Bank Concentration and Schumpeterian Growth: Theory and International Evidence

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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.

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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 enhance 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, however, 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 9. In our 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 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 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 2 outlines the basic structure of the theoretical model, section 3 confronts the theoretical predictions by using empirical investigation, and section 4 summarizes the findings.

2 Theoretical framework

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 $j = 1, \ldots, J$, 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

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

where $x_t(\nu)$ is the country input of intermediate good $\nu$ 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

$$\begin{align*}
\text{(FOC)} \quad & \begin{cases}
    p_t(\nu) = \alpha x_t(\nu)^{\alpha-1} A_t(\nu)^{1-\alpha} & \text{for all sectors } \nu \in [0, 1] \\
    w_t = (1 - \alpha) Y_t
\end{cases}
\end{align*}$$  \hspace{1cm} (2)
**Production of intermediate goods.** For each intermediate good \( \nu \), 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

\[
\pi_t(\nu) = p_t(\nu)x_t(\nu) - x_t(\nu) = \alpha x_t(\nu)^{\alpha} A_t(\nu)^{\alpha - 1} - x_t(\nu)
\]  

(3)

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

\[
\pi_t(\nu) = (1 - \alpha) \alpha \frac{\alpha}{1 + \alpha} A_t(\nu) = \pi A_t(\nu)
\]  

(4)

where \( \pi \equiv (1 - \alpha) \alpha \frac{\alpha}{1 + \alpha} \) so that the profit earned by the incumbent in any sector \( \nu \) 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) 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

\[
Y_t = \alpha \frac{\alpha}{1 + \alpha} A_t
\]  

(5)

as well as wages

\[
w_t = (1 - \alpha) \alpha \frac{\alpha}{1 + \alpha} A_t \equiv \omega A_t
\]  

(6)

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

\[
Y_t^{\text{net}} = Y_t - \int_0^1 x_t(\nu) d\nu = (1 - \alpha)(1 + \alpha) \alpha \frac{\alpha}{1 + \alpha} A_t
\]  

(7)

Therefore, the growth rate of net output is the same for the average productivity parameter:

\[
1 + g_t \equiv \frac{A_t}{A_{t-1}}. \quad \text{We focus on this last formula to determine the growth properties of a particular country.}
\]

**Technological change.** Following Aghion et al. (2005), in each intermediate good sector \( \nu \), 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 \( \nu^{th} \) incumbent at \( t + 1 \). We denote \( \mu_{t+1}(\nu) \) as the probability of entrepreneurial innovation, the level of technology of intermediate goods sector \( \nu \) in the period \( t + 1 \), \( A_{t+1}(\nu) \) according to the following process:

\[
A_{t+1}(\nu) = \begin{cases} 
\tilde{A}_{t+1} & \text{with probability } \mu_{t+1}(\nu) \\
A_t(\nu) & \text{with probability } 1 - \mu_{t+1}(\nu)
\end{cases}
\]
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 \( \nu \) thus evolves according to

\[
A_{t+1}(\nu) = \mu_{t+1}(\nu)\bar{A}_{t+1} + (1 - \mu_{t+1}(\nu))A_t(\nu)
\]  

(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

\[
A_{t+1} = \mu_{t+1}\bar{A}_{t+1} + (1 - \mu_{t+1})A_t
\]  

(9)

Let us denote \( a_t \equiv \frac{A_t}{\bar{A}_t} \) 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:

\[
a_{t+1} = \mu_{t+1} + \frac{1}{1 + g}(1 - \mu_{t+1})a_t
\]  

(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

\[
\frac{Z_{t+1}(\nu)}{A_{t+1}} = \psi \mu_{t+1}(\nu)\phi
\]  

(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 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 (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

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

\[
= \left[ \mu_{t+1}(\nu)\pi - \psi r_{t+1}\mu_{t+1}(\nu)\phi^2 \right] \bar{A}_{t+1}(\nu) - (1 - r_{t+1})(1 + r_{D,t})w_t
\]

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

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

(12)

