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Abstract

The connection between the financial crisis and global imbalances is controversial. This paper argues that this relationship is likely to be connected to the existence of heterogenous financial frictions in different domestic credit markets. By developing a general equilibrium model where adverse selection and limited pledgeability coexist, this work highlights why adverse selection may play a pivotal role in determining the different (often opposing) welfare effects of international capital flows on originating and destination countries. This perspective also advances an analytical framework that is flexible enough to analyze the global effects on investment allocation of the "Saving Glut", of the policies facilitating financial integration and macro-prudential policy.

Keywords: Limited Pledgeability, Asymmetric Information, International Capital Flows, Welfare, macro-prudential policy

JEL Classification: D53, E2, F3

Non-technical summary

Since the prolonged financial crisis that started in 2007, financial imperfections have returned at the center of macroeconomics. The financial crisis has also questioned the benefits of international financial integration. While the empirical debate regarding the exact nature of international capital flows developed (e.g. Alfaro et al. (2011) and Gourinchas and Rey (2013)) and financial imbalances appeared and persist in Europe (Lane (2013)), the question remains: to what extent does the direction, size and welfare effect of international capital flows depend on the nature and cross-country distribution of financial frictions among financially integrated economies? In other words: in order to evaluate the welfare and policy implication of financial integration, how important is to consider the nature of financial frictions in all countries rather than only the frictions present in the domestic credit market as it is typically assumed in the literature?

In macroeconomic models, financial frictions are most often identified by the assumption of limited pledgeability. This assumption consists in allowing individuals to borrow only against a limited share of their future stock of wealth and production, typically by providing collateral. Real-world financial markets though are also characterized by asymmetric information regarding investment's real value. Some (e.g. Brunnermeier (2009)) argues that the latter feature played a key role in explaining the financial crisis of 2007-09. Financial frictions have also been invoked to explain the run-up to the crisis and the unfolding of events during the crisis itself (Bernanke (2009)). This discussion raises a natural question: can we study the interaction of these two frictions - limits to leverage and asymmetric information - to provide a more comprehensive perspective to think about financial integration, the financial crisis and the appropriate policy response?

In this paper, we show that international capital flows and their welfare effects depend on the specific type and intensity of the financial frictions present in the domestic and foreign credit markets. The proposed perspective is applied to shed new light on the effect of the "Saving Glut", the decision regarding financial integration and macro-prudential policy.

Bernanke (2005) advanced the idea of a global "saving glut" in search for financial intermediation. This paper shows how this extraordinary liquidity may misplace and reduce credit to good entrepreneurs, lower productivity and produce a negative welfare effect. Therefore we point out that, if the policymaker wishes to facilitate a surge in investment connected to the "saving glut", the generation investing the "glut" needs to be compensated for the welfare loss. If the generation that invest in capital accumulation does not have the time to enjoy the benefit of this accumulation

through higher future wages, its welfare will be reduced. This is also the generation that has to make the choice regarding financial integration and it is then useful, at least from the point of view of political economy, to focus our welfare analysis almost exclusively on the surplus resulting to the investing generation.

In the context of financial integration, this perspective of this paper shows that, if a country is financially developed, it would be better off by developing a sufficiently large credit market before becoming integrated with less financially advanced countries. If, instead, the country were financially underdeveloped, it should try to integrate with equally large economies that are endowed with deeper and more developed credit markets.

Finally, in the context of macro-prudential policy, this research perspective shows that any policy directed at managing credit flows should take into account the degree of asymmetric information across sectors in the economy in allowing the level of leverage. Leverage should be facilitated in the sectors where private information is less important and should be closely monitored, if not limited, in the sectors where private information is more present. The combination of sector-dependent credit policy would serve macro-prudential objectives: it will raise the equilibrium interest rates, increasing investment where it's most productive and reducing it in the sectors where it is most inefficient.

Consistently with the recent literature on capital flows, our model assigns a key role to differences in limited pledgeability constraints across countries (Caballero, Fahri and Gourinchas (2008)). According to this view, the intensity of limited pledgeability has been at the heart of recent capital flows between Asia and the United States. Financial flows therefore go to those economies where credit market institutions allow greater leverage, e.g. the United States or the UK, because they are better able to provide financial intermediation.

In addition to the literature, our perspective points out how asymmetric information may expand these results. Is it possible that capital inflows into the United States or core countries in the Euro Zone, exacerbating the adverse effect of asymmetric information, lead to lower productivity? Could these countries ultimately suffer a welfare loss if the rest of the world uses their financial system to intermediate resources? We suggest that international capital flows that are driven primarily by differences in the severity of limited pledgeability and the intensity of asymmetric information across economies may be excessive from the perspective of all parties involved, so that *all* economies could benefit from some degree of capital controls. These are crucial issues when we think about the management of financial integration and the reform of the international architecture.

1 Introduction

Since the financial crisis started in 2007, financial imperfections have once again settled at the center of macroeconomics. In the context of international finance in particular, the financial crisis has questioned the benefits of international financial integration and raised the interest toward macro-prudential regulation. While the empirical debate regarding the exact nature of international capital flows develops (e.g. Alfaro et al. (2011) and Gourinchas and Rey (2013)) and financial imbalances also emerge in Europe (Lane (2013)), the question still remains: to what extent does the direction of international capital flows, the extent of financial integration and their combined welfare effect depend on the nature and cross-country distribution of financial frictions? This paper contributes to this question by providing a simple neoclassical growth model where domestic financial imperfections play a center role in the international allocation of capital. We show that the welfare implications of international capital flows and the design of macro-prudential architecture depend on the specific type, intensity and distribution of financial frictions between domestic and foreign credit markets. The proposed perspective is applied to discuss the possible effects of the global "Saving Glut", the policies to facilitate financial integration and the design of macro-prudential policy.

These questions are difficult to analyze with existing macroeconomic models that are mostly concerned with limited pledgeability, often neglect adverse selection or oversimplify credit contract dynamics. To address the limitations of this perspective, this paper brings forward adverse selection by developing and expanding the stylized model of growth in Martin and Taddei (2013). Entrepreneurs need to borrow in order to determine the size of their investment project. The projects themselves are used as collateral, but financial markets are characterized by two frictions: (i) collateral is limited by a pledgeability constraint, which restricts what creditors can seize in the event of a default, and; (ii) there is asymmetric information regarding the quality of collateral, as the productivity of projects is not observable. We find that adverse selection fosters unproductive investment and, in doing so, it (i) negatively affect the size of productive investment, and (ii) it generates a negative wedge between the marginal return to investment and the equilibrium interest rate. Under international financial integration, which is the case of particular interest to us, we show how asymmetric information may trigger welfare reducing capital inflows. We show that both frictions complement one another so that asymmetric information exacerbates the effects of limited pledgeability.

Differently from Martin and Taddei (2013) where "excess" investment was tamed by an increase in credit rationing, here the surge in investment is constrained by the entry of bad quality entrepreneurs that endogenously reduce the optimal size of the loan for good quality investors. This is not just a technical distinction: it shows that, especially with low interest rate, the presence of unproductive entrepreneurs not only displaces productive investment, as in the case of credit rationing, but it also reduce their size. It is then necessary to

study whether this displacement effect can be so powerful to reduce welfare for the current and future generations. In particular, the paper shows that the adverse effect of financial integration on the country with the highest level of potential leverage depends on the size adjustment of individual investment to the level of the interest rate. Moreover, we extend the study of financial integration to a simple world general equilibrium. We will show that the endogenous size of investment, due to the credit contract dynamics, allows to intersect our analysis with three topics that gained attention in international macroeconomics: the global "Saving Glut", the degree of financial integration and the design of macro-prudential policy.

In this contribution, we embed this richer framework into a general equilibrium model of the economy under financial autarky and then we extend it to one of the simplest versions of the world economy. In line with the recent literature on capital flows, this model would assign a key role to the world supply and distribution of collateral across countries. Consider the "asset shortage" view of global imbalances (Caballero, Fahri and Gourinchas (2008)). According to this view, collateral has been at the heart of recent capital flows between Asia and the United States. Even though Asian economies grow fast and have good investment opportunities, they lack the collateral so that debtors can commit repayment required to obtain credit that funds these investments. Financial flows therefore go to those economies where collateral is abundant, e.g. the United States or the UK, because they are better able to provide financial intermediation.

The model is consistent with the view outlined above that is extended by incorporating adverse selection. Could capital inflows into the United States or core countries in the Euro Zone, by exacerbating adverse selection, affect the average quality of investment in those economies and lead to inefficient allocations and lower productivity? Could these countries ultimately suffer a welfare loss if the rest of the world uses their financial system to intermediate resources? Our results suggest that, in fact, international capital flows that are driven primarily by differences in the supply (limited pledgeability) and quality (asymmetric information) of collateral across economies may be excessive from the perspective of all parties involved, so that *all* economies could benefit from some degree of capital controls. These are crucial questions for the management of financial integration and the reform of the international architecture. The model in this paper contributes to provide a deep but parsimonious framework to address them.

We also apply the proposed perspective to inform policies in three different issues. First, Bernanke (2005, 2013) advanced the idea of a global "saving glut" in search for financial intermediation. This paper shows the potentially negative welfare effect of this intermediation through the reduction in the credit to good quality entrepreneurs. We point out that, if the policymaker wishes to implement the surge in investment connected to the "saving glut", the generation investing the "glut" needs to be compensated for the welfare loss to avoid hindering the process of financial integration.

Second, in the context of financial integration, this paper shows that, if a country is

financially developed, it would be better off by reaching a sufficiently large size before becoming integrated with less financially advanced countries; if instead it were financially underdeveloped, a country should try to integrate with similar size partners that are endowed with deeper and more developed credit markets. Interestingly enough, advanced countries should consider sector specific capital requirements that are inversely related to the intensity of asymmetric information if they move toward enhanced international integration.

