate interacted with external financial dependence. It is also robust to the use of several econometric methods, such as weighted least squares and the rank method.

Our paper is related to several strands in the existing literature on the topic. First, the effects of financial development on economic growth have been the subject of numerous studies. The results obtained generally show that financial development has a positive and significant effect on growth (Schumpeter (1911), King and Levine (1993a, 1993b), Demirgüç-Kunt and Maksimovic (1998), Rajan and Zingales (1998), Beck *et al.* (2000), Levine and Demirgüç-Kunt (2004), Aghion *et al.* (2005)). These studies use private credit to measure the level of financial development of countries. Our paper assesses for the first time the relationship between financial development and economic growth using a direct measure of bank efficiency. It is also relates to a large empirical literature on the relationship between banking market structure and growth. Cetorelli and Gambera (2001) study the effects of bank concentration on growth. They find that bank concentration promotes the growth of those industrial sectors that are more in need of external financing by facilitating credit access to younger firms.

Second, our paper adds to the empirical literature the relationship between growth, banking crises and financial frictions. Braun and Larrain (2005) assess the relationship between finance and the business cycle across countries and industries. They show that industries that are more dependent on external finance are hit harder during recessions. For Raddatz (2006), larger liquidity needs create higher volatility, and financially underdeveloped countries experience deeper crises. Kroszner *et al.* (2007) use the same approach to investigate the growth impact of bank crises on industries with different levels of dependence on external finance. Using data from 38 developed and developing countries that have experienced financial crises, they find that those sectors that are highly dependent on external finance tend to experience a substantially greater contraction of value added during a banking crisis in countries with deeper financial systems than in countries with shallower financial systems. However, their results do not suggest that on net externally dependent firms fare worse in well-developed financial systems. Rancière *et al.* (2008) theoretically and empirically investigate the effects of systemic crises on growth using skewness and GDP growth in a large sample of countries over the period 1960-2000. They find that countries that have experienced occasional financial crises have on average grown faster than countries with stable financial conditions. Dell'Ariccia *et al.* (2008) study the effects of banking crises on growth in industrial sectors and find that in sectors more dependent on external finance, value added, capital formation, and the number of establishments grew slower than in sectors less dependent on external finance. The differential effect is stronger in developing countries where alternatives to bank financing are more limited, in countries with less access to foreign finance, and where bank distress is more severe. Piazza (2014) theoretically studies the relationship between growth and crisis, and finds that in the presence of financial market imperfections, sudden stops and financial crises can simply be the natural outcome of a typical growth process with decreasing marginal returns to capital. Laeven and Valencia (2013) analyze the impact of bank recapitalization on growth during the recent financial crisis. They find that the growth of firms dependent on external financing is disproportionately positively affected by bank capitalization policies. The remainder of the paper is organized as follows. Section 2 outlines the basic methodology, section 3 is the empirical investigation, and section 4 is the conclusion.

3.2 Methodology and Data

To study the relationship between bank efficiency, financial dependence and growth, we first estimate the following econometric specification :

$$\text{Growth}_{j,k} = \text{Constant} + \beta_1\text{*Country Indicators} + \beta_2\text{*Industry Indicators} + \beta_3\text{*Size}_j$$
$$+ \beta_4\text{*Financial dependence}_j \times \text{Efficiency Index}_k + \text{Controls}_{j,k} + \epsilon_{j,k}$$

where j and k denote industry and country, respectively. Growth is the annual growth rate in real value added of industry j in country k during 2009. Financial dependence measures industry j's dependence on external financing, and efficiency quantifies bank efficiency in country k. Size is measured by the logarithm of total assets of industry j. The country and industry indicators are based on the IFS country classification code and the International Industry Classification Code, respectively. Following the literature, this approach is less subject to criticism regarding omitted variable bias or model specification compared to cross-country specifications. We eliminate the U.S. which is our benchmark for measuring external financial dependence. We also drop countries with only one or two observations, such as Czech Republic and Nigeria. Our data is composed of 37 countries for a total of 2611 country-industry observations. The coefficients β_1 and β_2 capture country and industry dummies, respectively. The inclusion of these indicators allows us to control for factors that are unique to each country and industry. Our coefficient of interest is β_4. If bank efficiency has a positive and significant effect on growth for financially dependent industries, then it should be positive and statistically significant different from zero. The channel through which bank efficiency affects growth is the "credit-channel." Specifically, bank efficiency allows a better selection of borrowers and reduces the cost of credit, and a positive and significance sign for β_4 suggests that bank efficiency positively affects the supply of credit granted to firms, which in turn increases the growth rate in real value added for industries most dependent on external financing. We also include the size of firm captures by the coefficient β_3. A positive sign of this coefficient implies that the firm size positively and significatively affects growth.

Growth rate in real value added and financial dependence Growth is the annual growth rate in real value added as a percentage during the year 2009. The external finance dependence denotes the Rajan and Zingales (1998) measure of intensity reliance on external finance defined as a one minus industry cash flow over industry investment of large publicly-traded U.S. firms in the 1980s.[1] In terms of a robustness test, we use the external dependence computed over the period 1980-2006 taken from Laeven and Valencia (2013). Value added is measured using compustat data as the sum of earnings before taxes, depreciation and labor expenses. U.S. data is used to establish the benchmark of an industry's external dependence. In our paper we drop the U.S. into our specifications to treat a possible endogeneity. Table 9 shows external financial dependence measures across U.S. industries over the period 1980-1989.

Bank efficiency measure Bank efficiency is measured over the period 1999-2007 using the data envelope analysis (DEA) method[2]. Following Barth *et al.* (2013), the advantage of a non-parametric method compared to a parametric model, is that the latter requires one to assume a particular function form, thereby imposing a specific structure on the shape of the efficient frontier. The non-parametric DEA method envelops the multiple inputs (deposits, labor and physical capital) and outputs (total loans and securities) data of the sample for 4050 banks in 72 countries over the period 1999-2007. The coefficient obtained for bank efficiency does not suffer from the problem of functional form. The bank efficiency score lies between 0 and 1, and a higher value obtained with the DEA method indicates higher efficiency in the banking sector. A lower value means lower efficiency among banks. Table 8 shows the list of countries with efficiency scores. For details about DEA model estimation, see Appendix A.

