Essays on Capital Market Imperfections, Intergenerational Mobility and Economic Development

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« A mi hermano Miguel, y a esa sonrisa que estoy segura
me hubiese ofrecido al ver impreso este trabajo »

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Contents

Introduction

In traditional development economics, there were two schools of thought with sharply differing perspectives on the potential importance of financial markets. Economist like Joseph Schumpeter (1911) and Goldsmith (1969), saw financial markets as playing a key role in economic activity. They emphasizes the positive influence of the development of a country's financial sector on the level and the rate of growth of its per capita income. In contrast, Robinsons's (1952) view was that economic development creates demands for particular types of financial arrangements, and the financial system responds automatically to these demands. In part, this skeptical view is also derived from the mechanism of the neoclassical growth model: many believed that financial systems had only minor effects on the rate of investment in physical capital and changes in investment were viewed as having minor effects on economic growth, as a result of the Solow's analysis. As a consequence at that time, most of macroeconomic theory presumed that the financial system functions smoothly, and smoothly enough to justify abstracting from financial considerations.

In light of these conflicting views the preponderance of current theoretical and empirical evidence stress the importance of the financial markets.[1] Recently interest in exploring the possible links between the financial system and aggregate economic behavior has been renewed. The literature in this area has taken two different directions. The first one has identified the potential channels through which financial development could possibly promote economic growth. A more or less common consensus has emerged that financial

[1] On the empirical side, researchers have shown that a range of financial indicators are robustly positively correlated with economic growth, see for example King and Levine (1993), Levine (1997) and Ranjan and Zingales (1998).

development may affect economic growth either by increasing the social productivity on investment, as in Greenwood and Jovanovic (1990)[2] or by increasing the fraction of savings channelled to productive investment, as in Bencivenga and Smith (1991)[3].

The second line of research analyzes financial markets in the presence of informational asymmetries between borrowers and lenders. Instead of analyzing how financial development promotes economic growth or viceversa, the focus of this literature has been to show how informational problems in financial markets create frictions in transferring funds from lenders to borrowers and in turns how this affects the process of capital accumulation and the level of per capita income. Examples include Azariadis and Smith (1993), Tsiddon (1992), and Bencivenga and Smith (1993). This thesis attempts to shed some lights on these problems by examining the macroeconomic implications of imperfect credit markets. In particular, the two chapters analyze financial markets in the presence of informational asymmetries at the micro level, so that borrowers and financial intermediaries posse different pieces of information on the quality of the projects what may be financed. Under this approach, financial intermediation is a purely endogenous outcome which arises explicitly from the assumptions about the information structure. Along these two chapters we will show that financial constraints are likely to have impact on the decisions of individuals and that financial institutions, in overcoming this asymmetries of information, exert a fundamental influence on capital allocation.

[2] In Greenwood and Jovanovic intermediation arise endogenously, and the role of intermediation is to screen the projects. If the return is sufficiently high, the investment is realized otherwise the intermediary invests only in the safe assets. In this way the existence of financial intermediaries results in a better screening of projects, which fosters a higher rate of growth.

[3] The model of Bencivenga and Smith is more in line with the liquidity insurance models. Financial intermediation not only facilitates the allocation of savings to productive investments, but also leads to a lower rate of unnecesary project liquidation, which improves efficiency and promotes growth.

In a nutshell, the fundamental questions which we tried to address with this work are the following: in chapter one we would like to know to what extent and through what mechanism do asymmetries of information between borrowers and banks affect inequality and intergenerational mobility. That is, we would like to know if endogenous capital markets imperfections (CMI for short) are a barrier to intergenerational mobility and income inequality. By contrast, the second chapter analyzes why total factor productivity (TFP for short) is so different across countries, and how this differences in TFP can be explained by the existence of imperfections in the capital markets.

The rst chapter of this Thesis studies the implication of asymmetries of information in the distribution of income and intergenerational mobility. A huge literature has analyzed CMI in connection with income distribution and intergenerational mobility (Becker and Tomes (1986), Maoz and Moav (1999), Mulligan (1996), Loury (1981), Owen and Weil (1998)). The bottom line of such a research strategy is that poor individuals, who are unable to borrow, cannot optimally invest in human capital or become entrepreneurs and as a consequence, they will remain stacked in a sort of poverty trap for generations. Therefore, this branch of the literature concludes that capital market imperfections lead to higher inequality and lower mobility. This line of research has received such widespread support that a recent survey on this work concludes: “In fact persistence of inequalities across generations is possible only if capital markets are imperfect” (Aghion and Bolton, (1992) p. 606).

A careful reading of this literature suggest that most, if not all, of the existing literature in this area has been developed under the assumption that capital market imperfections are “exogenous”. By exogenous CMI we mean two things. First, exogenous credit constraints where credit limit is xed and independent of the observable characteristics and decisions of individuals. In some cases this credit limit is taken at the extreme so that agents can not borrow.[4] Alternatively, exogenous credit constraints are sometimes presented by an exogenous substantial wedge between the cost of borrowing and the return on lending[5], so that credit constraints among poor people are introduced without providing any micro-foundations.

In contrast to these analyses the rst chapter argues that when we endogenize capital market imperfections, intergenerational mobility may be promoted among poor and talented agents. Recognizing that modern nancial markets are characterized by a wide variety of informational imperfections, we endogenize capital market imperfections by assuming an adverse selection problem between borrowers and banks where credit constraints are endogenous. To this end, we develop a growth model where agents are heterogeneous in two dimensions: inherited wealth and ability. There are two types of agents low ability agents and high ability ones. Young agents can attend private education and the investment in human capital, which is divisible, may be nanced by a loan market. Even though banks know the inherited wealth of each applicant they do not know the borrower’s ability. In our model the returns from the investment in education are random. Our central and, very reasonable assumption is that ability affects positively not only the success probabil-

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4 Becker and Tomes (1986), Mulligan (1996), Loury (1981), Owen and Weil (1998), Maoz and Moav (1999).

5 Galor and Zeira (1993).

ity, which is also the probability of repay the debt, but also the return from the investment in education.