Substituting equation (12) into equation (11) and using \( Z_{t+1}(\nu) - (1 + r_{D,t})w_t = T_{t+1}(\nu) \) allows

\[1\)For \( \phi = 2 \), the cost of innovation is: \( \frac{Z_{t+1}(\nu)}{\bar{A}_{t+1}} = \frac{\psi}{2} \mu_{t+1}(\nu)^2 \)
us to find the demand for loans for innovators, which decreases with the loan rate \((r_{t+1})\), and the innovation cost parameter \((\psi)\), which increases with the world technology frontier \((\bar{A}_{t+1})\) and net profits \((\pi)\). Denoting that the wage is proportional to local productivity such that \(w_t = \omega A_t\), as displayed in equation (6), the demand for loans, identical in each sector, is given by

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

\[\text{(13)}\]

### 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 \(i = 1, \ldots, n\). 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

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

\[\text{(14)}\]

and subject to the following constraints:

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

\[\text{(15)}\]

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 \(\theta\) of deposits. The interbank rate \((\tau)\) and the coefficient of compulsory reserves \((\theta)\) 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

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

subject to

\[
T_{t+1} = \psi \left( \frac{\pi}{\phi \psi r_{t+1}} \right)^{\frac{\phi}{\phi - 1}} \bar{A}_{t+1} - (1 + r_{D,t})\omega A_t
\]
The banks have the same linear cost function and the same demand for loans; thus a unique equilibrium is given by

\[ T_{t+1} = \frac{T_{t+1}}{n} \]

so that the first order conditions are

\[
\begin{align*}
(FOC) & \left\{ 
\begin{array}{l}
T_{t+1} = T_{t+1}^\prime = \tau (1 - \theta) - \gamma_D \\
T_{t+1}^\prime T_{t+1} + \mu_{t+1} H + T_{t+1} = \tau + \gamma_T \\
\end{array}
\right.
\]

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

\[
\frac{r_{t+1} \mu_{t+1} - (\tau + \gamma_T)}{r_{t+1} \mu_{t+1}} = \frac{H}{\epsilon} \tag{17}
\]

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\(^2\)

\[
\frac{1}{\epsilon} = -\frac{T_{t+1}}{\partial T_{t+1} / \partial r_{t+1}} = \frac{\phi - 1}{\phi} - \frac{\bar{\omega}(\phi - 1)(1 + r_{D,t})r_{t+1}}{\pi \left( \frac{\pi}{\phi \psi r_{t+1}} \right)} \frac{1}{\psi - \pi - 1} \tag{18}
\]

where \( \bar{\omega} \equiv \frac{\omega}{1 + g} \). We assume that \( r_{t+1} < \left\{ \bar{\omega} \left[ \tau (1 - \theta) + (1 - \gamma_D) \right] a_t \right\}^{1-\phi} \left( \frac{1}{\psi} \right)^{\frac{1}{\psi - 1}} \left( \frac{\pi}{\phi \psi r_{t+1}} \right) \) to ensure that the Lerner index is positive. Using equations (12), (17), and (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\(^4\)

\[
(\tau + \gamma_T) \left( \frac{\phi \psi}{\pi} \right)^{\frac{1}{\psi - 1}} H \bar{\omega}(\phi - 1) [\tau (1 - \theta) + (1 - \gamma_D)] \left( \frac{\phi \psi}{\pi \phi} \right)^{\frac{1}{\phi - 1}} a_t r_{t+1} - \left( 1 - \frac{H(\phi - 1)}{\phi} \right) = 0 \tag{19}
\]

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 \( a_t \): \( \partial r_{t+1} / \partial a_t < 0 \).

**Proof.** See Appendix C. \( \blacksquare \)

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.

\(^2\)See Appendix A.

\(^3\)See Appendix B.

\(^4\)See Appendix C.
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 \( r_{t+1} < \{\bar{\omega} [\tau (1 - \theta) + (1 - \gamma_D)] a_t \}^{\frac{1}{\phi}} \left( \frac{1}{\psi} \right) \frac{1}{\phi} \pi \), then the loan rate \( r_{t+1} \) is an increasing function of bank concentration \( H \) measured by the Herfindahl index:

\[
\frac{\partial r_{t+1}}{\partial H} > 0.
\]