Finally, in the context of macro-prudential policy, the paper provides some guidance in the allocation of leverage across sectors in the economy. Leverage should be facilitated where private information is immaterial so as to increase the equilibrium interest rates in the economy and reduce inefficient investment in the sectors featuring asymmetric information. The positive spillovers to the sectors where asymmetric information is most intense take place only if sector specific leverage limits are implemented.

Financial frictions are most often identified in macroeconomic models by the assumption of limited pledgeability. This assumption consists in allowing individuals to borrow only against a limited share of their future stock of wealth and production. Real-world financial markets are characterized not only by a potential scarcity of collateral or by credit market institutions that do not allow to credibly commit for repayment a large share of the future proceedings of investment, but also by asymmetric information regarding collateral's real value. Some (e.g. Brunnermeier (2009)) argues that the latter feature played a key role in the recent financial crisis. In the case of the crisis of 2007-09, financial frictions have also been invoked to explain the run-up to the crisis and the unfolding of events during the crisis itself (Bernanke (2009)). This approach raises some key questions: how can we analyze the interaction of these two frictions, and how do the implications of standard models change when both financial frictions are present?

This paper is related to the large body of research in macroeconomics that deals with financial frictions. The part of this literature closest to this paper starts from Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) and highlights the role of borrowing constraints for macroeconomic outcomes. Most of these papers illustrate how financial frictions can restrict an economy's ability to borrow. Gertler and Rogoff (1990), Boyd and Smith (1997), Matsuyama (2004) and Aoki, Benigno and Kiyotaki (2009) develop this line of research. Similar models have been used recently to account for global imbalances. In Caballero, Fahri and Gourinchas (2008), for example, high-growing developing economies may nonetheless experience capital outflows due to pledgeability constraints that restrict their supply of financial assets. Heathcote and Perri (2013), in a thorough survey, asks a very related question to the one proposed here: is the international allocation of resources efficient? The main difference between their approach and ours is that, while they abstract from the inefficiencies within national credit markets, we show how they are in fact crucial to evaluate the welfare effect of international capital flows. To the best of our knowledge, however, this may be one of the first papers to analyze the interaction of adverse

selection with pledgeability constraints in order to draw policy implications in terms of financial integration and macro-prudential regulation. Differently from the emerging view that connects macro-prudential policy to international spillovers (e.g. Jeanne (2014)), our perspective emphasizes the role of financial frictions in domestic credit markets.

Section 2 provides the setup of the economy, Section 3 describes the functioning of credit markets, Section 4 derives the equilibrium under financial autarky, Section 5 applies the perspective to international integration. Section 6 concludes.

2 The Economy

Consider an economy inhabited by overlapping generations of young and old, all with size one. Time starts at $t = 0$ and then goes on forever. All generations maximize the expected consumption when old: $U_t = E_t c_{t+1}$; where U_t and c_{t+1} are the welfare and the old-age consumption of generation t. The output of the economy is given by a Cobb-Douglas production function of labor and capital: $F(l_t, k_t) = l_t^{1-\gamma} \cdot k_t^{\gamma}$ with $\gamma \in (0, 1)$, and l_t and k_t are the country's labor force and capital stock, respectively. All generations have one unit of labor which they supply inelastically when they are young, i.e. $l_t = 1$.

The central economic problem that we are considering is that of transforming consumption goods at time t into consumption at $t + 1$ in the most efficient way. To do so, individuals in our economy have two options. They may deposit their savings in a bank yielding r_{t+1} units of the consumption good at $t + 1$ for every unit stored at time t. Alternatively, they may start their own independent investment opportunity and become entrepreneurs. Investment opportunities producing capital at time $t + 1$ employ time t output. Banks will loan their deposits to entrepreneurs in exchange for a n interest rate. Since investment opportunities are individual dependent, they may be subject to different kinds of intermediation frictions.

The stock of capital in period $t + 1$ is produced through the investment opportunities activated by individuals in generation t during their youth.[1] To make the problem interesting, we assume that individuals differ in their ability to produce capital. In particular, it is assumed that the capital producing projects are of two qualities. Individuals are indexed by $j = B, G$ ("Bad" or "Good") and they are uniformly distributed over the unit interval. Individuals of each type have measure μ^j, $j \in \{B, G\}$, where $\mu^G + \mu^B = 1$. An entrepreneur of type j has a successful (unsuccessful) state tomorrow with probability p^j $(1 - p^j)$, where $p^G > p^B$. If successful (unsuccessful), an entrepreneur of type j who invests I_t^j units of the consumption good in t obtains a gross return of $\left(\alpha \cdot I_t^j\right)$ units of capital (zero) in $t + 1$. The size of investment is an optimizing decision of the entrepreneur.

[1] The paper assumes that (i) producing units of capital requires units of consumption, and that (ii) capital fully depreciates in production. We also assume that the first generation found some positive amount of capital to work with, i.e. $k_0 > 0$.

In this setting, the capital stock at $t+1$ will depend not only on the total investment made at time t, but also on the productivity of such investment. In particular, if we use $E(p)$ to denote the expected probability of success among investment projects that are undertaken, we can write the law of motion of capital as:

$$k_{t+1} = E_t(p^j) \cdot s_t \cdot k_t^{\gamma}, \tag{1}$$

where s_t is the investment rate, i.e. the fraction of output that is devoted to capital formation. Markets are competitive and factors of production are paid the value of their marginal product:

$$w_t = (1-\gamma) \cdot k_t^{\gamma} \text{ and } q_t = \gamma \cdot k_t^{\gamma-1}, \tag{2}$$

where w_t and q_t are the wage and the rental rate of capital, respectively.

To solve the model, we need to find the investment rate and the expected productivity of investment. The investment rate of this economy is immediate: the old do not save and the young save their entire income. The central question is what do the young do with their savings? In our economy, they can only use them to build capital. This means that, at the aggregate level, the investment rate equals the savings of the young. Since the latter equal labor income, which is a constant fraction $1-\gamma$ of output, the investment rate is constant as in the classical Solow (1956) model:

$$s_t = 1 - \gamma. \tag{3}$$

3 Credit Markets and Financial Intermediaries

The central question of the model is what determines the expected productivity of investment, $E(p)$. The driving force in the analysis lies in the choice to start an investment project and become an entrepreneur. This choice in turn depends on the functioning of credit markets. We now analyze the competitive equilibrium of the economy under different financial frictions. We first consider the effect of limited pledgeability in credit markets. We will then analyze the case in which credit markets are characterized by the presence of two financial frictions together: limited pledgeability and asymmetric information.

Since each individual has only her wage w_t to invest during youth, she may wish to access credit in order to increase the size of investment. We assume that all such borrowing is undertaken through banks. Banks are finite in number, risk neutral and perfectly competitive. They act as intermediaries that collect deposits from individuals to offer loan contracts to active entrepreneurs.

On the deposit side, they take the gross interest factor on deposits r_{t+1} as given and they compete on the credit market by offering loan contracts. Entrepreneurs and banks sign a loan contract of the form (C_t, L_t, R_{t+1}), where C_t is the amount invested by entrepreneurs from their own wealth at time t, L_t is the amount lent to entrepreneurs for investment at

time t and R_{t+1} is the contractual repayment on the loan at time $t+1$. In the event of success, entrepreneurs have the option to pay back the amount agreed to the bank $R_{t+1} \cdot L_t$. Otherwise, they default and the bank gets nothing.

This setup implies that the expected profit that a j-type entrepreneur obtains from loan contract (C_t, L_t, R_t) is

$$\pi^j(C_t, L_t, R_{t+1}) = p^j \cdot \{q_{t+1} \cdot \alpha [I_t = (C_t + L_t)] - R_{t+1} \cdot L_t]\}. \tag{4}$$

It is assumed that each bank gets the same share of total deposits and, if they design the same contract, they get the same share and composition of loan applications. A bank's expected profits in period $t+1$ of accepting an application for a contract (L_t, R_{t+1}, C_t) in period t from a type-j entrepreneur are given by

$$p^j \cdot R_{t+1} L_t - r_{t+1} \cdot L_t \tag{5}$$

At the outset of our discussion it is worthwhile to point out that, regardless of the specific type of credit-market friction under study, there are two features that any equilibrium must satisfy. First, all contracts offered must satisfy a zero-profit condition for banks: clearly, no equilibrium contracts can yield negative profits to intermediaries, and – due to perfect competition – no equilibrium contracts can yield positive profits either. Second, investment in equilibrium must satisfy the individual's participation constraint: since all individuals care only about second period consumption, they will become entrepreneurs only if the return of doing so exceeds that of opening a deposit account in the banking system. Given our technological assumption, it is immediate to observe that the equilibrium loan contract depends on the underlying financial frictions. Let us turn to these now.

3.1 Credit Market Equilibrium Contract under Limited Pledgeability

Given our setup, we can safely ignore the time subscript in the discussion regarding the determination of the equilibrium loan contract.[2] We start by analyzing the credit market equilibrium when individuals have no private information regarding the investment opportunity at their disposal. Even when individuals have no private information on the actual quality of their project, they may not be able to credibly pledge for repayment the entire proceedings of their investment. In fact, in the event of default, banks can only seize fraction $0 < \lambda < 1$ of the project's output. Formally, given loan contract (L, C, R), this implies:

$$R \cdot L \leq \lambda \cdot q\alpha (L + C). \tag{6}$$

In reality many are the reasons that prevent creditors from seizing the entire wealth of their debtors in the event of default. Here we want to emphasize the quality of credit

[2] The reader should keep in mind that the price of capital in the equations that follow refers to the period following the one of investment.

market institutions to enforce creditors' rights as the crucial determinant. Since we refer to a specific institutional feature, its quality may - and in general will - be country-specific.