When banks do not know the ability of the borrower they offer a menu of contracts, namely a pair of interest rate and a loan size, that satisfy the self-selection mechanism. In equilibrium, banks use the loan size to separate high from low ability borrowers. Indeed, they differentiate between agents by providing a high loan to talented borrowers. A force that helps poor and talented agents to become educated and to catch up with those rich agents.

The major results of Chapter 1 might be summarized as follows: endogenous capital market imperfections may promote intergenerational mobility among talented individuals, since talented children from poor families get educated even more than they wish, so that both income mobility is larger than in the first best world. In this way low ability individuals do not pose as high ability ones. Moreover, human capital investment is higher than in the first best world in the steady state. When we study inequality of wealth, we find that there are opposite effects making inequality ambiguous. On the one hand, there is a small number of people in the lower tale of the distribution. On the other hand, the middle class of talented borrowers is relatively poorer with respect to the first best benchmark.

In short, this first chapter contributes to the theoretical understanding of the linkage between income distribution and CMI. Our results should be taken as a complement to existing studies, not only raising doubts about the “consistent message,” but also suggesting that further careful reassessment of the interaction between CMI and income distribution needs to be consider.

In Chapter 2, which is joint with Andrés Erosa, we propose a theory which formalizes the recent empirical evidence suggesting that CMI may play an important role in generating low TFP.[6] However, the mechanism for which these imperfections lead to low TFP is still not well understood. In this chapter, we propose a theory where different degrees of capital markets imperfections are the source of difference in TFP across countries.[7] The bottom line of this second chapter tell us that not only poor countries have low aggregate TFP but that they are particularly inef cient in their production activities. Our ndings, therefore, formalize the evidence that poor countries are characterized by low TFP.[8] In our model CMI cause that low productivity technologies, even when they are not socially ef cient, are used in equilibrium and that entrepreneurs extract economic rents. That is, CMI may remain in place in poor countries despite its tremendous negative effects because some entrepreneurs bene ts from it.

To assess the importance of CMI in the determination of TFP across countries we develop a general equilibrium model where entrepreneurs need external funds in order to produce an intermediate good. Entrepreneurs form coalitions or nancial intermediaries as a mechanism to allocate resources among their members and organize production of intermediate goods. Contracts are given by the proportion of entrepreneurs that operate their technology (the others being workers), the output that entrepreneurs may produce, and the repayment to the coalition after production. However, the ability of coalitions to raise funds is weakened by two imperfections in the capital market. First, entrepreneurs

6 See Levine (1997) for a comprehensive survey of this empirical and theoretical work.

7 These predictions are born out by facts since indicators of nancial development are positively correlated with productivity across countries (Levine (1997)).

8 See Hall and Jones (1999), Prescott (1998).

have private information about productivity of their production technology. Second, there is an upper bound to how much entrepreneurs can commit to pay back once the returns of the project are realized namely, there is limited enforcement of loan contracts. We assume that countries are identical but they differ in their ability to enforce loan contracts.[9] We study how the level of enforcement affects the allocation of aggregate resources as well as the provision of the production technology by the nancial intermediaries.

Under asymmetric information, the way to provide incentives for low quality entrepreneurs to reveal their type depends on the enforcement parameter. Since the penalty if lying increases with the enforcement, low quality entrepreneurs have incentives to reveal their type only if enforcement is high. In fact, when enforcement is suf ciently high, the full information contract is incentive compatible and thus low productivity entrepreneurs, who are the one with a higher production cost, become workers. Indeed, only entrepreneurs with the highest productivity nd pro table to operate their technology in equilibrium. On the contrary, when the economy is characterized by a suf ciently low enforcement the only way low productivity entrepreneurs report their type is by assigning resources to operate their technology. As a result, low productivity technologies will be used in equilibrium, even when they are not pro table. This happen because low productivity entrepreneurs are subsidized in their business operation. Moreover we show that entrepreneurs extract rents when enforcement is low. Indeed, entrepreneurs make positive pro ts if and only if en-

[9] Laporta et al. (1998) examine empirically how laws protecting investors and how the quality of enforcement of these laws differ across countries. They show that the quality of law enforcement improves sharply with the level of income.

forcement is limited so that they have a vested interest in maintaining a status quo with low enforcement.

Another interesting finding of the second chapter is that our theory has implications for the allocation of resources across industries that differ in their needs of external funds and provide some insights into why poor countries face large differences in productivity across sectors. Recent literature on economic development stress the importance of differences in productivity across sectors for understanding the development process for those nations that are currently poor.[10] Restuccia et al. (2003) show that poor countries are characterized by a low agricultural labor productivity and a high agricultural labor share. They conclude that one of the reasons of this current differences in the agricultural sector is due to the low use of intermediate inputs in agriculture[11] and the second reason is "barriers to labor mobility."[12] Our theory points that CMI may play a key role in understanding both sectorial productivity differences and barriers to factor mobility. In our theory industries, which differ in their needs of external financing, are affected differently by CMI.[13] We find that when enforcement is sufficiently high, labor productivity and TFP does not differ across sectors. When CMI are very high, however, productivity varies across industries. Intermediate sectors are characterized by a very low productivity under limited enforcement. With low enforcement, the inputs needed in the production of intermediate goods are

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10 See Hsieh and Klenow (2002), Golin et al. (2002) and Kutnez (1966).

11 Distortions in the intermediate input market increase the cost of these inputs.

12 Barriers to labor mobility between agricultural and non-agricultural sectors suppress wages in the agricultural sector, giving farmers greater incentives to substitute labor for intermediate inputs in production.

13 Our conclusion supports the empirical evidence in Rajan and Zingales (1998). Using cross country data, they found that low levels of financial development affect more negatively industries that rely particularly heavily on external finance.

used very inef ciently and the amount of resources used in the production of intermediate goods are scarce. As a result, the price of intermediate goods increase. However, the rst and the second effects dominate the effects on prices, so that intermediate goods sectors exhibit low productivity in the presence of CMI. These effects become stronger for rms with a high xed production cost, since under CMI nancing problems are particularly severe in these rms. In fact prices increases more for rms that depend more on external funds, and thus relative productivity is higher for them. Moreover, factor inputs can not move to the most productive industries because of enforcement problems and thus inputs are combined in a very inef cient way. As a result, poor countries in our framework allocate a large fraction of its productive resources to industries with low productivity.