**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 (12), (17), (18), and the implicit relation (19), we derive the equilibrium probability of entrepreneurial innovation \( \mu_{t+1} \) according to the loan rate \( r_{t+1} \), the proximity to the world technology frontier \( a_t \), and the Herfindahl index \( H \), given by

\[
\mu_{t+1} = \left\{ \begin{array}{ll}
\frac{1}{\phi} \left[ 1 - H \left( \frac{\phi - 1}{\phi} - \bar{\omega}(\phi - 1) \left[ \tau (1 - \theta) + (1 - \gamma_D) \right] \left( \frac{\phi - 1}{\phi} \right) \frac{1}{\phi} \pi \right) \right]^{\frac{1}{\phi} - 2} & \text{if } \phi > 2 \\
\frac{2\bar{\omega} [\tau (1 - \theta) + (1 - \gamma_D)]}{\phi \left[ 1 - \frac{1}{\phi} \right] \pi} a_t & \text{if } \phi = 2
\end{array} \right.
\]

(20)

The condition \( \phi \geq 2 \) ensures that the probability of entrepreneurial innovation is strictly positive (\( \mu_{t+1} > 0 \)) and less than one (\( \mu_{t+1} < 1 \)). 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 \( \mu_{t+1} \) is an increasing function of the proximity to the world technology frontier \( a_t \):

\[
\frac{\partial \mu_{t+1}}{\partial a_t} > 0.
\]

**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 \( r_{t+1} < \{\bar{\omega} [\tau (1 - \theta) + (1 - \gamma_D)] a_t \}^{\frac{1}{\phi}} \left( \frac{1}{\psi} \right) \frac{1}{\phi} \pi \), the probability of entrepreneurial innovation is a decreasing function of the bank concentration \( H \) measured by the Herfindahl index:

\[
\frac{\partial \mu_{t+1}}{\partial H} < 0.
\]

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5See Appendix C.
6See 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 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 \( r_{t+1} < \left\{ \bar{\omega} \left[ \tau (1 - \theta) + (1 - \gamma_D) \right] a_t \right\}^{\frac{1 - \phi}{\phi}} \left( \frac{1}{\psi} \right)^{\frac{1}{2}} \frac{a_t}{\phi} \), then the bank concentration has a negative effect on economic growth for countries close to the world technology frontier: \( \frac{\partial^2 \mu_{t+1}}{\partial H \partial a_t} < 0 \).

**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.

### 2.3 Dynamics and bank concentration

Substituting the expression of the probability of entrepreneurial innovation into the equation (10) allows us to find the dynamics of the proximity to the world technology frontier:

\[
\begin{align*}
a_{t+1} &= \mu(a_t) + \frac{1}{1 + g} (1 - \mu(a_t)) a_t = F(a_t) \\
&= \left\{ \begin{array}{ll}
\frac{\pi}{\phi \psi (\tau + \gamma D)} \left[ 1 - H \left( \frac{\phi - 1}{\phi} - \bar{\omega} (\phi - 1) \left[ \tau (1 - \theta) + (1 - \gamma_D) \right] \left( \frac{\phi \psi}{\pi^2} \right)^{\frac{1}{2}} a_t r_{t+1}^{\frac{\phi - 1}{\phi}} \right] \right)^{\frac{1}{\phi - 2}} & \text{if } \phi > 2 \\
\frac{2 \bar{\omega} [\tau (1 - \theta) + (1 - \gamma D)]}{\psi \left[ 1 - \frac{2}{\phi} \left( 1 - \frac{\pi \psi}{\phi \phi} \right) \right]} a_t \right\}^{\frac{1}{2}} & \text{if } \phi = 2
\end{array} \right.
\end{align*}
\]

The equilibrium probability of entrepreneurial innovation is given by

\[
\mu(a_t) = \left\{ \begin{array}{ll}
\frac{\pi}{\phi \psi (\tau + \gamma D)} \left[ 1 - H \left( \frac{\phi - 1}{\phi} - \bar{\omega} (\phi - 1) \left[ \tau (1 - \theta) + (1 - \gamma_D) \right] \left( \frac{\phi \psi}{\pi^2} \right)^{\frac{1}{2}} a_t r_{t+1}^{\frac{\phi - 1}{\phi}} \right] \right)^{\frac{1}{\phi - 2}} & \text{if } \phi > 2 \\
\frac{2 \bar{\omega} [\tau (1 - \theta) + (1 - \gamma D)]}{\psi \left[ 1 - \frac{2}{\phi} \left( 1 - \frac{\pi \psi}{\phi \phi} \right) \right]} a_t \right\}^{\frac{1}{2}} & \text{if } \phi = 2
\end{array} \right.
\]

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
\[
z = \frac{H}{(\phi-2)(1+g)} \left[ \frac{\pi}{\phi \psi (r+\gamma_T)} \right]^{2-\phi} < 1.
\]

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
\[
a^* = \frac{(1+g)\mu^*}{\mu^* + g} < 1
\]

(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.