Under the stated assumptions, banks are competitive and so they make zero profits by setting expression (5) equal to zero; the only financial friction faced by lending institutions is the pledgeability constraint (6). Hence, letting $\{L^j, R^j, C^j\}$ denote the equilibrium contracts under full information, it is straightforward to verify that the loan contracts satisfy

$$\begin{aligned} C^j &= w \\ R^j &= \tfrac{r}{p^j} \\ \left(R^j \cdot L^j\right) &\leq \lambda \cdot q\alpha(L^j + w) \\ L^j &= \tfrac{q \cdot \lambda \alpha p^j}{r - q \cdot \lambda \alpha p^j} w \\ \text{for } j &\in \{G, B\}\,. \end{aligned} \tag{7}$$

Under full information, entrepreneurs invest all of their wealth in the project, banks break even in both contracts and the only source of credit rationing comes from the pledgeability constraint. In the absence of such constraint, we would have that the investment would be entirely concentrated within the most productive entrepreneurs $j = G$ and the interest rate would be $r = p^G \cdot q\alpha$. In our setup instead, it is interesting to observe what is the allocation of investment when the pledgeability constraint binds, i.e. $\lambda < 1$. In this case, entrepreneurs of type j can invest at most:

$$I^j = L^j + w = \left(\frac{r}{r - q(r) \cdot \lambda \alpha p^j}\right) \cdot w \tag{8}$$

where entrepreneurs invest all their wage because self financed investment can be leveraged to increase the total size of investment.

The price of capital $q(r)$ must be, in equilibrium, a concave and increasing function of the interest rate r. Suppose that $q(r)$ were a decreasing function of the interest rate: then we would get the immediate contradiction that, when the interest rate falls, the price of capital increases determining an increase in the size of investment I, - see equation (8), which delivers a fall in the marginal productivity of capital. But it is impossible that both $q(r)$ increases while the marginal productivity of capital falls. Thus, as the interest rate falls, also $q(r)$ must fall. Although the fall in the price of capital $q(r)$ decreases the size of investment I, the net effect of a falling interest rate on investment must be positive. Suppose that this were not the case: if a fall in r had an overall negative effect on individual investment I, because the price of capital falls "too much", aggregate capital would fall as the interest rate goes down, marginal productivity would raise and this would result into an increase in $q(r)$. This is, again, a contradiction. If we derive equation (8) with respect to the interest rate r keeping these considerations in mind, we can easily prove the following remark:

Remark: *When the pledgeability constraint binds, i.e.* $\lambda < 1$*, individual investment* I^j *is decreasing in the interest rate* r *and the price of capital is a concave function of the*

interest rate:

$$\frac{dI}{dr} < 0 \Leftrightarrow \frac{\partial q(r)}{\partial r} < \frac{q(r)}{r} \tag{9}$$

Finally, it is worthwhile noticing that, under full information, entrepreneurial wealth serves solely as collateral necessary to loosen the pledgeability constraint and it is not a screening device. The dynamic behavior of this economy is fully standard as it approximates the Neoclassical growth model.[3]

3.2 Credit Markets under Limited Pledgeability and Private Information

We now turn our attention to the more interesting case of an economy where individuals are privately informed regarding the quality of their investment opportunity. In this economy banks are not able to directly observe the probability of success of an entrepreneur applying for a loan. As in Besanko and Thakor (1987) and Reichlin and Siconolfi (2004), it is assumed that borrowers' types cannot be observed either directly (*ex ante*) or through realized project returns (*ex post*). Hence, all agents other than the owner of the project can only verify whether the latter was successful or not. In such a setup with linear technology, it is known (see De Meza and Webb (1987)) that the optimal contractual form is debt/loan. This is the contract that we will use in the following discussion.

Under asymmetric information, it becomes crucial how we model competition among banks. We model the credit market *à la* Hellwig as a three-stage game of screening. In the first stage, banks design the loan contracts; in the second stage, entrepreneurs apply for the available contracts; in third stage, applications are either accepted or rejected. This specification is useful because it avoids problems of existence that may otherwise arise in games of screening *à la* Rothschild-Stiglitz. As Hellwig shows, this structure implies that the allocation most preferred by good quality entrepreneurs emerges as the robust sequential equilibrium of the model. In other words, the most robust outcome of the aforementioned economy will be the separating contracts insofar they provide good entrepreneurs with higher profits than any pooling contracts. On the contrary, if there are pooling contracts that are Pareto superior to the separating contracts, the one mostly preferred by good entrepreneurs will emerge as the robust equilibrium of the model. Given the pivotal role for pooling equilibria in our arguments, this specification is a natural choice.

3.2.1 Loan Contracts under Asymmetric Information

Consider now the introduction of asymmetric information in credit markets. In particular, we assume that individuals are better informed about their actual productivity than their potential lenders. This is consistent with the kind of financial friction that has often been invoked to be central during the financial turmoil that started in 2007 (see Brunnermeier (2009) for a survey). Relative to the standard frictionless model, the formal modification

[3] The behavior is similar to Matsuyama (2004) and Martin and Taddei (2013).

of our setup is that individual j's probability of success, p^j, is private information and, thus, unobservable to banks.

Under the standard assumptions of exclusivity and no cross-subsidization, a separating equilibrium is defined as a pair of loan contracts $\{(R^B, C^B, L^B), (R^G, C^G, L^G)\}$ satisfying incentive compatibility and the zero profit condition of banks such that there are no profitable deviations for any type.[4] The triple (R^j, C^j, L^j) indicates the contractual interest rate, R^j, self financed investment, C^j, and loan size, L^j, designed for entrepreneurs of type j. The separating contract results from the following optimization problem:

$$\max_{L^G, R^G, C^G} \left\{\pi^G(L^G, R^G, C^G; r)\right\} = p^G \cdot \left[q(r)\alpha(L^G + C^G) - R^G L^G\right] + r\left(w - C^G\right) \tag{10}$$

subject to

$$C^j \leq w \tag{11}$$

$$\frac{rL^j}{p^j} = R^j L^j \leq \lambda \cdot q(r)\alpha(L^j + C^j) \tag{12}$$

$$\begin{aligned}\max_{L^B, R^B, C^B} \left\{\pi^B(L^B, R^B, C^B; r)\right\} = \left\{p^B \cdot \left[q(r)\alpha(L^B + C^B) - R^B L^B\right] + r\left(w - C^B\right)\right\} \geq \\ \geq \pi^B(L^G, R^G, C^G; r) = \left\{p^B \cdot \left[q(r)\alpha(L^G + C^G) - R^G L^G\right] + r\left(w - C^G\right)\right\}\end{aligned} \tag{13}$$

where we maximize the profit of good quality entrepreneurs subject to the following set of constraints: inequality (11) is the collateral constraint ensuring that entrepreneurs can not pledge as self financed investment more than their endowment, inequality (12) states that banks must make at least zero profits when they offer a loan contract and inequality (13) is the incentive compatibility constraint that ensures that bad quality entrepreneurs rather choose their loan contract and not the one designed for higher quality entrepreneurs.

In the construction of the candidate separating loan contracts, it is necessary to consider two different cases: when the bad project is sufficiently productive compared to the interest rate and when it is not. When the investment project in the hands of bad entrepreneurs is more productive than the interest rate, i.e. $r \leq q(r) \cdot \alpha p^B$, the optimal (separating) contract offered to bad entrepreneurs entails $L^B > 0$ and $C^B = w$. Instead, when bad projects are less productive than bank deposits, i.e. $r > q(r) \cdot \alpha p^B$, then $C^B = L^B = 0$. This means that whenever the technology of bad entrepreneurs yields less than the prevailing equilibrium rate of interest, any separating equilibrium allocation must entail that bad entrepreneurs are better off by depositing their resources in the bank instead of investing directly.

Since we want to focus on the economies where there is the potential for inefficient investment, let us study the case when the interest rate is larger than the productivity of bad entrepreneurs. Formally:

Remark: *Inefficient investment is possible iff depositors' interest rate r relative to the price of capital $q(r)$ satisfies the following inequalities:*

[4] Exclusivity implies that borrowers can only apply to one loan contract. No cross-subsidization means that banks can not use the profits in one loan contract to compensate the losses in another.

$$\alpha p^G > \frac{r}{q(r)} > \alpha p^B \tag{14}$$

In the set of economies where inequality (14) is satisfied, the investment of low productivity entrepreneurs, whenever it takes place, is suboptimal. The collateral constraint (11) will bind in equilibrium because self financed investment can be leveraged to increase the total size of investment. The constrained maximization of good quality entrepreneurs' profits (10) simplify into:

$$\max_{L^G} \left\{ \pi^G(L^G; r) \right\} = p^G \cdot q(r)\alpha(L^G + w) - rL^G \tag{15}$$

subject to

$$\frac{r}{p^G} L^G \leq \lambda \cdot q(r)\alpha(L^G + w)$$

$$rw \geq \pi^B(L^G, r) = p^B \cdot q(r)\alpha(L^G + w) - \frac{p^B}{p^G} rL^G \tag{16}$$

where the first inequality is the pledgeability constraint and the second inequality is the incentive compatibility constraint ensuring that B-type individuals do not become active entrepreneurs. It can be proved that whether inequality (16) binds or not depends on the relationship between the value of the interest rate, r, and the size of the loan, L^G. Simple calculations show that, if the interest rate is larger than the threshold $\overline{r}$, then unproductive entrepreneurs are (at least weakly) better off depositing their funds in the bank instead of operating their technology through the maximum (full information) loan size, i.e. $L^G = L^{G^*}$ defined in equation (7). Formally:

$$\begin{gathered} rw > \pi^B(L^G; r) \\ \Leftrightarrow \\ r > \overline{r} = q(\overline{r}) \cdot \alpha p^B \left[\frac{w + L^{G^*}}{w + \frac{p^B}{p^G} L^{G^*}} \right] = q(\overline{r}) \cdot \left[\alpha p^B + \alpha\lambda(p^G - p^B) \right] \\ \Leftrightarrow \\ \frac{r}{q(r)} > \left[\alpha p^B + \alpha\lambda(p^G - p^B) \right] \end{gathered} \tag{17}$$

where L^{G^*} is constrained only by the limited pledgeability to creditors of future income λ.