Our theory also offers a potential rationale for reconciling the tax implications of economic theory with empirical evidence. The conventional wisdom based on the neoclassical model has been that taxation can be an important determinant of the level of output. However, in the empirical work of Easterly and Rebelo (1993) the link between these variables are statistically fragile. Our results suggest that CMI matter because the effects of taxes on economic activity vary across economies depending on the development of their capital markets. In our framework, in particular, the negative effect of labor income taxation on economic activity is much distortionary when capital markets do not function well. Easterly and Rebelo (1993) did not nd evidence for the positive correlation between taxation and economic activity, and they pointed out that this conclusion was in part due to multicolinearity problems because scal variables tend to be highly correlated with the level of income. Our model extends this view and concludes that neglecting CMI may prove misleading in studying fiscal policy issues and that cross country regression analysis may face an omitted variable problem when abstracting CMI.

The message that underlines this Thesis is that understanding the role of information constraints and incentives is vital for explaining the kind of financial structures we observe. Moreover, this asymmetries of information are crucial to asses the different contributions on macroeconomics effects of financial intermediation. The importance of financial institutions on economic performance is still far from being well established, and like much of macroeconomics, crying out in need of refinement.

Chapter 1
Education, Inequality and Mobility: Does Information Matter?

1.1 Introduction

Do capital markets imperfections (CMI for short) increase inequality and intergenerational mobility? Are CMI a barrier to mobility?

A huge literature has tried to address these questions.[14] Nevertheless most, if not all this existing literature has been developed mainly under the "assumption" that CMI are exogenous. By exogenous CMI we mean two things. First, exogenous credit constraints where credit limit is fixed and independent of the observable characteristics and decisions of individuals. In some cases this credit limit is taken at the extreme so that agents can not borrow (see, for instance, Becker and Tomes (1986), Loury (1981), Maoz and Moav (1999), Mulligan (1996), Owen and Weil (1998)). Alternatively, exogenous credit constraints are sometimes presented by an exogenous substantial wedge between the cost of borrowing and the return on lending (Galor and Zeira (1993)). These authors tell us that under exogenous CMI inequality becomes persistent since poor individuals do not have access to the same investment opportunities as rich agents. Therefore, exogenous CMI harm poor, and more specifically lead to higher inequality and lower mobility. Certainly, both the economists and public policy literature have taken it for granted and based on this thought

[14] Aghion and Bolton (1992) provide a selective review of the literature on endogenous evolution of income distribution with CMI.

they have developed different policy analysis (public education, education subsidies or taxation programs for example).

This paper tries to address the question: To what extent and through what mechanism do asymmetries of information between borrowers and banks affect inequality and intergenerational mobility? Is the nature of CMI important for understanding inequality and mobility? That is, are these previous results sensitive to the way we model imperfections in the capital market? What we do in this chapter is study inequality and mobility in a model where CMI are endogenous. To this end we construct a growth model with adverse selection problems in the nancial sector.[15] In contrast to the previous analysis this chapter argues that when we endogenize CMI we found the surprising result that intergenerational mobility may be promoted among poor and talented people. Moreover, endogenous CMI may increase the accumulation of human capital. However, the effects of CMI on income inequality are ambiguous.

In this model agents are heterogeneous in two dimensions: inherited wealth and ability. Young agents can attend private education and the investment in human capital, which is divisible, may be nanced by a loan market.[16] There are two types of agents low ability agents and high ability ones. Moreover, nancial markets are characterized by the presence of informational asymmetries between borrowers and banks. Even though banks know the

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[15] In adverse selection models, the existence of equilibrium is an important issue. With perfect competition among banks existence are not ensure. See Rothschild, M. and Stiglitz, J. (1976) to illustrates this issue.

[16] An example of the importance of the amount borrowed in education is found in American law students. With rising tuitions, students have borrowed more to pay for their education. The sums that students are borrowing are much larger today than they were ten years ago, even after adjusting for the cost of living. For graduates at many schools, average cumulative debts of $40,000 in 1989-1990 from college and law school have become the norm (see Chambers (1994)).

inherited wealth of each applicant they do not know the borrower's ability. In our model the returns from the investment in education are random. Ability affects positively not only the success probability, which additionally is the probability of repay the debt, but also the return from the investment in education.[17]

When banks can not identify borrowers' ability, they offer a menu of contracts that satisfy the self-selection mechanism. That is, banks force borrowers to make a contract choice in such a way that both types reveal their characteristic. In equilibrium banks differentiate between agents by forcing talented borrowers to make an investment in human capital larger than they would have done in the first best world. In this way low ability individuals do not pose as high ability ones. In equilibrium, talented children from poor families get educated even more than they wish, so that both income mobility and human capital accumulation are larger than in the first best world.

If we analyze inequality of wealth we found that there are opposite effects making inequality unambiguous. On the one hand, there is a small number of people in the lower bound of the income distribution. On the other, hand the middle class of high ability borrowers has a lower wealth. We can show that the mean of the distribution of wealth is higher under asymmetric information.

The related literature can be classified in two different branches. The first one is when CMI are exogenous and the second when they are endogenous.

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[17] We assume that agents investing more in human capital receive a better quality of education. This helps the student's outcomes, so that he is more likely to succeed, works as educated and earns a higher income than if he fails and becomes uneducated. The idea behind this assumption is that buying more education is equivalent to having a higher probability of finishing studies and becoming educated.

Most of the papers analyze exogenous CMI. This literature does not model the reasons for the imperfections. The underlying conclusion is that imperfections lead to lower mobility. The intuition of this result is that when borrowing is expensive, individuals with low wealth have no longer access to the same investment opportunities as individuals with high wealth. In this context, inequality becomes persistent and intergenerational mobility decreases.