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1. The dataset comes from Krosner *et al.* (2007)

2. See Appendix A.

Controls Our specifications control for other firm-level variables such as firm leverage (lev), defined as the ratio of total liabilities to total assets. The asset tangibility variable is calculated as the ratio of fixed assets to total assets. The Tobin's Q variable, is computed as the ratio of the market value of equity plus the book of debt divided by the book value of total assets. The database of these three variables is taken from Laeven and Valencia (2013). Other control variables, from the World Bank WDI,[3] are used in our estimations : private credit, inflation rate, trade, and stock market capitalization. *Private credit* provided by the banking sector includes all credit to various sectors on a gross basis, with the exception of credit to the central government, which is net. *Inflation,*, as measured by the consumer price index, reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as annually (the Laspeyres formula is generally used). *Trade* is calculated as the sum of exports (% of GDP) and imports (% of GDP). *Market capitalization*, listed domestic companies are the domestically incorporated companies listed on the country's stock exchanges at the end of the year. Listed companies do not include investment companies, mutual funds, or other collective investment vehicles. We follow Laeven and Valencia (2013) by controlling our results for *total capitalization*, defined as the sum of private credit/GDP and stock market capitalization/GDP. We also control for the real GDP growth. To test the sensitivity of our results, we use bank concentration, measured as the share of assets of the three largest banks in total banking system assets. Its value lies between 0 and 1, where 0 indicates a low bank concentration and 1 a high bank concentration.[4] The Boone indicator, Lerner and adjusted Lerner indices are also used in our specifications to control for bank competition ; we give more details in Appendix A.[5] We control for the changes in monetary policy over the period August 2008-March 2009, exchange rate depreciation over the period August 2008-

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3. The World Development Indicators are publicly available at `http://www.worldbank.org/`.

4. Concentration and supervisory power measures are taken from Beck *et al.* (2010).

5. Data are come from Clerides *et al.* (2013).

March /2009, the change in monetary base/GDP over the period 2008q3-2009q1, and the local currency to USD, end-2009. These datasets come from Laeven and Valencia (2013). In order to take into account the effect of government policy intervention measures during the crisis, we control our main results for asset purchases used (% of GDP), announced asset purchases and lending by treasury (% of GDP), banking guarantees measured as the sum of asset guarantees (% of GDP) and bank creditors' guarantees (% of GDP), and liquidity support (% of GDP).[6] We also control for banking crises taken from Laeven and Valencia (2013). To continue to test the robustness of results we control for bank capitalization measured as the ratio of equity capital to total assets in percentages, and bank size measured by the logarithm of total assets. We also use overhead cost measured as the accounting value of a bank's overhead cost as a share of its total assets, and the net interest margin defined as the accounting value of a bank's net interest revenue as a share of its interest-bearing (total earning) assets.[7]

Table 3.1 shows the summary statistics of our variables. The average growth rate in real value added over the period 2009 is -4.559%. However, we observe a high dispersion between the firm at the 25th percentile, which grows at -25.218%, and the firm at 75th percentile, which grows at 14.364%. The average of bank efficiency is 0.798. The countries with the lowest banking efficiency values are Lithuania (0.470), the Philippines (0.51), Pakistan (0.56) and Peru (0.57). The countries with highest banking efficiency are The United Kingdom (0.940), Switzerland (0.920), Belgium (0.920), and Luxembourg (0.910). Firms required an average of 44.2% external financing. Market capitalization, private credit and total capitalization are on average 148.523%, 105.224%, and 253.748%, respectively. Bank concentration is on average 65.4%, with a minimum value of 0.291 (Luxemburg) and a maximum value of 0.944 (Sweden). The Boone indicator, Lerner and adjusted Lerner indices are on average -0.467, 0.233, and 0.180,

6. The dataset of these variables is taken from Laeven and Valencia (2013).

7. The data come from Beck *et al.* (2010) and are publicly available at `http://www.worldbank.org/`.

respectively. Tables 8 and 9 show countries with banking efficiency scores and external financial dependence across U.S. industries over the period 1980-1989, respectively.

Table 3.1 Summary statistics

Variables	Obs	Mean	Std. Dev.	Min.	Max.	25th Perc.	75th Perc.
Growth	2611	-4.559	34.669	-99.624	98.732	-25.218	14.364
Size	2611	5.052	2.443	-7.733	12.620	3.895	6.395
Lev	2611	0.484	0.258	0.015	4.283	0.318	0.618
Bank efficiency	2611	0.798	0.102	0.470	0.940	0.760	0.870
Financial dependence 1980	2611	0.442	0.414	-0.451	1.491	0.136	0.767
Financial dependence 1980-2006	2611	0.295	0.311	-1.757	0.934	0.104	0.503
Market capitalization	2611	148.523	120.748	13.570	471.350	59.130	157.920
Private credit	2611	105.224	43.178	13.020	194.740	93.610	139.400
Total capitalization	2611	253.748	147.554	50.240	610.750	165.430	292.160
Concentration	2611	0.654	0.138	0.291	0.944	0.562	0.735
Boone indicator	2611	-0.467	0.035	-0.582	-0.404	-0.493	-0.437
Lerner index	2611	0.233	0.064	0.124	0.341	0.172	0.282
Adjusted Lerner	2611	0.180	0.056	0.095	0.288	0.138	0.238
Supervisory power	2611	-0.516	1.254	-3.048	1.001	-1.155	0.720

Table 3.2 Summary statistics continued

Variables	Obs	Mean	Std. Dev.	Min.	Max.	25th Perc.	75th Perc.
Trade	2611	148.019	133.663	25.830	456.650	56.370	211.23
Real GDP growth	2611	-2.177	3.081	-17.955	6.771	-4.874	-0.770
Inflation	2611	3.237	2.855	-0.290	15.730	1.510	4.640
Liquidity support	2611	4.249	5.808	0	57.543	0	7.872
Bank guarantees	2611	71.424	85.640	0	295.2	3.300	115.600
Asset announced	2611	0.706	2.009	0	9.100	0	0
Asset used	2611	0.632	1.923	0	8.200	0	0
Crisis	2611	0.212	0.408	0	1	0	0

3.3 Results

This section presents the results of our specifications. The dependent variable is the annual growth rate in real value added over the period 2009. In each specification, we introduce the intercept, country and industry indicators. To treat heteroskedasticity problems in our regressions, we use White's consistent standard errors for statistical inference. The specifications are estimated using ordinary least squares (OLS).