### 3 Bank concentration and convergence: Cross-country and panel evidence

#### 3.1 Specification and data

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

\[
\text{Growth}_{i,t} = \alpha + \delta_1 \text{CONC}_{i,t} + \delta_3 \text{CONC}_{i,t} \times \text{FRONT}_{i,t} + \sum_{k=1}^{K} \beta_k x_{k,i,t} + \xi_i + \zeta_t + \varepsilon_{i,t}
\]

(23)

where \( i \) and \( t \) denote country and period; \( \alpha, \xi_i, \) and \( \zeta_t \) 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

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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/](https://pwt.sas.upenn.edu/). Our results remain robust using RGDPCH, i.e. per capita GDP instead of per worker GDP. See Table 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](http://www.rug.nl/research/ggdc/data/penn-world-table). For details see, Tables 10 and 11.
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.\footnote{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 3.}

$\text{CONC}_{i,t}$ is the bank concentration, which is equal to the share of assets of the three largest banks in total banking system assets.\footnote{Concentration measures, from Beck et al. (2010), are publicly available at \url{http://www.econ.brown.edu/fac/Ross_Levine/IndexLevine.htm}.} Its value lies between 0 and 1, where 0 indicates a low bank concentration and 1 indicates a high bank concentration. Table 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 6.

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).\footnote{Legal origin dummies are from Laporta et al. (2008), and their dataset is publicly available at \url{http://mba.tuck.dartmouth.edu/pages/faculty/rafael.laporta/publications.html}. We also use the legal origin as instrumental variables for the cross-country regressions.}

Other control variables, from the World Bank WDI,\footnote{The World Development Indicators are publicly available at \url{http://www.worldbank.org/}.} 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, consumer price 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, where the Laspeyres formula is generally used\textsuperscript{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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Table 2 around here

Table 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.

3.2 Cross-country regression results

Table 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

\textsuperscript{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 8.
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 3 around here

### 3.3 Panel results

In this section, we verify the predictions using panel data. The results are presented in Table 4 without control variables and in Table 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 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 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 6, 7, and 8.
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 4 and in columns (4), (8), and (12) of Table 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 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 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 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 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%.

In Table 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 7 around here

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 8, and the panel results are given in columns (4)-(7) of Table 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 8 around here

In our specifications, we include bank regulation variables (activity restriction, required reserves, bank development, and official supervisory power)\textsuperscript{14} by following Beck \textit{et al.} (2004). The results are presented in columns (2)-(5) of Table 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

\textsuperscript{14}Bank restriction and bank efficiency data, from Levine \textit{et al.} (2007) and Levine \textit{et al.} (2008), Survey of Bank Regulation and Supervision, publicly available at econ.worldbank.org
firms as a share of GDP, bank concentration and the interaction term \((\text{CONC} \times \text{FRONT})\); 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 \((\text{CONC} \times \text{FRONT})\); controlling for net interest margin, we find that bank concentration and the interaction term exert a negative and significant effect on growth at 5%. Controlling for bank efficiency, our theoretical predictions and empirical results remain robust.

In Tables 10 and 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 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.

We also use the average per capita GDP growth rate in Table 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

\(^{15}\)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.
findings confirm our theoretical and empirical results and validate at the same the robustness of our results.