The literature above assumes that borrowers and external suppliers of funds have the same information about the borrower's choice, investment opportunities, riskiness of projects, and output or pro ts. In practice, borrowers have signi cantly better information than outside investors about most aspects of the borrower's investment and its returns. For that reason, the second branch of the literature endogenizes CMI by assuming asymmetries of information. To the best of our knowledge, such literature typically uses a moral hazard framework Aghion and Bolton (1997), Piketty (1997). None of these studies, however, introduce adverse selection in the capital market in order to analyze inequality and mobility.[18]

Aghion and Bolton (1997) and Piketty (1997) examine the interaction between wealth distribution and the equilibrium interest rate. Our model differs from theirs, both in structure and results. Even though both papers study inequality, they do not model explicitly mobility.[19] Namely, both models assume that individuals do not differ in ability, steady

[18] There is a good reason to be interested in this adverse selection problem. In our model, it implies that the borrower knows the expected return and risk of his investment project, whereas the bank knows only the expected return and the risk of the *average investment* project in the economy, and thus there may be no objective way to determine the likelihood of the loan repayment. In our credit markets the *promised* repayments on loans differ from the *actual* ones because of the uncertainty concerning the borrower's ability, namely the quality of the investment. This creates the risk of borrower default.

[19] Aghion and Bolton (1997) focus on nding conditions under which there is a unique steady state distribu-

state mobility is therefore random and independent of abilities. In contrast, in our paper, mobility is a result of individuals' choices given their ex-ante heterogeneity.

Another important difference in term of results is that in their models poor agents are credit rationed, while in our model the opposite occurs since there is overinvestment among talented borrowers. The intuition for this result is quite intuitive. In their papers agents invest in their own project and they can go to the capital market to get into debt if necessary. The source of CMI in their model is moral hazard with limited wealth constraints (or limited liability). The returns from the investments depend positively on the effort that agents supply and the contract need to be sing before the effort is supply by borrowers. Under full information, effort is observable and thus, banks can make sure at no cost that borrowers supply the rst-best level of effort just by making the contract contingent on it. However, when effort is not veri able, the contract can not be contingent on the effort level. The poor is the borrower the more his interest diverges from the interest of the bank. Namely, the more the agent has to borrow, the higher are the marginal returns to share with banks and consequently, the less effort the borrower will supply. Since poor agents have no incentives to supply too much effort, banks will react by rationing them. Thus, in this type of models CMI leads to lower social mobility.

Our results, as we argue in more details in the next sections, are exactly the opposite. Namely, banks have incentives to overprovide loans since it is the way to reveal the borrower's type. Accordingly, our paper contributes to the theoretical understanding of the

tion of wealth. However, in Piketty (1997) multiple stationary interest rates and wealth distribution can exist because higher initial rates are self-reinforcing through higher credit rationing and lower capital accumulation.

linkage between income distribution and CMI. Our results should be taken as a complement to existing studies, not only raising doubts about the "consistent message," but also suggesting that further careful reassessment of the interaction between CMI and income distribution needs to be consider.

The paper is organized as follows. We set up the model in Section 2. The equilibrium in the capital market is described in Section 3. The consequences of asymmetric information in terms of mobility, inequality and education are developed in Section 4. Section 5 concludes the paper. Finally, an appendix contains all omitted proofs.

1.2 The Economy

The economy is populated by two-period-lived overlapping generations of agents. When individuals are young, they decide whether to go to school or not. Schooling is costly since it requires a cost (I) which is privately provided. There exist a loan market to get into debt if necessary which is characterized by the existence of an adverse selection problem. The capital market is competitive.

1.2.1 Individuals Human Capital Technology

The economy is populated by a continuum of families, indexed by $j \in (0;1]:$ For simplicity, there is one member of each family born in each period t, so that there is no population growth the parent-child connection creates a dynasty. Individuals differ in their initial wealth inherited from their parents and in their ability.

Let θ denote an agent's ability. Individuals can be either low ability named by $\underline{\theta}$ type, or high ability named by $\overline{\theta}$, where $\overline{\theta} > \underline{\theta} > 0$. The proportions of low ability is given by γ and of high ability is $1 - \gamma$, with $\gamma \in (0, 1)$. We assume that agents know their own ability while banks know only the proportion of individuals of each type, as well as the inherited bequest of each applicant.

Individuals are risk neutral. When young, agents maximize utility which depends on their second period consumption, c_{t+1} and on their bequest given to their child, b_{t+1}. More specifically, the utility function takes the form $U_t = z c_{t+1}^{1-\alpha} b_{t+1}^{\alpha}$, where $z = (1-\alpha)^{\alpha-1}\alpha^{-\alpha}$. According to this utility function, agents allocate the final wealth between consumption, $c_{t+1} = (1-\alpha) y_{t+1}$ and transfers to their children $b_{t+1} = \alpha y_{t+1}$. Hence, the indirect utility function is simply a linear function of the wealth realization $V_t = y_{t+1}$.

The human capital technology, which is given by the function $h(\theta, I_t)$, is stochastic at the individual level. In particular, human capital can take two different values depending on the realization of idiosyncratic shocks. We assume that in case of success agents become educated, in case of failure agents become uneducated. Banks are able to observe ex post and without any cost, whether the investment in human capital fails or succeeds. Hence, the returns from the investment are given by the common knowledge function,

$$h_{t+1}^{j} = h(\theta, I_t) = \begin{cases} h^e G_\theta & \text{if it succeeds with} \quad p(\theta, I) \\ h^u & \text{if it fails with} \quad 1 - p(\theta, I), \end{cases} \tag{1.1}$$

where $\theta = \{\underline{\theta}, \overline{\theta}\}$, I is the investment in education which takes values in the interval $I \in [0, \infty)$. As we will see later on, since the amount of investment is divisible, it can be used to convey information about the borrower's ability. The returns from the investment in human capital are such that educated agents accumulate higher human capital than uneducated agents since $h^e > h^u > 0$ and $G_\mu > 1$ hold: Notice that the human capital of educated agents is affected by talent through G_μ: Talented agents obtain more human capital since $(G_{\bar{\mu}} > G_{\underline{\mu}})$. Ability affects the returns from the investment as well as the probability of success.[20] A talented agent, by definition, will succeed more frequently since $p(\bar{\mu}; I) > p(\underline{\mu}; I)$ at any amount of investment I.