Since we know - by inequality (9) - that the price of capital $q(r)$ is a concave function of the interest rate, the ratio $r/q(r)$ is increasing in r. Therefore, when r falls below $\overline{r}$, the problem of incentive compatibility resurfaces and the stage is set for inefficient entry: a positive measure of individuals with B(ad) quality projects undertakes investments that are suboptimal. Therefore, once the risk free interest rate on bank deposits r falls below $\overline{r}$ the only way to achieve incentive compatibility while offering separating loan contracts is to restrict L^G below L^{G^*}. In this case, the separating contract allocation requires the loan

contract L^G to become, by the incentive compatibility constraint (16):

$$L^G = \frac{(r - q(r) \cdot \alpha p^B)}{q(r) \cdot \alpha p^B - \frac{p^B}{p^G} r} w \tag{18}$$

which is increasing in the deposit interest rate r.[5] The loan size in equation (18) states that, as r decreases below $\overline{r}$, L^G needs to contract in order to ensure incentive compatibility. Therefore, the profit of good entrepreneurs implied by the separating loan contract L^G in equation (18) delivers the following expected profits for good quality entrepreneurs:

$$\pi^G(L^G; r) = q(r) \cdot \alpha p^G w + \left(q(r) \cdot \alpha p^G - r\right) \left[\frac{(r - q(r) \cdot \alpha p^B)}{q(r) \cdot \alpha p^B - \frac{p^B}{p^G} r} w \right]. \tag{19}$$

In alternative to a pair of separating loan contracts, banks may offer a unique break-even loan that pools all entrepreneurs in a single contract:

$$\begin{gathered} \widehat{C} = w, \\ \widehat{R}\widehat{L} \leq q(r) \cdot \lambda \alpha (w + \widehat{L}), \\ \widehat{R} = \frac{r}{\widehat{p}}, \\ \widehat{L} = \frac{q(r) \cdot \lambda \alpha \widehat{p}}{r - q(r) \cdot \lambda \alpha \widehat{p}} w \end{gathered} \tag{20}$$

where

$$\widehat{p} = \frac{\mu^G p^G + \widehat{\mu}^B p^B}{\mu^G + \widehat{\mu}^B} \tag{21}$$

is the average probability of success of the active entrepreneurs applying for the pooling loan contract, since $\widehat{\mu}^B < \mu^B$ is the measure of B ("Bad") entrepreneurs joining the pool of active entrepreneurs. By substituting the pooling loan contract $\widehat{L}$, defined in equation (20), into the incentive compatibility constraint of bad quality entrepreneurs (16), we observe that low productivity entrepreneurs prefer the pooling loan contract to depositing their wage in the bank as long as the deposit interest rate r falls below a threshold. This can be computed by comparing the profit of unproductive entrepreneurs to the return of deposits:

$$\begin{gathered} \pi^B(\widehat{L}; r) \geq rw \\ \Leftrightarrow \\ r \leq \underline{r} = q(\underline{r}) \cdot \alpha p^B \left[\frac{w + \widehat{L}}{w + \frac{p^B}{\overline{p}} \widehat{L}} \right] = q(\underline{r}) \cdot \left[\alpha p^B + \alpha \lambda (\overline{p} - p^B) \right] \end{gathered} \tag{22}$$

where

$$\overline{p} = \frac{\mu^G p^G + \mu^B p^B}{\mu^G + \mu^B} \tag{23}$$

[5] $\frac{dL^G}{dr} = \frac{\alpha p^B \left(1 - \frac{p^B}{p^G}\right) \cdot (q(r) - r q'(r))}{\left(q(r) \cdot \alpha p^B - \frac{p^B}{p^G} r\right)^2} > 0$ because of inequality (9).

is the average (unconditional) probability of success if *all* individuals in the economy becomes entrepreneurs by starting their investment project. The inequality (22) provides two important indications: first, unproductive entrepreneurs may invest only if they are offered the pooling loan contract; second, they have a stronger incentive to start their investment project the lower the interest rate. Moreover, comparing equations (17) and (22) and the fact that the price of capital is a concave and increasing function $q(r)$ of the interest rate, we can immediately observe that $\underline{r} < \overline{r}$. This implies the following characteristics of equilibria in the economy:

Proposition 1 *If the risk free interest rate $r \leq q \cdot \alpha p^G$, G(ood) entrepreneurs choose to become active and undertake their investment project. Moreover:*

- *when the interest rate $\overline{r} < r \leq q \cdot \alpha p^G$, B(ad) entrepreneurs do not want to enter the pool of active entrepreneurs and G(ood) entrepreneurs' investment is limited by the pledgeability constraint;*
- *when the interest rate $r \in [\underline{r}, \overline{r}]$, a positive measure of B(ad) entrepreneurs joins the pool of active entrepreneurs and invest only if a pooling loan contract is offered in equilibrium;*
- *when the interest rate $r < \underline{r}$, all B(ad) entrepreneurs become active whenever a pooling loan contract is offered in equilibrium.*

Therefore, to determine the investment allocation of the economy, the central question becomes which type of loan contract arise in equilibrium for intermediate values of the interest rate r. Does the economy display a pair of separating contracts that restricts the investment of good types or rather a pooling loan contract in which bad entrepreneurs - possibly not all - enter? Answering this question provides the novel result of this framework and the basis for the set of macroeconomic and welfare implications we will exploit.

We start by studying why would unproductive (B) entrepreneurs decide to join the investment pool. Their decision depends on the size of the "subsidy" that they receive through the pooling contract. The subsidy in turn depends on the size of the loan, which banks increase in the average quality of the investment pool, $\widehat{p}$ by equation (20). Therefore, it is central to focus on the average probability of success of the investment pool.

Let us define the average probability of success - $\widehat{p}^B$ - at which B(ad) quality entrepreneurs are (weakly) better off accepting the pooling loan contract rather than depositing their wage in the bank in exchange for the risk free interest rate r:

$$\begin{aligned} \pi^B(\widehat{L}; r) &\geq rw \\ &\Leftrightarrow \\ p \geq \widehat{p}^B(r) &= \tfrac{r - q(r)\cdot\alpha p^B}{q(r)\cdot\alpha\lambda} + p^B \end{aligned} \tag{24}$$

By the same reasoning, we can also calculate the average probability of success of the investment pool - $\widehat{p}(r)$ - that keeps good entrepreneurs weakly better off in the pooling

contract rather than accepting the separating loan contract corresponding to their quality. In order to compute it, we compare the expected profits of the good entrepreneur in the pooling $\pi^G(\widehat{L};r)$ and in the separating contract $\pi^G(L^G;r)$ - equation (19):

$$\begin{gathered}\pi^G(\widehat{L};r) \geq \pi^G(L^G;r) \\ \Leftrightarrow \\ p \geq \widehat{p}(r) = \frac{r-q(r)\cdot\alpha p^B}{q(r)\cdot\alpha\lambda} + p^B\end{gathered} \tag{25}$$

Comparing equations (24) and (25) we establish a useful result. The two average probabilities of success of the investment pool that make high quality entrepreneurs indifferent between separating and pooling loan contracts and make low quality entrepreneurs indifferent between investment and deposits are in fact identical:

$$\widehat{p}^B(r) = \widehat{p}(r). \tag{26}$$

This is an interesting result. Equality (26) shows that the average probability of success of actual investment in a pooling contract is the same that would make productive entrepreneurs just indifferent between choosing the pooling or separating contract. The central decision maker still is the low quality entrepreneur though. His desire to become active and invest depends on how many of them make the same decision: the more unproductive entrepreneurs are active, the lower is the incentive for an additional unproductive entrepreneur to borrow for investment. When the interest rate $r \in [\underline{r}, \overline{r}]$, $B(\text{ad})$ entrepreneurs keep on entering the investment pool until the average probability of success of active entrepreneurs falls to $\widehat{p}^B(r)$. At $\widehat{p}^B(r)$, an additional unproductive entrepreneur is indifferent between investing and depositing his funds in the bank. Since $\widehat{p}^B(r) = \widehat{p}(r)$, this is also the average probability of success at which $G(\text{ood})$ entrepreneurs make (weakly) more expected profits if they are offered a pooling instead of a separating loan contract. Therefore, banks have an incentive to offer a unique - "pooling" - loan contract that will be accepted by individuals differing in their probability of success. Modelling bank competition *a la* Hellwig guarantees that this loan contract is supported in equilibrium[6].

It is then easy to derive the actual measure $\widehat{\mu}^B(r)$ of $B(\text{ad})$ entrepreneurs that choose to become active in equilibrium consistent with $\widehat{p}(r)$ of the pooling loan contract and the interest rate r. We can compute this measure by comparing the expression for $\widehat{p}(r)$ of equation (25) into the definition of $\widehat{p}$ in equality (21):

$$\begin{gathered}\widehat{p} = \widehat{p}(r) \\ \Leftrightarrow \\ \frac{\mu^G(r)}{\mu^G+\widehat{\mu}^B(r)}p^G + \frac{\widehat{\mu}^B(r)}{\mu^G+\widehat{\mu}^B(r)}p^B = \frac{r-q(r)\cdot\alpha p^B}{q(r)\cdot\alpha\lambda} + p^B\end{gathered}$$

which implies

$$\widehat{\mu}^B(r) = \min\left\{\mu^G\left(\frac{\left(p^G-p^B\right)\alpha\lambda}{\frac{r}{q(r)}-\alpha p^B}-1\right), \mu^B\right\}. \tag{27}$$

[6] This result is consistent with DeMeza and Webb (1987).

$\widehat{\mu}^B(r)$ is the measure of low quality entrepreneurs consistent with the equilibrium pooling contract.