What is the effect of bank efficiency on growth for financially dependent industries during the crisis? Our main results are shown in column (1) of Table 2. The coefficient associated with the industry size is positive and significant at the 1% level. This suggests that industry size has a positive and significant direct effect on growth during the crisis. The interaction term between bank efficiency and external financial dependence enters positively and statistically significant at the 5% level. This finding implies that bank efficiency matters for improved growth of firms in industries that are more financially dependent on external finance. The regression in column (1) allows us to find the difference in growth in real value added between industries. The difference in growth during the crisis between an industry at the 75th percentile and the

25th percentile of external financial dependence is 2.41 percentage points higher in a country at the 75th percentile of bank efficiency than in a country at the 25th percentile. This result is the first in the existing literature, to the best of our knowledge. Bank efficiency thus makes banks more resilient to financial crisis. The channel through which bank efficiency affects growth is the "credit-channel." During the crisis, bank efficiency positively affected the supply of credit granted to firms, which in turns enhanced the growth rate in real value added. Our main result stipulates that bank efficiency alleviates the negative effects of financial frictions on growth.

In order to disentangle the impact of bank efficiency from other factors that might be correlated with our measure of bank efficiency, we control for other interactions of external financial dependence with measures of financial development, bank concentration and competition, bank size, bank capitalization, net interest margin, overhead costs, banking crises measures, bank supervision, and other government policy interventions measures during the crisis. This approach is also used by (Aghion *et al.* (2005), Claessens and Laeven (2005) among others). This allows us to check if the positive relationship between bank efficiency and growth is robust to including several variables listed above.

Is bank efficiency simply a proxy for financial development ? The measure of bank efficiency in a country may capture other aspects of financial development. More precisely, our main result could simply be that countries with a high level of financial development have more efficient banking systems. Financial development could have offered alternative sources of firms that are more dependent on external finance during the recent global financial crisis. To disentangle bank efficiency from financial development we introduce the interaction term between market capitalization and external financial dependence in column (2) and the interaction term between total capitalization and external financial dependence in column (3). We follow the literature by using market and total capitalization as measures of the level of financial development of a given country. The coefficient of the interaction term between our measure of bank efficiency and external financial dependence is positive and significant at the 5% and 10% levels, respectively. This suggests that bank efficiency enhances the growth rate for financially dependent industries during crisis. However, the interaction term between market and total capitalization, and external financial dependence enters positively but insignificant. Interestingly, we show that bank efficiency disproportionately enhances the growth rate for financially dependent industries. This suggests that the finding that industries with greater financial dependence benefit in growth terms from greater bank efficiency is not due to a better level of financial development.

Table 3.3 Financial dependence, growth, bank efficiency, financial development and bank concentration as controls

	(1)	(2)	(3)	(4)
Size	0.961***	0.961***	0.960***	0.968***
	(0.316)	(0.316)	(0.316)	(0.315)
Bank efficiency × Financial dependence	0.348**	0.345**	0.327*	0.315**
	(0.154)	(0.161)	(0.172)	(0.161)
Market capitalization × Financial dependence		0.001		
		(0.015)		
Total capitalization × Financial dependence			0.003	
			(0.013)	
Concentration × Financial dependence				0.089
				(0.119)
Industry indicators	Yes	Yes	Yes	Yes
Country indicators	Yes	Yes	Yes	Yes
Number of observations	2611	2611	2611	2611
Number of countries	37	37	37	37
R^2	0.121	0.121	0.121	0.121

Note that (***, ** and *) indicate significance at 1%, 5% and 10%, respectively. Robust standards errors are in parenthesis, all regressions include a constant, country and industry fixed effects. The dependent variable is the annual growth rate in real value added of a firm during the period 2009.

Is bank efficiency simply a proxy for bank competition or concentration ? In column (4), we introduce the interaction term between concentration and external financial dependence. The coefficient associated with firm size remains positive and significant at the 1% level. The interaction term between bank efficiency and external financial dependence is positively and significantly related to growth at the 5% level. However, the interaction term between bank concentration and external financial dependence is positive and insignificant. Our result is not driven by bank concentration. We find that the real growth rate in value added is disproportionately positively affected by bank efficiency for financially dependent industries.

In terms of bank competition, we use three measures, namely the Boone indicator, the Lerner index and the adjusted Lerner index. We do not use the Panzar and Rosse (1987) approach applied in the empirical studies to measure bank competition for several reasons. First, Bikker *et al.* (2012) find that the price equation and scaled revenue function are not valid measures of bank competition and cannot identify imperfect competition. Second, Clerides *et al.* (2013) show that the H-statistic obtained with the Panzar and Rosse method is not a continuous variable because it maps the various degrees of market power only weakly. We present the results of our specifications in Table 3.4. Column (1) introduces the interaction term between the Boone indicator and external financial dependence. The coefficient of the interaction term between bank efficiency and external financial dependence remains positive and significant at the 5% level, while the coefficient associated with the interaction between the Boone indicator and external financial dependence is positive but insignificant. Columns (2) and (3) add the interactions terms between the Lerner and the adjusted Lerner indices, respectively. Bank efficiency interacted with external financial dependence enters positively and statistically significant at the 5% level. This suggests that firms that are more financially dependent grow faster in financial systems that are more efficient. It also suggests that our main results do not suffer from possible endogeneity problems with bank competition measures. The coefficients associated with the interaction terms between the Boone indicator, the Lerner and adjusted Lerner indices and external financial dependence enter positively but insignificant.