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:

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

$$\frac{\partial T_{t+1}}{\partial r_{t+1}} = - \frac{\pi}{(\phi - 1)r_{t+1}^2} \left( \frac{\pi}{\phi \psi r_{t+1}} \right)^{\frac{1}{\phi - 1}} \bar{A}_{t+1}$$ (25)

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

$$\frac{\partial T_{t+1}}{\partial r_{t+1}} r_{t+1} = - \frac{\pi}{(\phi - 1)r_{t+1}} \left( \frac{\pi}{\phi \psi r_{t+1}} \right)^{\frac{1}{\phi - 1}} \bar{A}_{t+1}$$ (26)

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

$$\frac{1}{\epsilon} = - \frac{T_{t+1}}{\frac{\partial T_{t+1}}{\partial r_{t+1}} r_{t+1}} = \frac{\phi - 1}{\phi} - \frac{\bar{\omega} (\phi - 1)(1 + r_{D,t}) r_{t+1} a_t}{\pi \left( \frac{\pi}{\phi \psi r_{t+1}} \right)^{\frac{1}{\phi - 1}}}$$ (27)

where $\bar{\omega} = \frac{\omega}{1 + g}$. The inverse of the elasticity of the demand depends on $\phi$, the parameter that captures the curvature of the cost of innovation; a share of wages and profits, $\bar{\omega}$ and $\pi$; $r_{D,t}$, 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 $r_{t+1}$:

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

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:

$$\frac{1}{\epsilon} = - \frac{T_{t+1}}{\frac{\partial T_{t+1}}{\partial r_{t+1}} r_{t+1}} = \left( 1 - \frac{1}{2} \frac{[\tau (1 - \theta) + (1 - \gamma_D)] \omega \psi r_{t+1} a_t}{\pi^2 (1 + g)} \right)$$ (28)
Appendix B: Lerner Index

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

(FOC) \[
\begin{cases}
H r_{t+1}' T_{t+1} \mu_{t+1} + r_{t+1} \mu_{t+1} = \tau + \gamma_T \\
\tau_D = r_D^* = \tau (1 - \theta) - \gamma_D
\end{cases}
\]  

(29)

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

\[ r_{t+1} \mu_{t+1} = \frac{\tau + \gamma_T}{r_{t+1} + 1} \]

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

\[ \frac{r_{t+1} \mu_{t+1} - (\tau + \gamma_T)}{r_{t+1} \mu_{t+1}} = \frac{H}{\epsilon} \]  

(30)

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

\[ \frac{1}{\epsilon} = \frac{\phi - 1}{\phi} - \frac{\bar{\omega}(\phi - 1)(1 + \bar{r}_D) r_{t+1} a_t}{\pi \left( \frac{\pi}{\phi \psi r_{t+1}} \right)^{\phi - 1}} - \Gamma a_t^{\frac{\phi - 1}{\phi}} \]  

(31)

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

**Case of \( \phi = 2 \).** The Lerner index is given by:

\[ 1 - \frac{\psi (\tau + \gamma_T)}{\pi} = \frac{H}{\epsilon} \]  

(32)

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

\[ \frac{1}{\epsilon} = \frac{1}{2} - \left( \frac{\pi}{\phi \psi} \right)^{\phi - 1} \bar{r}_{t+1} a_t \]  

(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 \( \mu_{t+1} \). First, we rewrite the expression of \( r_{t+1} \mu_{t+1} \) using equation (12) such that:

\[ r_{t+1} \mu_{t+1} = \Omega r_{t+1}^{2 - \phi} \]  

(34)
where $\Omega \equiv \left( \frac{\pi}{\varphi \psi} \right)^{\frac{1}{\phi - 1}}$. Then, substituting equation (31) and equation (34) into the equation (30), we get:

$$1 - \frac{(\tau + \gamma T)}{\Omega} r_t^{\frac{2 - \phi}{\phi - 1}} = H \left( \frac{\phi - 1}{\phi} - \Gamma a_t r_t^{\frac{\phi - 1}{\phi - 1}} \right)$$

(35)

Finally, rewriting equation (35) allows us to find the implicit relation between the loan rate $r_{t+1}$ and the proximity to the worldwide technological frontier $a_t$:

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

(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 (33) into the equation (32).

$$1 - \frac{\psi(\tau + \gamma T)}{\pi} = H \left( \frac{1}{2} - \frac{[\tau(1 - \theta) + (1 - \gamma_D)]}{\pi^2} \bar{\omega} \psi r_t^{2} a_t \right)$$

and finally the equilibrium loan rate is obtained as:

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

(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:

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

(38)

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

**Case of $\phi = 2$.** To prove Proposition 1 for $\phi = 2$, we differentiate the equilibrium loan rate given by equation (37) with respect to the proximity to the worldwide technological frontier $a_t$:

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

(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:

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

(40)

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

Case of $\phi = 2$. To prove the Proposition 1 for $\phi = 2$, we differentiate the equilibrium loan rate given by equation (37) with respect to the Herfindahl index $H$:

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

(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 (31) into equation (30) we get the following expression for the loan rate:

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

(42)

which we substitute into equation (12) to obtain the equilibrium probability to innovate:

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

(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 $\frac{\phi - 1}{\phi} > \Gamma a_t r_{t+1}^{\frac{\phi - 1}{\phi}}$ (by positivity of the Lerner index) and since $\Gamma a_t r_{t+1}^{\frac{\phi - 1}{\phi}} > \frac{\phi - 1}{\phi} - \frac{1}{H}$.
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 (43) to obtain:

$$\frac{\partial \mu_{t+1}}{\partial a_t} = \frac{1}{\phi - 2} \left( \kappa \left[ 1 - H \left( \frac{\phi - 1}{\phi} - \Gamma a_t \frac{\phi}{\phi + 1} \right) \right] \right)^{\frac{3 - \phi}{\phi - 1}} \left[ H \kappa \Gamma \left( r_{t+1}^{\phi} + a_t \frac{\phi}{\phi - 1} \frac{\partial r_{t+1}^{\phi}}{\partial a_t} \right) \right] \quad (44)$$

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

Substituting the expression of \( \frac{\partial r_{t+1}^{\phi}}{\partial a_t} \) given by (38), we get:

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

Case of \( \phi = 2 \). We first derive the expression of the equilibrium probability to the entrepreneurial innovation. We substitute equation (37) into equation (12) to obtain the probability to innovate:

$$\mu_{t+1} = \sqrt{\frac{2\omega \left[ \tau(1 - \theta) + (1 - \gamma D) \right] a_t}{\psi \left[ 1 - \frac{2}{H} \left( 1 - \frac{1}{\psi(\tau + \gamma z)} \right) a_t \right]}} \quad (45)$$

To prove the Proposition 2 for \( \phi = 2 \) we differentiate equation (45) such that:

$$\frac{\partial \mu_{t+1}}{\partial a_t} = \frac{\omega \left[ \tau (1 - \theta) + (1 - \gamma D) \right]}{\psi \left[ 1 - \frac{2}{H} \left( 1 - \frac{1}{\psi(\tau + \gamma z)} \right) a_t \right]} \left\{ \frac{2\omega \left[ \tau (1 - \theta) + (1 - \gamma D) \right]}{\psi \left[ 1 - \frac{2}{H} \left( 1 - \frac{1}{\psi(\tau + \gamma z)} \right) a_t \right]} a_t \right\}^{\frac{1}{2}} > 0 \quad (46)$$

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 (43). Differentiating this equation with respect Herfindahl index \( H \), we get:

$$\frac{\partial \mu_{t+1}}{\partial H} = -\frac{1}{\phi - 2} \left( \kappa \left[ 1 - H \left( \frac{\phi - 1}{\phi} - \Gamma a_t \frac{\phi}{\phi + 1} \right) \right] \right)^{\frac{3 - \phi}{\phi - 2}} \left[ \kappa \left( \frac{\phi - 1}{\phi} - \Gamma a_t \frac{\phi}{\phi + 1} \right) \right] \quad (47)$$
Since we assume that \( \phi > 2 \) and \( \mu_{t+1} > 0 \), \( \frac{\partial \mu_{t+1}}{\partial H} < 0 \) if \( \left( \frac{\phi-1}{\phi} - \Gamma a_t r_{t+1}^{\frac{\phi}{\phi-1}} \right) > 0 \). This condition implies that: \( r_{t+1} < \left( \frac{\phi-1}{\phi} \right)^{\frac{\phi}{\phi-1}} \) (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 (45). Differentiating this equation with respect to Herfindahl index \( H \), we get:

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

(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:

\[ a_{t+1} = \mu(a_t) + \frac{1}{1+g}(1-\mu(a_t))a_t = F(a_t) \] (49)

where

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

\[
F(0) = \begin{cases} 
\mu(0) = \left[ \frac{\pi}{\phi \psi(\tau + \gamma_T)} \left( 1 - \frac{H(\phi-1)}{\phi} \right) \right]^{\frac{1}{\phi-2}} > 0 & \text{if } \phi > 2 \\
\mu(0) = 0 & \text{if } \phi = 2
\end{cases}
\] (51)
At the worldwide technological frontier, we have (recall that \( \mu \) is a probability and therefore is between 0 and 1 as shown in the main text):

\[
F(1) = \mu(1) + \frac{1}{1 + g} (1 - \mu(1)) = g\mu(1) + \frac{1}{1 + g} < 1
\]  

(52)

where

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

From Proposition 3, we already know that \( F(\alpha_t) \) is an increasing function of the proximity to the worldwide technological frontier \( \alpha_t \) and \( F(\alpha_t) \) 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:

\[
F'(0) = \mu'(0) + \frac{1}{1 + g} (1 - \mu(0))
\]  

(53)

where equation (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:

$$
\|F(1) - F(0)\| = \left\| \mu(1) + \frac{1}{1+g}(1 - \mu(1)) - \mu(0) \right\|
= \left\| g\mu(1) + \frac{1}{1+g} - \mu(0) \right\|
= \frac{1}{1+g} \|g\mu(1) - (1+g)\mu(0) + 1\|
$$

$$
= \frac{1}{1+g} \left\| g \left\{ \kappa \left[ 1 - H \left( \frac{\phi - 1}{\phi} - \Gamma r(1) \frac{\phi}{\phi^2} \right) \right] \right\}^{\frac{1}{\phi-2}} - (1 + g) \left[ \kappa \left( \frac{H(\phi - 1)}{\phi^2} \right) \right]^{\frac{1}{\phi-2}} + 1 \left\|
\leq \frac{\kappa^{\frac{1}{\phi-2}}}{1+g} \left\| g \left\{ \left[ 1 - \frac{H}{\phi-2} \left( \frac{\phi - 1}{\phi} - \Gamma r(1) \frac{\phi}{\phi^2} \right) \right] \right\} - (1 + g) \left[ \left( 1 - \frac{H}{\phi-2} \frac{\phi - 1}{\phi} \right) \right] + 1 \left\|
= \frac{H}{(\phi - 2)(1 + g) \kappa^{\frac{1}{\phi-2}}} \left\| g \Gamma r(1) \frac{\phi}{\phi^2} - \frac{\phi - 1}{\phi} \right\|
\leq \frac{H}{(\phi - 2)(1 + g) \kappa^{\frac{1}{\phi-2}}}
$$

where $\kappa \equiv \frac{\pi}{\phi \psi (\tau + \gamma_2)}$. 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. ■
References


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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).
Table 4: Panel regressions without control variables

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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).
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</table>

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).
Table 6: Cross-country regressions using Herfindahl Index

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<td>(0.014)</td>
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<td>(0.005)</td>
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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).

Table 7: Panel regressions without control variables using the average per capita GDP growth rate

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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).
Table 8: Cross-country and panel regressions using inflation measured by the annual growth rate of the GDP implicit deflator

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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).

Table 9: Cross-country using bank control variables

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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.
Table 10: Panel regressions using Penn-World Table 8 and the average per worker GDP growth rate

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<td>(0.025)</td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>CONC × FRONT</td>
<td></td>
<td></td>
<td></td>
<td>-0.004</td>
<td>-0.018</td>
<td>-0.026</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
<td>(0.033)</td>
<td>(0.009)</td>
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</tr>
<tr>
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<td>518</td>
<td>518</td>
<td>517</td>
<td>517</td>
<td>517</td>
</tr>
<tr>
<td>Country dummies</td>
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<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Year dummies</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

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.

Table 11: Panel regressions using Penn-World Table 8 and the average per capita GDP growth rate

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<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
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<td>-0.024</td>
<td>-0.025</td>
<td>-0.068</td>
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<td>(0.061)</td>
<td>(0.152)</td>
<td>(0.003)</td>
<td>(0.017)</td>
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<tr>
<td>CONC × FRONT</td>
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<td></td>
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<td>-0.003</td>
<td>-0.016</td>
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<td>(0.040)</td>
<td>(0.036)</td>
<td>(0.003)</td>
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<tr>
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<td>yes</td>
</tr>
</tbody>
</table>

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.