It may be worthwhile to consider that even though we have confined here to studying investment in education, we can think also this model as an investment project for becoming entrepreneurs.

Ability is not the sole determinant of the success probability. Investment in education is the other factor that influences it. More human capital investment results in a higher success probability but at a decreasing rate, $p_{II} < 0$: Moreover, talented agents have higher marginal return in the successful state. We formalize this reasoning with the assumption that ability and the amount of investment are complementary factors in the production of human capital $p_{\mu I} > 0$. So that high ability borrowers have higher total and marginal returns in the successful state. More specifically, we use the probability function

$$p(\mu; I) = B(\mu)(1 - e^{-I}) \quad \text{and} \quad 1 - p(\mu; I) = 1 - B(\mu)(1 - e^{-I}); \qquad \text{(A1)}$$

where $B(\mu) < 1$ and $B(\bar{\mu}) > B(\underline{\mu}) > 0$:

Agents live for two periods. In the first period, individuals learn their ability and receive an inherited wealth paid at the beginning of this period. The parental gift b_t that an individual born in period t receives is publicly known. This inherited wealth can be

[20] If ability were affecting only the returns from the investment, we would find that full information contract is incentive compatible. If ability were affecting the probability of the investment, we would find that agents are better off with a pooling contract and thus, the equilibrium does not exist. To understand this line of reasoning see subsection 1.3.2.

used either to finance education, since education is privately provided, or to invest in the capital market at the riskless interest rate R.[21] Because of the properties of the investment probability it is always profitable to invest in education.[22]

Some agents will borrow to finance their investment in education from a bank if necessary. Banks offer contracts that we denote by $\xi = (F_{t+1}; I_t)$, where F_{t+1} is the interest rate charged and I_t is the amount of investment in education. Some other agents have enough inherited wealth to finance all their investment in education and, thus they become lenders. Namely, they optimally decide to invest the excess of bequest in the capital market at the riskless rate of return (see the subsection First Best Investment bellow). In summary, individuals can either lend, borrow or not participate in the capital market. If they lend the final wealth or similarly the second period wealth is

$$y_{t+1} = \begin{cases} h^e G_\theta + R(b_t^j - I) & \text{with} \quad p(\theta; I) \\ h^u + R(b_t^j - I) & \text{with} \quad 1 - p(\theta; I); \end{cases}$$

where R is the opportunity cost of funds.

If they borrow when young, the final wealth is

$$y_{t+1} = \begin{cases} h^e G_\theta - F(I - b_t^j) & \text{with} \quad p(\theta; I) \\ h^u & \text{with} \quad 1 - p(\theta; I). \end{cases}$$

We are assuming that when projects succeeds agents become educated and earn an income high enough to repay the debt. By contrast, when projects fail borrowers are unable to repay the debt.

21 This model need to be interpreted for postsecondary education. For brevity, we refer to postsecondary education as educated and someone who fails the investment in education or decide do not go to the school as uneducated.

22 It is so since $\lim_{I \to 0} p_I(\theta; I)(h^e G_\theta - h^u) > R$ which implies that $B(\theta)(h^e G_\theta - h^u) > R.$

If they do not participate in the capital market they invest their inherited bequest, the final income is

$$y_{t+1} = \begin{cases} h^e G_\theta & \text{with} \quad p(\theta; b_t) \\ h^u & \text{with} \quad 1 - p(\theta; b_t). \end{cases}$$

We will see later on that in equilibrium everybody will be lender or borrower, and thus there are no self-financed agents of low wealth rejecting the contract.

At the beginning of the second period of their life (when they are old), the uncertainty about the investment is resolved. Afterwards, banks receive profits and agents obtain their wealth. Agents allocate it between consumption, $(1 - \alpha)y_{t+1}$ and transfers to their children, αy_{t+1}.

First Best Investment: When ability is known by agents there is no problem of asymmetric information. The first-best level of investment, which is denoted by I^*, maximizes the expected returns net of the opportunity cost of the investment,

$$I^* \in \arg\max_{I \geq 0} \; p(\theta; I)h^e G_\theta + (1 - p(\theta; I))h^u - RI.$$

The FOC is,

$$\frac{dp(\theta; I)}{dI}(h^e G_\theta - h^u) = R. \tag{1.2}$$

It is worth noticing that the fundamental problem of the agent is to optimally decide how much of the inherited wealth is invested in human capital and how much is invested in the capital market. Eq. (1.2) represents the non arbitrage condition between human an physical capital. It tells us that the current gross interest rate R equals the expected marginal profit of the investment in human capital. From Eq. (1.2) and A1 (which provides the functional form of $p(\theta; I)$) we can derive the first best level of investment,

$$I_{\theta}^{*} = \ln\left(\frac{B(\theta)(h^{e}G_{\theta} - h^{u})}{R}\right); \qquad (1.3)$$

where $\theta = \{\underline{\theta}; \overline{\theta}\}$: It depends positively on the return gap $(h^{e}G_{\overline{\theta}} - h^{u})$; and negatively on the return from saving R. Since talented borrowers have higher total and marginal returns in the successful state they decide to invest a higher level in education, i.e. $I_{\overline{\theta}}^{*} > I_{\underline{\theta}}^{*}$.

When agents spend in human capital above the first best, namely when there is over-investment, the expected marginal profits of the investment are below the riskless interest rate R. This means that agents are not investing properly. By merely reducing human capital investment and putting the excess of bequest into the capital market; agents would increase their wealth. Accordingly, agents with an inherited wealth above I_{θ}^{*} will invest the first best amount and become lender. When agents invest bellow the first best, namely when there is underinvestment, the expected marginal profits of the investment are above the riskless interest rate. It will be optimal for the agents to increase the investment in education (if they have the necessary inherited wealth) until both rates of return equates. Therefore, agents with the inherited wealth below the first best investment, are the one who become borrower.

In the next section we study the loan market for the applicants. We start by defining the contract and then, we characterize the equilibrium.