Table 3.4 Financial dependence, growth, banking efficiency and bank competition, supervision as controls

	(1)	(2)	(3)	(4)	(5)	(6)
Size	0.954***	0.956***	0.958***	1.111***	1.207***	1.202***
	(0.317)	(0.316)	(0.317)	(0.345)	(0.307)	(0.307)
Bank efficiency × Financial dependence	0.340**	0.348**	0.353**	0.076***	0.111***	0.089*
	(0.155)	(0.154)	(0.155)	(0.026)	(0.042)	(0.052)
Boone indicator × Financial dependence	0.244					
	(0.493)					
Lerner index × Financial dependence		0.159				
		(0.254)				
Adjusted Lerner index × Financial dependence			0.125			
			(0.294)			
Supervisory power × Financial dependence				-1.830		
				(1.588)		
Net interest margin × Financial dependence					-0.972	
					(1.021)	
Overhead × Financial dependence						-0.387
						(1.254)
Industry indicators	Yes	Yes	Yes	Yes	Yes	Yes
Country indicators	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	2611	2611	2611	2611	2611	2611
Number of countries	37	37	37	37	37	37
R^2	0.121	0.121	0.121	0.041	0.066	0.066

Note that (***, ** and *) indicate significance at 1%, 5% and 10%, respectively. Robust standards errors are in parenthesis, all regressions include a constant, country and industry fixed effects. The dependent variable is the annual growth rate in real value added of a firm during the period 2009.

Is bank efficiency simply a proxy for bank supervision ? We investigate whether our results reflect bank regulation measured by the official supervisory power rather than bank efficiency. Indeed, Barth *et al.* (2013) find a strong interaction and positive effect of official supervisory power on bank efficiency. We then control our results using the interaction term between supervisory power and external financial dependence. Column (4) of Table 3.4 shows the results. The coefficient of the interaction term between bank efficiency and external financial dependence remains positive and significant at the 1% level, even though it changes in magnitude. Bank efficiency has a positive and significant effect on growth for financially dependent industries during the crisis. More specifically, we show that the difference in growth during the crisis between an industry at the 75th percentile and the 25th percentile of external financial dependence is 0.52 percentage point higher in a country at the 75th percentile of bank efficiency than in a country at the 25th percentile. This effect is largely relative to mean annual industry value-added growth in our sample (-4.559%). The official supervisory power interacted with external financial dependence is negatively related to growth but remains insignificant.

Is bank efficiency simply a proxy for net interest margin and overhead cost ? Beck *et al.* (2010) argue that higher levels of net interest margins and overhead costs indicate lower levels of banking efficiency. It could be that our measure of bank efficiency depends on net interest margins or overhead costs. We introduce in column (5) and (6), the interaction terms between net interest margin and external financial dependence, and overhead cost and external financial dependence, respectively. As we can, our interest variable, namely the interaction term between bank efficiency and external financial dependence enters positively and statistically significant at the 1% and 10% levels, respectively even though the magnitude of the coefficients changes. This suggests that bank efficiency increases the growth rate of firms in industries that are more dependent on external financing. This confirms that our result is nit driven by net interest margins and overhead costs.

Is bank efficiency simply a proxy for other country characteristics ? In Table 3.5, we control for the level of economic development measured by the real GDP growth, the degree of openness measured by the trade, inflation and exchange rates and changes in monetary policy and monetary base that may affect our measure of bank efficiency. Controlling for these variables reduces concerns about omitted variables. Columns (1) and (2) add the interaction terms between real GDP growth and external financial dependence, and trade and external financial dependence. Firm size remains positively and significantly related to growth at the 1% level. The interaction term between bank efficiency and financial dependence remains positive and significant at the 5% level. This suggests that bank efficiency has a positive and significant growth effect for financially dependent industries. Real GDP growth and trade positively affect growth for financially dependent industries even though the coefficients are insignificant. Inflation and exchange rates are introduced in columns (3) and (4). Our interest variable, namely the interaction between bank efficiency and external financial dependence remains positive and significant at the 5% level. Monetary policy variables are used in columns (5) and (6). We find that bank efficiency interacted with external financial dependence is statistically significantly different from zero at the 5% level. This suggests that bank efficiency plays a positive and significant for growth in financially dependent industries during a crisis. We add all variables in column (7). We show that bank efficiency disproportionately increases the growth rate in real value added of firms that are dependent on external financing during the crisis. Our main results remain robust with the use of real GDP growth rate, trade, inflation and exchange rates, and monetary policy and base as controls, and validate at the same time the fact that bank efficiency makes countries more resilient to financial frictions. To the best of our knowledge, this finding is the first in the existing literature.

Table 3.5 Financial dependence, growth, bank efficiency and macroeconomic variables as controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Size	0.962***	0.959***	0.952***	0.973***	0.954***	0.966***	0.947***
	(0.316)	(0.318)	(0.314)	(0.316)	(0.316)	(0.316)	(0.318)
Bank efficiency × Financial dependence	0.354**	0.346**	0.417**	0.375**	0.370**	0.366**	0.487***
	(0.156)	(0.154)	(0.190)	(0.152)	(0.155)	(0.157)	(0.183)
Real GDP growth × Financial dependence	0.051						0.299
	(0.424)						(0.425)
Trade × Financial dependence		0.001					0.017
		(0.013)					(0.016)
Inflation × Financial dependence			0.510				0.425
			(0.756)				(0.821)
Exchange rate × Financial dependence				27.062			35.584
				(17.981)			(19.409)
Monetary policy × Financial dependence					-0.599		-0.797
					(1.003)		(1.104)
Monetary base × Financial dependence						-0.322	-0.255
						(0.453)	(0.521)
Industry indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	2611	2611	2611	2611	2611	2611	2611
Number of countries	37	37	37	37	37	37	37
R^2	0.121	0.121	0.121	0.122	0.121	0.121	0.123