We can conclude this section with two summarizing observations. First, the equilibrium of the economy entails a pooling loan contract that *all* good and *some* bad quality entrepreneurs join to build the investment pool. Second, the equilibrium loan contract $\widehat{L}$ in equation (20) is affected by the risk free interest rate paid on deposits, r, in two ways: first, as it is standard, *directly* because higher interest rates require smaller loan sizes for given promised payments; second, *indirectly* because a rise in the effective interest rate $\frac{r}{q(r)}$ decreases the number of bad quality entrepreneurs that decide to start their project, i.e. $\frac{\partial \widehat{\mu}^B(r)}{\partial\left(\frac{r}{q(r)}\right)} < 0$, and so it improves the average quality of the borrowing pool, $\widehat{p}(r)$, resulting in larger loans.[7]

3.3 Investment Demand with Financial Frictions

Once we have established that financial intermediaries offer a pooling loan contract when both limited pledgeability and private information are present, we are now ready to summarize the investment demand of the economy through the following proposition.

Proposition 2 *In equilibrium banks offer a pooling loan contract and the demand of investment depends on the interest rate belonging to one of the following three regions:*

- *when $r > \overline{r}$, B(ad) entrepreneurs do not initiate their investment projects and the only active entrepreneurs belong to the G(ood) type. The measure of active entrepreneurs is μ^G;*
- *when $r \in [\underline{r}, \overline{r}]$, measure $\widehat{\mu}^B(r) < \mu^B(r)$ of B(ad) entrepreneurs start their projects if and only if the average probability of success of active entrepreneurs is at least equal to $\widehat{p}(r)$. The measure of active entrepreneurs is $\mu^G + \widehat{\mu}^B(r) < 1$;*
- *when $r < \underline{r}$, all B(ad) entrepreneurs start their projects, i.e. $\widehat{\mu}^B(r) = \mu^B(r)$, the average probability of success of active entrepreneurs is equal to $\overline{p}(r)$, the average entrepreneurial quality in the entire population. The measure of active entrepreneurs is $\mu^G + \mu^B(r) = 1$.*

The previous Proposition allows us to compute all investment levels, $I^j = \left(L^j + w\right)$, in closed form as a function of the interest rate, r. Total investment in the economy, I, is described as follows:

$$I(r) = \left[\mu^G + \widehat{\mu}^B(r)\right]\left(\widehat{L}(r) + w\right) = \begin{cases} \mu^G \left(\frac{r}{r - q(r)\cdot\lambda\alpha p^G}\right) w & \text{for } \; r > \overline{r} \\ \left(\mu^G + \widehat{\mu}^B(r)\right) \frac{r}{q(r)\cdot\alpha p^B(1-\lambda)} w & \text{for } r \in [\underline{r}, \overline{r}] \\ \frac{r}{r - q(r)\cdot\lambda\alpha\overline{p}} w & \text{for } r < \underline{r} \end{cases} \tag{28}$$

[7] If $r \in [\underline{r}, \overline{r}]$: $\frac{\partial \widehat{\mu}^B(r)}{\partial r} = \mu^G \cdot \left(p^G - p^B\right) \alpha\lambda \frac{q'(r)\cdot r - q(r)}{\left(r - q(r)\cdot\alpha p^B\right)^2} < 0$ and $\frac{\partial \widehat{p}(r)}{\partial r} = \frac{\left[q(r) - r\cdot q'(r)\right]}{q(r)^2\cdot\alpha\lambda} > 0$ because of inequality (9).

The important feature to keep in mind regarding investment demand is that more and more $B(ad)$ quality entrepreneurs choose to become active and enter the investment pool as the risk free interest rate falls within the region $[\underline{r}, \overline{r}]$. We can formally study the effect of this entry on the aggregate level of investment $I(r)$, rearranging the total investment function in (28) using the expression for $\widehat{\mu}^B(r)$ in (27):

$$I(r)|_{r\in[\underline{r},\overline{r}]} = \underbrace{\frac{\mu^G \cdot \left(p^G - p^B\right) \alpha\lambda}{\left(\frac{r}{q(r)} - \alpha p^B\right)}}_{\text{loan size effect}} \cdot \underbrace{\frac{r}{q(r) \cdot \alpha p^B (1-\lambda)}}_{\text{composition effect}} w \tag{29}$$

We refer to the first and second terms in equation (29) as, respectively, the *loan size* and the *composition* effects. They disentangle the effect of the interest rate on total investment. A fall in the interest rates fosters total investment through the following trade-off. As r falls, so does $\frac{r}{q(r)}$ as we observed in the Remark in Section 3.1. The size of the loan expands because lower interest rates allow to leverage more self financed investment: this is the *loan size* effect and it is standard. The novel effect goes through the change in the loan contract triggered by change interest rate: larger loans due to a fall in the interest rate foster the entry of bad quality entrepreneurs in the investment pool. This in turn feeds back into the equilibrium loan contract that, as a consequence of this larger share, forces banks to restrict the size of the loan to both infra-marginal and marginal investors. This last effect is the *composition* effect and, as we will see in the sections that follow, it is pivotal in generating the welfare implications. The sum of these two effects is negative implying that aggregate investment expands as the interest rate falls, as standard intuition suggests.

This result shows the implication of the modeling choice of introducing variable size investment. Differently from Martin and Taddei (2013) where "excess" investment was tamed by an increase in credit rationing, here the surge in investment is reduced by the entry of bad quality entrepreneurs that reduce the optimal size of the loan. This is not just a technical result: it shows that, with low interest rate, the presence of unproductive entrepreneurs not only displaces productive investment, as in the case of credit rationing, but it also reduce their size. It is then necessary to study whether this displacement effect can be so powerful to reduce aggregate investment. We will see in the following section that this is not the case.

3.3.1 Overinvestment Demand and Asymmetric Information

The observation that the investment schedule is downward sloping in the interest rate is not sufficient to conclude whether the level of investment is higher in the economy with both private information and limited pledgeability or in the one where only the pledgeability constraint holds. We turn to this issue now. As usual we restrict our attention to the region where the level of the interest rate generates inefficient entry, i.e. $\alpha p^G > \frac{r}{q(r)} > \alpha p^B$. In

this region, let us define the total investment in the economy characterized solely by limited pledgeability and where information is symmetric (σ) by:

$$I(r)^{\sigma} = \mu^{G} \cdot \left(\frac{r}{r - q(r) \cdot \lambda \alpha p^{G}} \right) w \tag{30}$$

The investment level of the economy with both financial frictions instead is, joining equations (25) and (28):

$$I(r) = \mu^{G} \frac{\left(p^{G} - p^{B}\right)}{\left(\widehat{p}(r) - p^{B}\right)} \left(\frac{r}{r - q(r) \cdot \lambda \alpha \widehat{p}(r)} \right) w. \tag{31}$$

Comparing the two total investment functions (30) and (31), we have:

$$\begin{array}{c} I(r) > I(r)^{\sigma} \\ \Leftrightarrow \\ \frac{\left(p^{G} - p^{B}\right)}{\left(\widehat{p}(r) - p^{B}\right)} > \left(\frac{r - q(r) \cdot \lambda \alpha \widehat{p}(r)}{r - q(r) \cdot \lambda \alpha p^{G}} \right) \end{array} .$$

Since the two investment level are trivially equal when only good type entrepreneurs invest, i.e. $\widehat{p}(r) = p^{G}$, we have to study the differential behavior of investment when the inefficient entry of bad quality entrepreneurs take place, i.e. when $\frac{r}{q(r)} < \alpha p^{G}$. Employing the expression (25) for the average quality of active entrepreneurs, $\widehat{p}(r)$, and substituting for the interest rate r we find that:

$$\begin{array}{c} I(r) > I(r)^{\sigma} \\ \Longleftrightarrow \\ \frac{p^{B}}{\widehat{p}} > \lambda \end{array} \tag{32}$$

Inequality (32) implies that the economy with private information displays overinvestment with respect to its full information benchmark only if limited commitment is sufficiently severe. In particular, overinvestment takes place for any interest rate $\frac{r}{q(r)} \in \left[\frac{\underline{r}}{q(\underline{r})}, \frac{\overline{r}}{q(\overline{r})} \right]$ if debtors can credibly pledge for repayment to banks a share of future income smaller than

$$\frac{p^{B}}{p^{G}} > \lambda \tag{33}$$

The following proposition summarizes:

Proposition 3 *The economy with asymmetric information presents larger investment demand than the symmetric information benchmark for all intermediate levels of the interest rate, $\frac{r}{q(r)} \in \left[\frac{\underline{r}}{q(\underline{r})}, \frac{\overline{r}}{q(\overline{r})} \right]$, only if the limited pledgeability constraint is sufficiently tight, i.e. inequality (33) holds.*

This result is not obvious at all: it is not asymmetric information *per se* to be responsible for overinvestment, but it is the interaction with a sufficiently tight leverage constraint to deliver the result. In fact in the economies where the two frictions interact, when the

interest rate falls below $\frac{\overline{r}}{q(\overline{r})}$ and bad quality entrepreneurs start entering the investment pool, the size of the loan for good productive entrepreneurs endogenously fall. The net effect of a falling interest rate nonetheless is that aggregate investment grows in excess of the full information benchmark.

3.3.2 Adverse Selection and Welfare Implications

After fully characterizing the investment behavior of the economy, we can finally turn our attention to the welfare effect of a change in the interest rate. In particular, we study what happens to the total surplus generated by investment as a function of the interest rate in the economy where both asymmetric information and limited pledgeability coexist. We start by asking whether the net present value (NPV) of total investment can ever be negative because of inefficient entry by bad quality entrepreneurs. With this question in mind, it is useful to study the extreme case in which all entrepreneurs, both G(ood) and B(ad) become active and the interest rate would be

$$\underline{r} = q(\underline{r}) \cdot \left[\alpha p^B + \alpha\lambda(\overline{p} - p^B)\right] \tag{34}$$

so that the average productivity of investment became

$$q(\underline{r}) \cdot \alpha\overline{p} \tag{35}$$

Comparing equations (34) and (35), it is immediate to observe that the average productivity of investment is always above the interest rate, even when all unproductive entrepreneurs become active, i.e. $\widehat{p}(\underline{r}) = \overline{p}$. Hence, also the NPV of total investment is always positive.