1.2.2 The Financial Contract

Banks know the level of bequest of loan applicants. Being unable to observe θ, banks cannot discriminate among borrowers at a given level of inherited wealth. This means that there is a submarket for each level of bequest with banks offering a menu of contracts at each level of it. As a result, there are a continuum of contracts in the level of bequest and from now own we will analyze the contract conditional upon one level of bequest. After that we will see how this contract is modified when the inherited wealth changes.

Banks compete in two dimensions:

i) The rate of interest charged F_{t+1} (one plus the interest rate on the loan).

ii) The amount of investment in education, I_t, so that the extent of the loan is determined by the investment in education minus the intergenerational transfer received, $(I_t - b_t^j)$.

The contract will be contingent upon the borrowers' inherited wealth. Therefore, bank's offer consists of a vector $\xi = (F_{t+1}(b_t), I_t(b_t))$ that specifies the interest rate F_{t+1}, and the amount of investment in education I_t, for any level of bequest.

Under asymmetric information, agents with an inherited wealth $b_t^j < I^*_{\underline{\theta}}$ regardless of their talent become borrowers and banks are unable to distinguish among borrowers of different ability. Hence, banks offer the asymmetric information contract to those agents. As we have argued in the section above, low ability agents with $b_t^j \geq I^*_{\underline{\theta}}$ become lenders investing the first best amount $I^*_{\underline{\theta}}$. Similarly, high ability agents with $b_t^j \geq I^*_{\bar{\theta}}$ become lenders investing the first best amount $I^*_{\bar{\theta}}$. High ability agents with wealth $I^*_{\underline{\theta}} \leq b_t^j < I^*_{\bar{\theta}}$, do not have enough funds to invest the first best amount, and they thus apply to the capital market. Since only individuals of type $\bar{\theta}$ apply, the bank offers the full information contract to all of them. Therefore, the asymmetric of information problem is only present for agents with $b_t^j < I^*_{\underline{\theta}}$.

Once agents invest in their education, the project could succeed or fail. In case of success, they become educated and earn an income high enough to repay their debt. In case of failure, agents become uneducated and earn an income so low that they can not repay the debt. Borrowers' expected utility is thus given by their expected future wealth

$$U = p(\theta; I)[h^e G_\theta - F(I - b_t^i)] + (1 - p(\theta; I))h^u. \qquad (1.4)$$

[Insert Figure 1]

Indifference curves $U_{\theta;b_t}(I;F) = \overline{U}$ for the borrower are depicted in Figure 1. The interest rate (F) is represented in the vertical axis and in the horizontal axis is represented the investment in human capital (I). Each figure is drawn conditional on a certain level of bequest.[23] The indifference curves (denoted in the figures by U_θ) are concave (see appendix B.1. for a proof of this property).

Because ability and investment in human capital are complements, and the returns from the investment are higher for $\overline{\theta}$ type, the marginal rate of substitution between investment and interest rate is an increasing function of ability. Hence, high type borrowers are inclined to accept higher increases in interest rate for a given increase in the amount of investment. As a result, the indifference curves of a borrower satisfy the "single crossing" property, i.e. $\frac{dF}{dI}|_{\overline{\theta}} > \frac{dF}{dI}|_{\underline{\theta}}$.[24] This fact enables banks to offer a pair of different contracts, where the loan size is used to reveal the ability of the borrower.

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[23] We will see later on that the higher is the inherited wealth, the sharper is the slope of the indifference curve for both agents.

[24] It means that $\overline{\theta}$ type borrowers will exhibit a higher marginal rate of substitution than $\underline{\theta}$ type borrowers.

The utility increases in the southeast direction, when the quantity of the loan increases at a lower price. The dashed line $I^w_{\underline{\theta}}$ gives us the first best level of investment. As it was established in the previous section, $I^w_{\overline{\theta}}$ is situated at the right of $I^w_{\underline{\theta}}$:

We assume a competitive loan market, with risk neutral banks obtaining their funds in a perfect capital market at the exogenous interest rate R since we suppose a small and open economy. Because banks offer contracts with limited liability, the repayment is $F(I - b^j_t)$ in case of success and zero in case of failure. The returns of the banks in expected terms are given by

$$\Pi = p(\theta; I)F(I - b^j_t) - R(I - b^j_t):$$

Since the loan market is competitive, in equilibrium bank's profits are zero. The break-even line (denoted by π_θ) of the bank in the plane $(F; I)$ is downward sloping (see appendix B.2. for a proof). Contracts above the break-even line will provide with positive profits for the bank, contracts below it will provide with losses. The zero iso-profit contour shifts down for high ability agents (for a level of investment the interest rate is lower for them because they fail less).

1.2.3 Characterization of the Equilibrium

We look for a pure strategy Nash Equilibrium in a two-stage game. In the first stage, each bank announces a pair of contracts $\{\xi_{\underline{\theta}}; \xi_{\overline{\theta}}\} = \{(F_{\underline{\theta}}; I_{\underline{\theta}}); (F_{\overline{\theta}}; I_{\overline{\theta}})\}$; for each level of bequest. In the second stage, borrowers simply select their most preferred loan contract from the set of all contracts offered by banks.

We allow for “free entry” so that an additional bank could always enter if a profitable contracting opportunity existed. For simplicity, we assume that a borrower can apply to only one bank during the period under consideration. Because of perfect competition banks take other’s bank offers as given.

Under these conditions, an equilibrium in a competitive market is a set of contracts such that:

i) Each contract $\{\xi_{\underline{\theta}}; \xi_{\overline{\theta}}\}$ guarantees nonnegative profits for the bank.

ii) Contracts announcements are incentive compatible in the presence of other announced contracts, that is,

$$p(\overline{\theta}; I_{\overline{\theta}})[(h^e G_{\overline{\theta}} - h^u) - F_{\overline{\theta}}(I_{\overline{\theta}} - b_t^j)] \geq p(\overline{\theta}; I_{\underline{\theta}})[(h^e G_{\overline{\theta}} - h^u) - F_{\underline{\theta}}(I_{\underline{\theta}} - b_t^j)]; \quad (1.5)$$

$$p(\underline{\theta}; I_{\underline{\theta}})[(h^e G_{\underline{\theta}} - h^u) - F_{\underline{\theta}}(I_{\underline{\theta}} - b_t^j)] \geq p(\underline{\theta}; I_{\overline{\theta}})[(h^e G_{\underline{\theta}} - h^u) - F_{\overline{\theta}}(I_{\overline{\theta}} - b_t^j)]: \quad (1.6)$$

iii) No banks have an incentive to offer an alternative set of profitable, incentive compatible contracts.