Note that (***, ** and *) indicate significance at 1%, 5% and 10%, respectively. Robust standards errors are in parenthesis, all regressions include a constant, country and industry fixed effects. The dependent variable is the annual growth rate in real value added of a firm during the period 2009

The effects of government interventions during the crisis To obtain the results featured above, we conducted some robustness checks using government intervention measures as controls, as shown in Table 3.6. We first control for the interaction terms between announced assets purchases and asset purchases used, and external financial dependence. The results are presented in columns (1) and (2). Bank efficiency interacted with external financial dependence is positively and significantly related to growth for financially dependent industries at the 5% level, while announced assets and assets used interacted with external financial dependence enter positively but insignificant. This suggests that our result is not driven by bank policy intervention measures during the crisis. Indeed, bank efficiency exerts a positive and significant effect on growth of firms in industries that are more dependent on external financing. We investigate two other measures used during the crisis by governments, namely bank guarantees and liquidity support. Controlling for the interaction term between bank guarantees and external financial dependence in column (3), we show that our interest variable remains remains positive and significant at the 5% level. However, bank guarantees interacted with financial dependence enters negatively and insignificant. Finally, column (4) adds liquidity interacted with external financial dependence as a control. The coefficient of the interaction term between bank efficiency and external financial dependence is positive and statistically significantly different from zero at the 5% level. This suggests that the real growth rate in value added is disproportionately positively affected by bank efficiency for financially dependent industries.

The effect of banking crises versus non-banking crises It could also be that our result depends on whether the impact of the financial crisis on the banking sector is a function of the measure of bank efficiency. We control our results for banking crises in Table 3.7. In column (1) we introduce the interaction term between the banking crisis variable and external financial dependence. Banking crisis is a dummy variable that takes the value 1 if the country experienced a systemic banking crisis in 2009 and 0 if not. The coefficient associated with the interaction term between bank efficiency and external

Table 3.6 Financial dependence, growth, bank efficiency and government interventions as controls

	(1)	(2)	(3)	(4)
Size	0.959***	0.958***	0.964***	0.961***
	(0.315)	(0.315)	(0.317)	(0.316)
Bank efficiency × Financial dependence	0.329**	0.328**	0.355**	0.365**
	(0.161)	(0.159)	(0.154)	(0.171)
Assets announced × Financial dependence	0.352			
	(0.717)			
Assets used × Financial dependence		0.430		
		(0.735)		
Bank guarantees × Financial dependence dependence			-0.005	
			(0.020)	
Liquidity support × Financial dependence				-0.076
				(0.334)
Industry indicators	Yes	Yes	Yes	Yes
Country indicators	Yes	Yes	Yes	Yes
Number of observations	2611	2611	2611	2611
Number of countries	37	37	37	37
R^2	0.121	0.121	0.121	0.121

Note that (***, ** and *) indicate significance at 1%, 5% and 10%, respectively. Robust standards errors are in parenthesis, all regressions include a constant, country and industry fixed effects. The dependent variable is the annual growth rate in real value added of a firm during the period 2009.

financial dependence enters positively and statistically significantly different from zero at the 10% level. This suggests that our measure of bank efficiency is not affected by the systemic banking crisis. In column (2), we include countries considered as having a borderline systemic banking crisis.[8] As we can see, our interest variable, namely the interaction term between bank efficiency and external financial dependence, remains positive and significant at the 10% level. This suggests that deeper bank efficiency enhances the growth rate in real value added for firms in industries that are more dependent on external financing during the crisis.

Additional external finance dependence measures and firm controls To continue to test the robustness of our results we introduce an alternative measure of external financial dependence. This measure is calculated using the same method of Rajan and Zingales (1998) over the period 1980-2006. The results are shown in column (3) of Table 3.7, and we find bank efficiency interacted with the external financial dependence enters positively and statistically significantly different from zero at the 10% level. To investigate that our result is not driven by the financial condition of firms, we then introduce, in column (4) of Table 3.7, the ratio of firm liabilities to total assets (leverage) and the ratio of fixed assets to total assets (fixed assets). Doing this, the interaction term between bank efficiency and external financial dependence remains positive and significant at the 5% level, while the coefficient associated with the fixed assets enters negatively and significantly at the 1%. This confirms that efficiency in the banking system matters for improved access to all forms of external financing during the crisis, regardless of whether we control for firms, characteristics.

Additional estimation methods and growth opportunities We investigate the sensitivity of our measure of bank efficiency and the results are shown in Table 3.8. First, we use weighted least squares regressions and the rank order of the efficiency measures;

8. These countries are composed of France, Greece, Hungary, Portugal, Russia, Slovenia, Spain, Sweden and Switzerland. For more details, see Laeven and Valencia (2013)

Table 3.7 Financial dependence, growth, bank efficiency and banking crises as controls

	(1)	(2)	(3)	(4)
Size	0.962***	0.962***	0.964***	0.975***
	(0.315)	(0.316)	(0.316)	(0.315)
Bank efficiency × Financial dependence	0.301*	0.340*		0.347**
	(0.160)	(0.181)		(0.154)
Banking crisis × Financial dependence	3.047			
	(3.878)			
Banking crisis border × Financial dependence		0.332		
		(3.883)		
Banking efficiency × Financial dependence (80-06)			0.367*	
			(0.208)	
Leverage				-2.964
				(3.015)
Fixed assets				-12.937***
				(4.663)
Industry indicators	Yes	Yes	Yes	Yes
Country indicators	Yes	Yes	Yes	Yes
Number of observations	2611	2611	2611	2611
Number of countries	37	37	37	37
R^2	0.121	0.121	0.120	0.124

Note that (***, ** and *) indicate significance at 1%, 5% and 10%, respectively. Robust standards errors are in parenthesis, all regressions include a constant, country and industry fixed effects. The dependent variable is the annual growth rate in real value added of a firm during the period 2009.

the results are shown in columns (1) and (2). More precisely, we use the weighted least squares using the inverse of the standard deviation of our efficiency measure as weights and the rank order of bank efficiency. The coefficient associated with the interaction term between bank efficiency and external financial dependence enters positively and significantly different from zero at the 1% and 10% levels, respectively. This suggests that the positive effect of bank efficiency on growth for financially dependent industries is unaltered after using the weighted least squares and rank order method, even though the coefficient of the interaction term in column (2) changes in magnitude. It also confirms our main results and validates at the same time the fact that a more efficient banking system provides external financially dependent firms with more and better access to financing and allowing them to grow rapidly during the crisis.