This observation though is not enough to conclude that total surplus is increasing in the interest rate. In fact, the average surplus per unit of investment, $S(r)$, is decreasing in the interest rate. By construction of the equilibrium, for all intermediate levels of the interest rate $r \in [\underline{r}, \overline{r}]$, the average productivity of investment equals

$$q(r) \cdot \alpha\widehat{p}(r), \tag{36}$$

while the interest rate is

$$r = q(r) \cdot \left[\alpha p^B + \alpha\lambda(\widehat{p}(r) - p^B)\right] \tag{37}$$

so that the difference between average productivity in (36) and equilibrium interest rate (37) is:

$$S(r) = q(r) \cdot \alpha(1-\lambda)(\widehat{p}(r) - p^B) \tag{38}$$

which clearly falls in the average quality of investment $\widehat{p}(r)$.

Why does average productivity fall? As the interest rate decreases, the average quality of investment reduces more than proportionally because (i) investment per existing entrepreneur decreases, which is in particular relevant for good quality entrepreneurs, and

(ii) the share of bad entrepreneurs increases. Hence, the overall surplus *per* unit of investment, $S(r)$, falls.

Though interesting, this is not enough to claim that total surplus and so welfare is also going down as the interest rate falls. In order to study the behavior of total surplus, $TS(r)$, we have to decompose the income generated by total investment $I(r)$ - defined in (28) - into the share that goes to entrepreneurs and the one that goes to depositors:

$$TS(r) = \underbrace{q(r)\alpha \cdot \widehat{p}(r) \cdot I(r) \cdot (1-\lambda)}_{\text{Entrepreneurs' Income}} + \underbrace{\left[1 - \left(\mu^G + \widehat{\mu}^B(r)\right)\right] \cdot rw}_{\text{Depositors' Income}}$$

which can be written as a function of the risk free interest rate $r \in [\underline{r}, \overline{r}]$, after replacing the average probability of success in investment, $\widehat{p}(r)$, employing equations (25) and (29):

$$\begin{aligned} TS(r) = & \underbrace{\left(\frac{\frac{r}{q(r)} - \alpha p^B (1-\lambda)}{\left(\frac{r}{q(r)} - \alpha p^B\right)} \right) \cdot \frac{\mu^G \cdot \left(p^G - p^B\right)}{p^B} \cdot rw +}_{\text{Entrepreneurs' Income}} \\ & + \underbrace{\left[\frac{\left(\frac{r}{q(r)} - \alpha p^B\right) - \mu^G \cdot \left(p^G - p^B\right) \alpha\lambda}{\left(\frac{r}{q(r)} - \alpha p^B\right)} \right] \cdot rw}_{\text{Depositors' Income}} \end{aligned} \tag{39}$$

By differentiating the expression above with respect to the risk free interest rate, we find that

$$\frac{dTS(r)}{dr} > 0 \tag{40}$$

under fairly general conditions[8]. Inequality (40) means that decreasing the interest rate leads to a *decrease* in total surplus and, hence, in output and welfare. This results depends on the participation to the investment pool of low quality entrepreneurs and thus applies only to economies where the interest rate lies in the region $[\underline{r}, \overline{r}]$. We can summarize the discussion of this section through the following proposition:

Proposition 4 *When inefficient entry by unproductive entrepreneurs takes place, i.e.* $r \in [\underline{r}, \overline{r}]$, *the total surplus of investment decreases when the interest rate falls.*

This results may seem counter intuitive. After all, a fall in the interest rate is bringing about an expansion in investment demand that should, in principle, expand surplus. In Martin and Taddei (2013), this expansion was addressed by credit rationing. The result

[8]Inequality (40) is satisfied, among other cases, if $\frac{p^G}{p^B} > \frac{2-\mu^B}{\mu^G} = \frac{1+\mu^G}{\mu^G}$. This implies that welfare is negatively affected by low interest rates in economies characterized by sufficiently large quality heterogeneity ($p^G >> p^B$) or where the share of high quality entrepreneurs tend to be relatively larger ($\mu^G \longrightarrow 1$).

was somewhat paradoxical: better credit conditions, channeled through low interest rates, delivered credit rationing while high interest rates determined the opposite. In the current more general setup, because investment projects have an endogenous size, the surge in investment demand is absorbed by varying loan size and the composition of the investment pool. In fact the problem is that investment demand expansion comes at the expenses of good quality entrepreneurs who see the size of their individual loan shrinking as the interest rate falls. This is due to the fact that, *ceteris paribus,* banks increase the loan size as the interest rate falls. Larger loans imply more cross-subsidization for bad quality entrepreneurs, who then wish to join the investment pool. Since the average quality of the investment pool falls, the average repayment to the bank falls. Therefore, for the banks to break even, they can not afford to pay the same risk free interest rate to depositors. The combination of lower average productivity and lower interest rate paid to depositors is more than enough to decrease total surplus when the interest rate falls.

While the connection between total surplus and welfare may seem immediate, it is not all obvious in the context of an overlapping economy such as the current one. In our discussion, we have emphasized the effect on total surplus of the level of investment and the interest rate consistent with it. This focus is the one that matters from the perspective of the current generation, the one undertaking the investment and enjoying its proceedings.

It must be noted that the perspective of the generations that follow is, in general, different. These generations only care about the amount of capital that will be available to them once they will work for a wage. In fact it is the amount of capital during their youth that determines their wage and, thus, their ability to invest. In principle, future generations are not at all concerned with the inefficiencies connected with capital production. Under financial autarky though, when the amount of investment is fixed at the value w, the higher is the average productivity of capital investment, the higher is the capital stock in the subsequent period and, thus, the wage then. Therefore, higher interest rate today, by improving the allocation of investment toward good quality entrepreneurs, also improve the welfare of the generations that follow.

4 Equilibrium under Financial Autarky

We can conclude our discussion of the model by studying the equilibrium of the economy when it is closed to international capital flows. As usual, we focus on the equilibrium under financial autarky and when the equilibrium interest rate lies in the region $r \in [\underline{r}, \overline{r}]$. We start by computing the equilibrium level of interest rate in the closed economy, r^c, which is given equating the demand of funds, i.e. the investment schedule defined in (28), to the supply of funds, w, in the economy, i.e. the entire supply of savings by the young generation. Market clearing in the credit market is:

$$I(r) = \left(\mu^G + \widehat{\mu}^B(r)\right) \cdot \left(L^j + w\right) = w \tag{41}$$

which can be solved to determine the equilibrium interest rate

$$\frac{r^c}{q(r^c)} = \frac{p^B(1-\lambda)\cdot\alpha\left(p^B\right)}{p^B(1-\lambda)-\mu^G\left(p^G-p^B\right)\lambda} \tag{42}$$

Notice in particular two important features of the equilibrium interest rate defined in (42): it is increasing in the level of pledgeable income λ and is independent from the level of wealth (wage) w.[9] The latter result is an artifact due to the assumption that individuals are uniformly distributed over the unit interval[10]. The former result has an interesting interpretation: economies that have developed credit market institutions that better guarantee creditors - higher λ - display higher interest rates under financial autarky.

We can now turn to the more interesting question of how welfare depends on the level of pledgeable income λ when $r \in [\underline{r}, \overline{r}]$. If we were to derive the equation for total surplus (39) with respect to λ, we would find no effect whatsoever. This is a misleading though: if we want to understand the effect of relaxing limited pledgeability on total surplus, we have to consider the effect of a change in λ on the equilibrium interest rate. Since we have already observed that an increase in λ increases the interest rate and we know that total surplus increases in the interest rate, we can conclude that better credit market institutions foster total surplus by improving the average productivity of investment, not its aggregate amount. We can confirm our intuition by rewriting total surplus in this economy:

$$TS(r) = \alpha\cdot\widehat{p}\cdot I(r) = \alpha\underbrace{\left(\frac{p^G\mu^G + p^B\widehat{\mu}^B(r)}{\mu^G+\widehat{\mu}^B(r)}\right)}_{\text{average productivity}}\cdot\underbrace{I(r)}_{\text{total investment}}. \tag{43}$$

Substituting the expression (28) in equation (43), we find:

$$TS(r) = \underbrace{\alpha\left(\frac{p^G\mu^G + p^B\widehat{\mu}^B(r)}{\mu^G+\widehat{\mu}^B(r)}\right)}_{\text{average productivity}}\cdot\underbrace{\left(\mu^G+\widehat{\mu}^B(r)\right)\frac{r}{q(r)\cdot\alpha p^B(1-\lambda)}w}_{\text{total investment}}$$

which, by using the definition of $\widehat{p}$ in equation (23) and (27), can be written as

$$TS(r^c) = \underbrace{\alpha\widehat{p}(r^c)}_{\text{average productivity}}\cdot\underbrace{\frac{r^c}{q(r^c)}\frac{1}{\alpha p^B(1-\lambda)}w}_{\text{total loans}}. \tag{44}$$

The expression (44) is increasing in the level of pledgeable income λ. The important feature to note regarding this measure of welfare is that it is made of two parts. The first term is the direct effect of limited liabilities on the average productivity of investment: because the interest rate increases with the level of pledgeable income, the composition

[9] $\frac{\partial r^c}{\partial\lambda} = q(r)\cdot\alpha\left(p^B\right)^2\frac{\mu^G\left(p^G-p^B\right)\lambda}{\left[(1+\nu)\cdot p^B(1-\lambda)-\mu^G\left(p^G-p^B\right)\lambda\right]^2} > 0$

[10] This assumption will be relaxed later when we discuss the "Saving Glut".

of the investment pool improves. So does average productivity which has a positive effect on the total surplus. The second term captures the effect of limited liability on total loans: an increase in λ raises the equilibrium interest rate (42). By doing so, bad quality entrepreneurs leave the investment pool thus improving the average productivity of investment, $\widehat{p}(r^c)$. This boosts the loan size further: better average quality for the borrowing pool allows banks to lower the interest payment they demand, R, and this increases the maximal leverage further. In conclusion:

Proposition 5 *Under financial autarky, the higher is the maximum leverage by private investors, i.e. λ, the higher is the interest rate, the average productivity of investment and welfare.*

5 International Financial Integration: a Bipolar World Equilibrium

In this section our analysis extends to the case of international financial integration. We ask a simple question that represents the natural extension of our discussion above: is it possible that the effect of financial frictions on equilibrium, total surplus and thus welfare changes once the economy becomes financially integrated with other countries? An answer to this question is extremely relevant for macroeconomic policy design. We will show that, in the context of international financial integration, it is not only important the type of financial frictions but also their distribution across countries. Therefore, if we want to evaluate the welfare effect of financial frictions, we should carefully ponder the presence and typology of financial frictions not just in the country under consideration but also in the other economies that are financially integrated with the one under study.