In part ii) we have introduced as restrictions the incentive compatibility constraint. Banks are unable to distinguish borrowers. They can do so only by offering a pair $(\xi_{\underline{\theta}}; \xi_{\overline{\theta}})$ of different credit contracts that act as a self-selection mechanism. These restrictions force borrowers to make choices in such a way that they reveal their types.

1.2.4 Discussion of Modeling Assumptions

The model developed assumes that parents obtain utility from bequests. This simplify the dynamics of the model and allow us to have a close solution of the model. Assuming that parents were altruistic towards their children (in the sense that parents value the utility of their offspring) or assuming that ability were transmitted from father to son with some persistency would substantially complicate the model. Under either of these two assumptions our economy would need to be solved using a signalling framework.

In our model, banks compete in price and in quantities. Bose and Cothren (1997) and Becivenga and Smith (1993) use as instruments of the nancial contract the interest rate, the amount of the loan, and the probability of rationing. In their models, lenders use credit rationing as a response to the adverse selection problem. The pivotal modeling difference between their analysis and ours is that in their models each borrower receives the same amount of investment: As a result, lenders can not discriminate in the amount of investment, nor in the interest rate (since there is perfect competition) and use credit rationing as the instrument to differentiate among agents. Notice that the possibility of introducing the probability of rationing as instrument could easily be incorporated in our paper. In fact, our results will not change since everybody will receive the loan, and the distortion is still given by the amount of investment.

Besanko and Thakor (1987a), (1987b), Bester (1985) use as instruments the collateral. The only role of collateral is to allow for self-selection of borrowers. But in our model the loan size is variable and it helps us to separate them. Therefore, when loans are of variable size, no collateral is required anymore. Observe that collateral requirement is similar in its economic effects to a rise in b_t.[25]

1.3 The Equilibrium Contracts

In the next subsections we analyze the behavior of banks and borrowers. To provide a benchmark against which to measure the effects of information asymmetries, we first consider the equilibrium when there is full information.

1.3.1 Full Information

The equilibrium credit policy maximizes a borrower's expected utility subject to Eq. (1.7) which represent the participation constraint for the bank. It holds with equality given the hypothesis of free entry and perfect competition among banks. Therefore, for any agent with an inherited wealth $b_t^i < I_\theta^*$ the bank solves the following problem

$$\max_{\{F;I\}} p(\theta; I)[h^e G_\theta - F_\theta(I_\theta - b_t^i)] + (1 - p(\theta; I))h^u;$$

subject to

$$p(\theta; I_\theta)F_\theta(I_\theta - b_t^i) = R(I_\theta - b_t^i); \tag{1.7}$$

where $\theta = \{\underline{\theta}; \overline{\theta}\}$. It is straightforward to verify that for any high ability agent with wealth $b_t^i < I_{\underline{\theta}}^*$ and any less able applicant with $b_t^i < I_{\overline{\theta}}^*$, the equilibrium contract is given by $\xi^* = \{\xi_{\underline{\theta}}^*; \xi_{\overline{\theta}}^*\}$ with

$$\xi_\theta^* = (F_\theta^*; I_\theta^*) = \left(\frac{R}{p(\theta; I_\theta^*)}; \ln\left(\frac{B(\theta)(h^e G_\theta - h^u)}{R}\right)\right);$$

[25] Stiglitz and Weiss (1981) acknowledge this in footnote 8 on page 402.

where $\theta = \{\underline{\theta}, \overline{\theta}\}$.[26]

The interest rates charged to borrowers are entirely determined by the opportunity cost of funds and success probabilities. The equilibrium contract $\lambda^* = \{\lambda^*_{\underline{\theta}}, \lambda^*_{\overline{\theta}}\}$ is independent of the inherited wealth. This is so since there is perfect competition among banks and agents are risk neutral. The implication of this result is that independently of how wealth is distributed, banks provide the same amount of investment in human capital within each type.

High ability borrowers are better off than the low ability ones at any b_t. Since talented agents have high returns when they succeed and since they failure less often, banks provide better contracts to high ability applicants. Thus, it is not odd that under full information banks provide talented borrowers with more funds at a lower interest rate.

The contract $\lambda^*_{\underline{\theta}}$ is not incentive compatible.[27] Namely, if ability is private information the contract $\{\lambda^*_{\underline{\theta}}, \lambda^*_{\overline{\theta}}\}$ is not longer an equilibrium since the low ability borrowers are strictly better off accepting the contract $\lambda^*_{\overline{\theta}}$. Therefore, if a bank offers $\{\lambda^*_{\underline{\theta}}, \lambda^*_{\overline{\theta}}\}$ under private information, there will be losses for the bank.

1.3.2 Asymmetric Information

The equilibrium contract must specify the pair (F, I) offered to each θ type. The equilibrium could be a separating equilibrium, where different types choose different contracts or a pooling one, where different types choose the same contract. Arguments identical to those

26 Notice that the only contract at which there is no profitable deviation is the Pareto optimal contract $\lambda^* = \{\lambda^*_{\underline{\theta}}, \lambda^*_{\overline{\theta}}\}$.

27 For a proof see appendix B.7.

given in Rothschild and Stiglitz (1976) establish that Nash equilibria are never pooling and any offer induce self-selection of borrowers.[28]

Under asymmetric information the equilibrium contract is characterized by the following proposition.