To show that the main result obtained is not driven by a change in growth opportunities rather than external financial dependence, we control our result for the interaction term between bank efficiency and Tobin's Q, a proxy of a firm's growth opportunities.[9] In column (3), the interaction term between bank efficiency and external financial dependence remains positive and statistically significant at the 10% level, while the interaction between bank efficiency and Tobin's Q is positive but insignificant. This suggests that our measure of external financial dependence captures the financing channel and it operates differently from the growth opportunities. Controlling for growth opportunities, our results remain robust and confirm that bank efficiency disproportionately increases the growth rate of firms that are more dependent on external financial during the crisis.

To ensure that the result is not driven by a change in working capital financing than external financial dependence, we introduce in column (4) the interaction term between bank efficiency and working capital needs.[10] Bank efficiency interacted with external financial dependence enters positively and significantly different from zero at

9. See Fishman and Love (2007), Claessens and Laeven (2005), Laeven and Valencia (2013).

10. See Raddatz (2006), Laeven and Valencia (2013).

the 5% level, while the interaction between bank efficiency and capital needs is negative and insignificant. This suggests that bank efficiency enhances the growth rate of firms in industries that are more dependent on external financing. More specifically, we show that the difference in growth during the crisis between an industry at the 75th percentile and the 25th percentile of external financial dependence is 2.63 percentage points higher in a country at the 75th percentile of bank efficiency than in a country at the 25th percentile. This effect is largely relative to mean annual industry value-added growth in our sample (-4.559%).

Table 3.8 Financial dependence, growth and bank efficiency using weighted least squares and rank order, growth opportunities, and bank size and capitalization

	(1)	(2)	(3)	(4)	(5)	(6)
Size	1.109***	0.967***	0.959***	0.966***	1.015***	0.999***
	(0.007)	(0.316)	(0.350)	(0.315)	(0.317)	(0.317)
Bank efficiency × Financial dependence	0.416***		0.314*	0.380**	0.302*	0.270*
	(0.003)		(0.177)	(0.166)	(0.155)	(0.156)
Rank Bank efficiency × Financial dependence		0.003*				
		(0.002)				
Bank efficiency × Tobin's Q			0.013			
			(0.008)			
Bank efficiency × Capital Needs				-0.570		
				(1.104)		
Bank size × Financial dependence					0.883	
					(0.611)	
Bank capitalization × Financial dependence						43.866
						(30.267)
Industry indicators	Yes	Yes	Yes	Yes	Yes	Yes
Country indicators	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	2611	2611	2222	2611	2593	2593
Number of countries	37	25	37	37	37	37
R^2	-	0.120	0.127	0.119	0.119	0.120

Note that (***, ** and *) indicate significance at 1%, 5% and 10%, respectively. Robust standards errors are in parenthesis, all regressions include a constant, country and industry fixed effects. The dependent variable is the annual growth rate in real value added of a firm during the period 2009.

Is bank efficiency simply a proxy for bank size or bank capitalization ? Finally, well-capitalized and larger banks are probably more efficient and that may affect our measure of efficiency. To take into account this fact, we control our main results obtained above using the interaction terms between bank size, bank capitalization and external financial dependence, respectively. We present the results in columns (5) and (6) of Table 3.8. The interaction term between bank efficiency and external financial is positively and significantly related to growth rate at the 10% level. This suggests that bank efficiency has a positive and significant effect on growth for financially dependent industries during the crisis. This confirms that efficiency in the banking system matters for improved access to all forms of external financing during the crisis, regardless of whether we control for bank size or bank capitalization.

3.4 Concluding remarks

This paper studies the relationship between bank efficiency, financial dependence and economic growth during the financial crisis. Our study focuses on international evidence from 37 countries over a wide variety of industries. We first find that bank efficiency enhances growth in real value added for financially dependent industries during the crisis. Our results remain robust to the use of several measures of external financial dependence and the use of control variables. We especially control for the level of financial development, bank concentration and competition, bank size and capitalization, bank supervision, net interest margin, overhead costs, the level of economic development measured by real GDP growth rate, inflation and trade. We also control our results for exchange rate, changes in monetary policy, growth opportunities and working capital needs as an alternative measures of financial dependence.

This paper contributes to the literature on financial frictions with new evidence of the importance of bank efficiency through the credit channel. Efficiency makes banks more resilient to shocks, thereby positively and significantly affecting growth rate of firms that are more dependent on external financing.

Appendix A : Bank efficiency measure

Bank efficiency using the DEA approach. This section draws from Barth *et al.* (2013). Suppose the sample size is n and there are m inputs and s outputs for each bank. Let $x_j = (x_{j1}, x_{j2}, ..., x_{mj})$ as $m \times 1$ vector of inputs for bank j, $X = (x_1, x_2, ..., x_n)$ as $m \times n$ matrix of inputs, $y_j = (y_{j1}, y_{j2}, ..., x_{sj})$ as $s \times 1$ vector of outputs of bank j, and $Y = (y_1, y_2, ..., y_n)$ as $s \times n$ matrix of outputs, respectively. The outputs are : total loans and securities, while the inputs include : deposits, labor and phyiscal capital. The data of outputs and inputs are taking from Bankscope and covers 4050 banks in 72 countries over the period 1999-2007. The variable returns to scale the DEA model can be written with the following n linear programming problems for each bank j ($j = 1, 2, ..., n$) :

$$\max(\psi_j \geq 1 | x_j, y_j, X, Y) = \max(\psi_j \geq 1 | \psi_j y_j \leq Y\lambda_j, X\lambda_j \leq x_j, \lambda_j \geq 0, I_1'\lambda_j = 1) \tag{3.1}$$

where I_1 denotes an $n \times 1$ vector of ones, ψ_j denotes a scalar parameter, and $\lambda_j = (\lambda_{1j}, \lambda_{2j}, ...\lambda_{nj})'$ denotes a $n \times 1$ non-negative vector of parameters.