In order to address the question above, we consider the simplest version of a world economy. We study the world equilibrium where two countries (H and L) become financially integrated. Both are characterized by private information regarding the quality of investment projects and individual savings can freely move from one country to the other. Thus, all individuals can borrow from and/or lend to the international financial market at the new equilibrium gross return r^*, where the superscript "*" denotes the open economy. The only country-specific factor remains the quality of domestic credit market frictions, i.e. λ. When an individual borrows, she is subject to the credit market institutions of the country where the investment project takes place and thus to the country specific limited pledgeability constraint. The crucial difference among the two countries is therefore the severity of the limited pledgeability constraint and the implied maximum level of leverage:

$$\lambda^H > \lambda^L.$$

We will assume that in every other respect the two countries are assumed to be identical. This may seem overly simplistic if we consider the financial integration of developed and

developing countries. It may seem more realistic though in the context of a currency union - such as the Euro Area - where countries share the same market but differ in the quality and development of their credit market institutions.

In the closed economy, aggregate investment is constrained by the availability of domestic savings and – ultimately – by the preexisting domestic capital stock determining the wage workers earn. In the open economy, this is no longer the case because investment can be financed by foreign savings: the determinant of investment is the international interest rate r. We have already observed that, under financial autarky, the interest rate is increasing in the share of income that can be credibly pledged for repayment, λ. Therefore the international interest rate lies in the interval $\left[r^L, r^H\right]$ where r^i is the equilibrium interest rate of country i under financial autarky. The exact position of the interest rate depends on the combinations of factors that fully describe the two economies but we can already conclude that, as the two economies become financially integrated, savings flow from the country with tighter pledgeability constraints to the one with looser constraints.[11] This difference can be confirmed by the average productivity of investment which becomes, by equation (25):

$$r^* = q^H(r^*)\alpha \cdot \left[p^B + \lambda^H \left(\widehat{p}^H(r^*) - p^B\right)\right] = q^L(r^*)\alpha \cdot \left[p^B + \lambda^L \left(\widehat{p}^L(r^*) - p^B\right)\right]. \qquad (45)$$

This implies, almost directly, that under international financial integration the average productivity of investment in country H will be *lower* than in country L, i.e. $\widehat{p}^H(r^*) < \widehat{p}^L(r^*)$.

Given our assumptions of homogeneity across countries, we can focus on the effect of differential financial frictions, i.e. limited pledgeability when investors are privately informed regarding the investment opportunity at their disposal. The world equilibrium risk free interest rate r^* can be determined by equating the world demand for investment to the world supply of savings, as we did in the case of financial autarky (see equation (42)). It is not possible to get a closed form solution for the equilibrium interest rate but we can employ the results we have derived so far to analyze how the welfare of the economy changes under international financial integration.

5.1 Welfare in the Open Economy

In order to evaluate the welfare effect of international financial integration, it is correct to apply the same definition of total surplus in (39) for the closed economy to the case when

[11] See Caballero, Fahri and Gourinchas (2008) and Martin and Taddei (2013) for analogous results.

the economy is financially integrated. Total surplus of country i, TS^i, therefore is:

$$TS^i(r^*) = \underbrace{\left(\frac{\frac{r^*}{q^i(r^*)} - \alpha p^B(1-\lambda^i)}{\left(\frac{r^*}{q^i(r^*)} - \alpha p^B\right)}\right) \cdot \frac{\mu^G \cdot \left(p^G - p^B\right)}{p^B} \cdot r^* w +}_{\text{Entrepreneurs' Income}}$$
$$\underbrace{+\left[\frac{\left(\frac{r^*}{q^i(r^*)} - \alpha p^B\right) - \mu^G \cdot \left(p^G - p^B\right)\alpha\lambda^i}{\left(\frac{r}{q^i(r^*)} - \alpha p^B\right)}\right] \cdot r^* w}_{\text{Depositors' Income}}$$

In general, the world interest rate r^* differs from the autarky interest rate and is, in particular, lower than its autarchic counterpart for the economy where the maximal leverage is higher, i.e. λ^H. We have already observed, as Proposition 4 reports, that a fall in the interest rate is detrimental to the total surplus of the economy. When this result is applied to the context of international financial integration, it implies that capital inflows have a negative welfare effect on the current generation in the country with the highest financial depth, i.e. leverage. This result contrasts with the literature connecting financial frictions and international capital flows. In Matsuyama (2004) and Caballero, Fahri and Gourinchas (2008), where only limited pledgeability is present, the capital importing country gains from international financial integration while the capital exporter may lose.

This is certainly not the first paper to state that capital inflows can be detrimental to a country. What is novel is the motivation of this negative welfare effect: the typical argument *à la Calvo* present in the international literature argues that capital importers may lose from financial integration because of the risk of *sudden stops* and reversals of capital flows. Also Aizenman (2015) argument for the emergence of international cooperation during financial crisis relies on the complete collapse of financial intermediation.

The present contribution instead points out that, because of the combined effect of limited pledgeability and adverse selection, there is at least one generation in the country that loses from the low interest rate due to international financial integration. This loss is entirely due to the fact that low interest rate determine a contraction of investment by good quality entrepreneurs and an expansion - through inefficient entry - of investment by the bad quality ones. This result is due to the fact that the size of individual investment is endogenous in this setup. In Martin and Taddei (2013), international integration would *add* inefficient investment without necessarily reducing the amount of good projects.

This result is also in sharp contrast with the behavior of the economy under financial autarky. While we have shown that a country endowed with credit market institutions that allow debtors to pledge for repayment a larger share of their proceedings is always better off, this is not the case anymore when the country has to decide to become financially integrated with another country where the amount of leverage is reduced. In the case of international financial integration it is precisely this kind of countries that lose.

Our discussion has so far ignored the structure of our overlapping generations economy. This may seem puzzling. We have nested our credit market in the context of an overlapping generation economy to show how our analysis can be implemented in a dynamic setup. While the overlapping generations structure has been helpful in reducing the intricacies of our contracting problem, it makes the welfare analysis slightly more cumbersome when we abandon financial autarky and we enter into international financial integration. This is why we have focused on the total surplus that investment generates in the case of one generation and we have abstracted from the effects this investment may have on the following generations.

When capital are allowed to flow internationally between economies characterized by asymmetric financial frictions, they bring about a global reallocation of investment that may exceed the span of the generation directly involved. It may very well be the case that a surge in inefficient investment - possibly due to a sharp reduction in the interest rate when the country opens up to international capital flows - determines an increase in future capital that benefits future generations. The issue for the generation that undertakes that investment nonetheless remains: if the generation that invest in capital accumulation does not have the time to enjoy the benefit of this accumulation through higher future wages, its welfare will be reduced. This is also the generation that has to make the choice regarding financial integration and it is then appropriate, from the point of view of political economy, to focus our welfare analysis almost exclusively on the surplus resulting to the investing generation.

An important consideration regarding policy and welfare is due at this point. The discussion of the previous paragraph does not imply that, because of the welfare loss on the investing generation, the economies with credit market institutions able to increase private leverage should avoid financial integration. Instead this perspective points out that, whenever international integration takes place in the most financially advanced countries, the investing generation must be compensated for this change. Any policy ranging from the issuance of public debt to a (temporary) increase in the generosity of the pension system would be more than appropriate to provide such compensation. Any of these two compensating schemes may work in practice but the policymaker should closely monitor their effect on the world interest rate and that their financing is undertaken by international savers (through the purchase of government debt). These conditions are not easy to obtain in practice.

It is worthwhile concluding this discussion with the central message of our perspective: when different types of financial frictions are brought into the analysis, capital flows do not just follow productivity differentials but are also motivated by the prevailing financial friction. In our bipolar world economy, there is in fact no initial productivity differential between the two economies and capital is nonetheless reallocated on the basis of the heterogenous financial frictions. In practice, one would have to ponder the possibility that financial frictions can easily be so strong to overturn the effect of productivity differential

on capital flows. The case of welfare reducing capital inflows presented here is, arguably, a specific example. It is not at all obvious whether this specificity is also extreme. The benefit of this general equilibrium approach is that it can be developed further trough a quantitative approach. It could prove useful to a set of analytical applications and policy implications. In the meantime, we use the perspective of the model to discuss qualitatively some of the most natural applications in the following section.

5.2 Financial Frictions in Practise: Policy Applications

Saving Glut. In the years before the financial crisis, Bernanke (2005, 2013) advanced the idea that the world economy is often featuring an excess amount of saving looking for financial intermediation. Before the crisis, Bernanke referred to the latest occurrence of this phenomenon as the "saving glut". According to this view, economies endowed with the capability to financially intermediate world savings have been the recipient of very large capital inflows. It is not at all obvious how the "glut" and the severe misallocation of investment that led to the financial crisis may be connected (Obstfeld (2012)). We may employ our setup to provide at least a consistent argument supporting this relationship. In the discussion so far, we have always assumed that all individuals are homogeneous. In fact, everyone could in our economy become an entrepreneur. This was a simplifying assumption that we will remove now.