The intuition of (3.1) is as follows. For each bank j, a virtual output $Y\lambda_j$ is constructed as a weighted output of all banks by choosing some non-negative weights, $\lambda_j \geq 0$, $I_1'\lambda_j = 1$. It then seeks to expand the virtual output $Y\lambda_j$ as much as possible, subject to the inputs constraints of bank j, $X\lambda_j \leq x_j$. The virtual output $Y\lambda_j$ is then compared with the actual output y_j of bank j. If the maximized virtual output $Y\lambda_j$ is higher than the actual output of bank j by a scalar factor $\psi_j > 1$, then the bank j is inefficient. Otherwise, bank j is located at the efficiency frontier since $\psi_j = 1$. So, the input-oriented efficiency score is defined as $eff_j = \frac{1}{\psi_j}$ $(0 \leq eff_j \leq 1)$ for bank j.

Boone indicator The empirical Boone *et al.* (2005) and Boone (2008) indicator is as follows :

$$ln\pi_i = \iota + \vartheta lnmc_i \tag{3.2}$$

where π is the profit of the bank i and mc the marginal cost. The marginal cost of bank i in the period t using linear cost function is given by :

$$lnc_{i,t} = \alpha_0 + \alpha_1 lnq_{i,t} + \alpha_2 lnd_{i,t} + \alpha_3 lnw_{i,t} + e_{i,t} \tag{3.3}$$

where c is the total cost of bank i in the period t, q is bank output, d is the value of bank deposits, w are the prices of inputs and e is a disturbance. We can see easily that $\frac{\partial c_{i,t}}{\partial q_{i,t}}$ is the marginal cost of bank output. The data for the banking sector are taken from Bankscope, an unbalanced panel dataset of 89,778 observations corresponding to 12,206 banks that were operating in 148 countries between 1997-2010. The bank costs c are measured by real expenses of bank i in the period t; bank output q is measured by the real total earning assets (loans, securities, derivatives, investments and insurance assets) ; d is the real total deposits and short-term funding. First, the input prices w_1 is measured by the price of labor, which is proxied by the ratio of personnel expenses to total assets, and second, w_2 is measured by the price of physical capital, which is proxied by the ratio of total depreciation and other capital expenses to total fixed assets.

Lerner and Adjusted Lerner indices Clerides *et al.* (2013) use an unbalanced panel with 89,778 observations, corresponding to 12,206 banks operating in 148 countries between 1997-2010. The cost equation takes the form :

$$TC_{i,t} = f(q_{i,t}, w_{l,it}, w_{k,it}, w_{d,it}) \tag{3.4}$$

Where TC is total cost, $q_{i,t}$ is bank output, and $w_{l,it}$, $w_{k,it}$, $w_{d,it}$ are factor prices for labor, capital and deposits, respectively. Total cost is measured by real total expenses, while bank output is measured by real total earning assets. The prices for labor, capital and deposits are measured by the ratio of personal expenses to total assets, by the ratio of capital expenditures to fixed assets and as total interest expenses over total customer deposits, respectively. For the adjusted Lerner index, the profit by using the total profits before taxes. The aggregate price is calculated as the ratio of total income over total earning assets.

Table 3.9 Bank efficiency scores.

Isocode3	Isocode2	Country	Efficiency score
ARG	AR	Argentina	0.66
AUS	AU	Australia	0.81
AUT	AT	Austria	0.81
BEL	BE	Belgium	0.92
BRA	BR	Brazil	0.75
CAN	CA	Canada	0.88
CHE	CH	Switzerland	0.92
DEU	DE	Germany	0.87
DNK	DK	Denmark	0.76
ESP	ES	Spain	0.91
FRA	FR	France	0.89
GBR	GB	United Kingdom	0.94
GRC	GR	Greece	0.75
HKG	HK	Hong Kong	0.82
HRV	HR	Croatia	0.54
HUN	HU	Hungary	0.78
IND	IN	India	0.7
ITA	IT	Italy	0.83
KEN	KE	Kenya	0.56
LTU	LT	Lithuania	0.47
LUX	LU	Luxembourg	0.91
LVA	LV	Latvia	0.56
MAR	MA	Morocco	0.65
MYS	MY	Malaysia	0.76
NLD	NL	Netherlands	0.81
NZL	NZ	New Zealand	0.75
PAK	PK	Pakistan	0.56
PER	PE	Peru	0.57
PHL	PH	Philippines	0.51

Table 3.10 Bank efficiency scores.

Isocode3	**Isocode2**	**Country**	**Efficiency score**
POL	PL	Poland	0.59
PRT	PT	Portugal	0.84
RUS	RU	Russia	0.73
SGP	SG	Singapore	0.86
SVN	SI	Slovenia	0.65
SWE	SE	Sweden	0.79
THA	TH	Thailand	0.78
TUR	TR	Turkey	0.75
ZAF	ZA	South Africa	0.72

Table 3.11 External financial dependence 1980-1989 across U.S. industries.

ISIC code	Sector	External financial dependence
314	Tobacco	-0.45
361	Pottery	-0.15
323	Leather	-0.14
3211	Spinning	-0.09
324	Footwear	-0.08
372	Nonferrous metal	0.01
322	Apparel	0.03
353	Petroleum refineries	0.04
369	Nonmetal products	0.06
313	Beverages	0.08
371	Iron and steel	0.09
311	Food products	0.14
3411	Pulp, paper	0.15
3513	Synthetic resins	0.16
341	Paper and products	0.18
342	Printing and publishing	0.20
352	Other chemicals	0.22
355	Rubber products	0.23
332	Furniture	0.24
381	Metal products	0.24
3511	Basic excluding fertilizers	0.25
331	Wood products	0.28
384	Transportation equipment	0.31

Table 3.12 External financial dependence 1980-1989 across U.S. industries.

ISIC code	Sector	External financial dependence
354	Petroleum and coal products	0.33
3843	Motor vehicle	0.39
321	Textile	0.40
382	Machinery	0.45
3841	Ship	0.46
390	Other industries	0.47
362	Glass	0.53
383	Electric machinery	0.77
385	Professional goods	0.96
3832	Radio	1.04
3825	Office and computing	1.06
356	Plastic products	1.14
3522	Drugs	1.49

CONCLUSION

Dans cette thèse nous étudions l'importance du développement financier et le rôle du système bancaire dans le développement économique. Nous montrons le rôle prépondérant du marché bancaire comme moteur pour la croissance et le développement économiques à l'aide de trois articles scientifiques.

Le premier article de la thèse étudie les effets négatifs de la concentration bancaire sur la croissance économique. Le second article analyse le rôle des réformes bancaires sur la croissance, et enfin le dernier article étudie l'importance de l'efficience bancaire pour la croissance en temps de crise économique.

Nous pouvons donc retenir trois principaux résultats obtenus dans cette thèse. Nous montrons que la concentration bancaire affecte négativement la croissance économique pour tous les pays. Cependant, cet effet est d'autant plus négatif pour les pays qui sont proches de la frontière technologique mondiale. Ce résultat s'explique en partie par le fait que la concentration bancaire diminue les montants alloués aux entrepreneurs parce qu'elle augmente les taux d'intérêts des emprunts. Ainsi, il en résulte une baisse de l'innovation et par conséquent de la croissance économique. De plus, la concentration bancaire affecte plus négativement les pays proches de la frontière technologique mondiale. Nous observons des opportunités d'innovation plus importantes pour ces pays, une hausse de la concentration bancaire diminuant les montants alloués à l'innovation, il s'ensuit une baisse importante de la croissance économique. Empiriquement, nous montrons également que la concentration bancaire mesurée par plusieurs indices a un effet négatif et significatif sur la croissance économique. Cet effet est d'autant plus négatif lorsque le pays s'approche de la frontière technologique mondiale. Ces résultats sont robustes à l'introduction de plusieurs types de variables de contrôle et à l'utilisation de plusieurs techniques économétriques pour traiter l'endogénéité.

Le second résultat important à retenir est le suivant : les réformes bancaires peuvent avoir des effets différents sur la croissance pour les pays en fonction de leur niveau de développement technologique. Nous analysons un cadre théorique et empirique en utilisant l'idée des *institutions appropriées* pour étudier ces effets. Nous montrons qu'il existe un seuil de développement technologique à partir duquel les réformes bancaires exercent un effet positif et significatif sur la croissance économique. Quand un pays atteint ou dépasse ce seuil, il doit impérativement réformer son système bancaire par la libre entrée pour augmenter son taux de croissance. Cependant, pour les pays dont le niveau de développement technologique est inférieur à ce seuil, les réformes bancaires par une libre entrée ne sont pas souhaitables. Ces résultats sont assez intuitifs dans le sens où ils permettent de mettre en place des politiques économiques en fonction du seuil de développement technologique que nous calculons théoriquement et empiriquement. L'innovation et la R&D sont les moteurs de la croissance dans nos modèles théoriques. Ainsi, pour les pays proches de la frontière technologique mondiale, des réformes bancaires approfondies permettent aux entrepreneurs d'obtenir plus facilement des fonds dédiés à l'innovation en payant des taux d'intérêts plus faibles. Ce processus augmente, par voie de conséquence, la croissance économique. En effet, quand les pays sont loin du seuil de développement technologique, des réformes bancaires ne sont pas nécessaires. Nous observons des problèmes d'asymétries informationnelles très élevées dans les secteurs bancaires de ces pays. Le pouvoir de marché dans le secteur bancaire peut pallier ces lacunes en établissant des relations de proximité et de confiance entre les banques et les entrepreneurs. Ce processus facilite l'obtention de crédits pour l'innovation et augmente la croissance économique. Cependant, une fois que le pays atteint le niveau de développement technologique, il doit impérativement réformer son système bancaire pour continuer à bénéficier de taux de croissance élevés. Nous validons empiriquement ce résultat en utilisant un échantillon de 78 pays sur la période 1980-2010. L'effet des réformes bancaires sur la croissance dépend du niveau de développement technologique. Ce résultat est robuste à l'utilisation des données en coupe transversale et panel ainsi qu'à l'introduction de plusieurs types de variables de contrôle.

Le troisième et dernier résultat important à retenir dans cette thèse est le suivant : en période de crise économique, les pays disposant de marchés bancaires efficients résistent mieux aux chocs négatifs liés aux contraintes de crédit et croissent plus vite. Nous montrons empiriquement que l'efficience dans le secteur bancaire affecte positivement et significativement le taux de croissance pour les industries qui ont le plus besoin de financement externe. Un marché bancaire efficient diminue les contraintes de crédit pour les industries qui ont le plus besoin de financement externe. Ce résultat est robuste à l'introduction de plusieurs types de variables de contrôle pour dissocier les effets réels de l'efficience bancaire sur la croissance.

Cette thèse apporte donc trois nouvelles contributions à la littérature étudiant le lien entre le développement financier et la croissance économique, en tenant de la structure microéconomique du marché bancaire. Pour en arriver là, nous avons présenté trois modèles théoriques et empiriques sur les effets de la structure du marché bancaire à savoir la concentration, la concurrence et l'efficience bancaires sur la croissance économique. Malgré l'importance des ces nouveaux résultats, il s'agit d'un programme de recherche et d'une nouvelle voie de recherche novateurs que nous ouvrons pour toute la communauté scientifique. Nous suggérons ainsi de continuer à travailler sur ces modèles pour apporter de nouvelles réponses sur le sujet.

Nous espérons que cette thèse permettra également de réduire les inégalités entre pays riches et pauvres. De ce fait, elle suggère aux décideurs politiques et économiques de tenir compte de la structure microéconomique du marché bancaire pour définir des programmes de développement durable, efficace et de long terme.

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