Let us assume that, in addition to the usual unit measure of potential entrepreneurs distributed between G(ood) and B(ad) quality, there is a group of measure $\nu > 0$ of individuals that supply inelastically their labor but can not become entrepreneurs. It is inconsequential, for our qualitative results, to assume that they belong to the economy or not. What matters is that they supply savings without ever contributing to investment demand. The market equilibrium condition in (41) that equates investment to the supply of savings thus becomes:

$$I(r) = \left(\mu^G + \widehat{\mu}^B(r)\right)\left(L^j + w\right) dj = F(r) = w + w \cdot \nu$$

which can be rearranged into the following:

$$\frac{r^{sg}}{q(r^{sg})} = \frac{(1+\nu)\cdot p^B(1-\lambda)\cdot \alpha\left(p^B\right)}{(1+\nu)\cdot p^B(1-\lambda) - \mu^G\left(p^G - p^B\right)\lambda}$$

where the superscript "^{sg}" denotes the presence of a saving glut. It is then immediate to observe that the larger is the share of additional savers, ν, the smaller is the equilibrium interest rate in the economy. We have already observed that a reduction of the interest rate leads to a fall of the total surplus of investment for the current generation. Naturally, the saving glut may be responsible for an "overaccumulation" of capital that is beneficial to the following generations, but its detrimental effect on the investment surplus of the current generation still remains.

Our perspective can easily accommodate the idea of a saving glut that, while increasing investment, it lowers its average productivity up to the point that total surplus falls. The intuition is the same we presented before: the surge in savings that lowers the interest rate increases investment by bad quality entrepreneurs at the expenses of the fall in the loan size of good quality entrepreneurs. It is worthwhile highlighting that this negative welfare effect of additional investment is solely due to the fact that the reduction of the interest rate enhances adverse selection. If the surge in investment and the connected increase in future capital is implemented, the current generation needs to be compensated by a transfer when old. Government debt would be the appropriate policy in this context if it were accompanied by a transfer to the old generation present during the appearance of the saving glut. Alternatively, the government could implement an ex post redistribution scheme through taxation. If the future generations are benefiting by the extra capital through boosted wages, future wages should be taxed in order to transfer financial resources (*ex post*) to the overinvesting generation.

Financial Integration. Our discussion in the previous section focused on the effect of international financial integration on the country with better credit market institutions. This is due to the fact that the most novel result apply to that context. There is a tightly connected question that should be asked within this framework: what characteristics should be sought after if an economy could select the partner countries for international financial integration? This is a relevant question while economies around the world become progressively more integrated, as it is the case in Europe, or consider the adoption of tighter trade relationship, with the potential for increased financial integration, as it is currently debated across the Atlantic or the Pacific.

We found that an economy featuring both limited pledgeability and private information benefits from financial integration with countries that have credit market institutions that allow larger leverage. Such integration will in fact increase the total surplus of investment for the current generation. More cumbersome is the case in which a country enters an area of financial integration with economies featuring lower λ than the one prevalent in its domestic credit market. The reader should keep in mind though that this negative effect is due to the fact that capital importer features asymmetric information. If the informational asymmetry could somehow be isolated, then the welfare implications of international financial integration for the capital recipient country would remain positive. If a domestic credit market were to be characterized by sector specific degree of informational asymmetry, it would be appropriate to combine the enhancement of international financial integration with sector specific capital requirements or leverage limits.

Moreover, we should point out that, because of the heterogenous welfare effects on different generations, in the presence of limited pledgeability and adverse selection, the negative welfare effect of financial integration on the first generation should be minimized. A country opening up to international financial integration should therefore select part-

ner economies that are either endowed with similar credit market institutions or that are smaller in size and, thus, in the supply of savings. Countries may unload a disproportionate burden on the generation experiencing financial integration with countries that are substantially larger in terms of size or that display smaller financial development. The required compensation scheme may turn out to be unfeasible therefore hindering the whole process of financial integration. The recommendation for macro-prudential regulation would then be two-fold: if financially developed, a country should reach a sufficiently large size before becoming integrated with less financially advanced countries; if financially underdeveloped, a country should try to integrate with similar size partners that are endowed with deeper credit markets, i.e. higher λ. This is just one instance in which this perspective can be applied to macro-prudential policy. We turn our attention to this issue now.

Macro-Prudential Policy. The emphasis on financial frictions is especially topical as countries try to design institutions and policies that may shield them from future financial crisis. This is equivalent, in the context of this paper, to the policies that aim at maximizing total surplus from investment. In order to help the intuition and develop the perspective, let us take at a slightly richer version of our model. Consider an economy where there are two sectors of potential capital producers. The entrepreneurial population is split in two groups. The first group of entrepreneurs may choose to operate a technology on which there is full information but they are subject to the limitations of credit market institutions and regulation, i.e. they can not borrow more than share λ of the proceeding of their investment and so they are subject to the limited pledgeability constraint. The other group of entrepreneurs is in line with the one described in this paper: in addition to leverage limits, entrepreneurs are privately informed regarding the quality of their investment project. This second group features the same characteristics we have discussed in the presentation of the model.

The question then becomes how we should regulate leverage in the context of international financial integration when the economy is made of heterogeneous sectors? While improving credit markets institutions to relax the limited pledgeability constraint may seem an appropriate response, international financial integration cast some doubt on the effectiveness of this policy. The perspective of this paper is not that leverage should be constrained but rather that it should be optimally distributed and allocated away from the sector of the economy where informational asymmetries interact with limited pledgeability. The policymaker could do so by increasing the financial depth in the sector lacking asymmetric information or, similarly, by increasing capital requirements in sectors particularly prone to informational asymmetries. This will increase the interest rate in the economy and, by doing so, it would also ameliorate the adverse selection effect in the sectors where asymmetric information is present. If policymakers, attempting to reduce the investment misallocation due to international financial integration, wanted to limit the maximal amount of aggregate leverage in the economy, the perspective in this paper

suggests that this should be attained by constraining borrowing in the sectors with asymmetric information, while expanding lending in the other sectors as much as possible. This macro-prudential recommendation does not rely on a precautionary principle intended to shield the economy from sharp change (e.g. Korinek and Sandri (2014)). It is rather a general guideline to facilitate financial integration among heterogenous countries: policymakers should recognize the need for sector specific capital requirement/leverage limits to guarantee a smooth transition toward a globalized capital market.

In conclusion, it is the combination of adverse selection and limited pledgeability that threatens welfare and should therefore make policymakers cautious in allowing unconditional and economy-wide homogenous leverage expansion. Whenever multiple sectors characterized by heterogeneous financial frictions coexist in the economy, leverage should be facilitated where private information is immaterial so as to increase the equilibrium interest rates in the economy and reduce inefficient investment in the sectors featuring asymmetric information. The positive spillovers on the sectors in the economy muddled by asymmetric information can only be generated if macro-prudential policy adopts sector specific regulations. The allocation of leverage is particularly important whenever a process of financial integration is chosen.

6 Conclusions

The financial crisis has resulted in a greater interest for macro-prudential policy. It has also highlighted the importance of adverse selection in financial markets. This friction tends to be marginalized by macroeconomic models of financial frictions. They have stressed instead the effects of limited pledgeability. In this paper, we contribute to the literature by developing an economy where both adverse selection and limited pledgeability coexist and give rise to inefficient investment.

Our main result is that, when both financial frictions coexist, their combination has the potential of generating inefficient investment that is larger as the interest rate falls. these inefficiencies are not due to credit rationing but to the endogenous loan contract dynamics. Asymmetric information, by fostering unproductive investment, increases adverse selection: (i) good quality entrepreneurs end up being penalized by low interest rate as their investment size falls, and; (ii) low quality investors are less productive than the equilibrium interest rate. Under financial autarky though, the interest rate endogenously increase to ameliorate some of the detrimental effects of asymmetric information. Interestingly enough, the negative effects of asymmetric information fall when the limits to leverage are reduced. In the case of international financial integration though, these effects translate into excessive capital inflows for the *deeper* (more leveraged) financial system. Excessive is measured from the point of view of investment productivity and welfare of the current generation.

Our analysis has emphasized the risks brought about by international financial inte-

gration with economies that differ substantially both in terms of size and credit market institutions. This perspective seems in contrast with the intuition behind the standard "gains from trade" argument. According to this, countries benefit by becoming economically integrated with heterogeneous rather than similar countries. Our analysis and its implications should be taken as a complement rather than a substitute to this prevailing point of view. We highlight how, in the context of financial frictions, integration among financially heterogeneous countries may turn more costly than it is anticipated.

Although the full welfare implications of adverse selection and limited pledgeability on international capital flows would benefit from a quantitative extension that is absent in this paper, we may use the perspective herewith to advance some policy recommendations regarding the optimal timing of financial integration - how large should a country be when it chooses financial integration -, the choice of financial partners and the optimal allocation of leverage across sectors in the economy.

The prevailing view on global imbalances and financial frictions is that limited pledgeability has been at the heart of capital flows between Asia and the United States. According to this view, capital importers such as the United States at the global level or Germany at the Euro Zone level, have only stood to gain from these inflows. This paper suggests instead that the sizable financial imbalances that we have been observing around the world and, recently, within the Euro Zone (Lane (2013)) may threat the future financial stability in a way that is still underestimated in the current debate. Some policy recommendations, especially in terms of sector specific capital requirements are advanced to address the concerns abovementioned.

The view in this paper is that once adverse selection is brought into the picture, we should be very cautious in evaluating the transitional effects of international capital inflows. Through their effects on the interest rate, capital inflows may exacerbate adverse selection and lead to inefficient investment. It is particularly interesting to observe that this risk, differently from *sudden stops,* seems particularly important for the most financially developed economies. This does not mean that international financial integration should be rejected as a policy objective. Rather, it should be managed with caution and with the understanding that even countries that are capital importers because of the depth and development of their financial system may suffer welfare losses. Failing to prevent or compensate those losses may end up hindering the process of international financial integration.

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