Proposition 1: For any agent with $b_t^j < l_{\underline{\theta}}^*$, the equilibrium under asymmetric information (if it exists) is given by the credit contract $\xi' = \{\xi_{\underline{\theta}}^*; \xi_{\bar{\theta}}'\}$ where

$$\xi_{\underline{\theta}}^* = (F_{\underline{\theta}}^*; l_{\underline{\theta}}^*) = \left(\frac{R}{p(\underline{\theta}; l_{\underline{\theta}}^*)}; \ln \left(\frac{B(\underline{\theta})(h^e G_{\underline{\theta}} - h^u)}{R} \right) \right); \tag{1.8}$$

and

$$\xi_{\bar{\theta}}' = (F_{\bar{\theta}}'; l_{\bar{\theta}}') = \left(\frac{R}{p(\bar{\theta}; l_{\bar{\theta}}')}; l_{\bar{\theta}}' \right);$$

with $l_{\bar{\theta}}'$ given by

$$p(\underline{\theta}; l_{\underline{\theta}}^*)[(h^e G_{\underline{\theta}} - h^u) - F_{\underline{\theta}}^*(l_{\underline{\theta}}^* - b_t^j)] = p(\underline{\theta}; l_{\bar{\theta}}')[(h^e G_{\bar{\theta}} - h^u) - F_{\bar{\theta}}'(l_{\bar{\theta}}' - b_t^j)]. \tag{1.9}$$

Proof. See appendix.

[Insert Figure 2]

Low type borrower receives the full information contract. The bank's incentive problem is to deter $\underline{\theta}$ type borrowers from claiming to be $\bar{\theta}$ type borrowers. This incentive can be counteracted by making the $\bar{\theta}$ contract less favorable to $\underline{\theta}$ type borrowers, i.e. by "distorting" the first-best contract of the $\bar{\theta}$ type borrowers. This is the only way to ensure that the $\underline{\theta}$ type will satisfy the self-selection mechanism and therefore, will not have incentives to choose the contract for the $\bar{\theta}$ type.

[28] If pooling contracts are offered, then there exists another credit offer that is profitable because it attracts only high ability type from the pooling contract. Hence, pooling contract is never viable against competition.

The bank distorts the high type borrowers by providing overinvestment, namely the amount of investment is higher than the first best. As a result, talented individuals are worse off under asymmetric information. The intuition behind this overinvestment result is that since the interest rate is the instrument used to ensure the zero profit condition hence, the only way banks can sort out borrowers is by adjusting the investment level. Because $p_{\mu I} > 0$ and ability affects positively the returns from the investment, the marginal rate of substitution between investment and interest rate is an increasing function of the ability, namely high ability borrowers are willing to pay more for an incremental amount of investment.[29] Therefore, investment can be used to reveal the borrowers' ability. And thus, a contract specifying a suboptimal high investment is relatively more attractive to talented borrowers.

This overinvestment affects the debt repayment in two different ways. First, it increases the amount of the loan $(I^{0}_{\bar{\mu}} - b_t)$. And second, since this overinvestment increases the success probability, banks react by lowering the interest rate charged to $\bar{\mu}$ applicants $(F^{0}_{\bar{\mu}} = \frac{R}{p(\bar{\mu}, I^{0}_{\bar{\mu}})})$. Because the first effect prevails, the debt repayment is higher than the one under full information for $\bar{\mu}$ type borrowers. As a result, the high type is worse off under asymmetric information even though mobility (as we will see in the next section) will be higher among them (i.e. they have a better chance to become educated). In fact, the losses induced by private information can be measured by the debt repayment for $\bar{\mu}$ type applicants, which is higher than with full information.

[Insert Figure 3]

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29 It makes sense, since it is precisely the $\bar{\mu}$ type, the one with a higher success probability and higher returns from the investment.

If a borrower has stronger balance sheet positions the distortion of the contract will be lower. The more a borrower invests in his own project the less his interest will diverge from the interest of the bank. This greater compatibility of interest reduces the informational problem associated with the investment process. Thus ceteris paribus, the distortion is lower when the inherited wealth increases. This can be observed by comparing Figures 2 and 3, where in Figure 3 the borrower has a higher inherited wealth than in Figure 2: The equilibrium amount of investment $I_{\mu}^{\P}$ in Figure 3 (rich agent) is closer to $I_{\mu}^{¤}$ than it is $I_{\mu}^{\P}$ (poor agent) in Figure 2. It is important to emphasize that the indifference curves move with bequest. In fact, as the inherited wealth increases the indifference curves become steeper.

Clearly, since $\underline{\mu}$ type borrowers receive the first best contract they will prefer to borrow rather than to not participate in the capital market. Because talented borrowers are the one who are distorted, they could prefer to refuse the contract and to not participate in the capital market. However, high ability agents will choose to borrow rather than to fully self-finance their investment. The intuition of this result is as follows. As we have seen, the contract is written such that the distortion will be higher for poorer and talented borrowers. Moreover, borrower with high inherited wealth will be the one with more incentives to refuse the loan (if they refuse they will invest in education their own wealth), namely agents who will prefer not to participate in the capital market are the ones with the level of inherited wealth close to $I_{\mu}^{¤}$; and these borrower are precisely the less distorted in equilibrium.[30]

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30 For a proof see Appendix B.8.

Once we have characterized the candidate separating equilibrium we need to be completely sure that there is no way to distort our proposed equilibrium. Namely, we need to check that no banks have an incentive to offer an alternative set of profitable, incentive compatible contracts. By construction, no bank has incentive to offer any other contract which attracts only one type of borrower. Thus, there is no loan contract that low ability borrowers prefer to $\xi^{*}_{\underline{\theta}}$ which earns non-negative profits when only low type accepts it. Similarly, there is no incentive compatible loan contract that high type prefers to $\xi'_{\overline{\theta}}$ which earns non-negative profits when it is taken by high ability individuals only. As a consequence, an equilibrium exists if no bank has an incentive to offer a pooling contract. Since Nash equilibrium is never pooling we need to check under which conditions pooling contracts are never offered. If we find these conditions, our equilibrium exists and it is the one characterized by Proposition 1. In a pooling contract the losses that banks make with the contract offered to $\underline{\theta}$ type are offset by the profits of $\overline{\theta}$ type. Therefore, when the probability of being low type is very small, the incentives to have a pooling contract increase. Proposition 2 tells us that in order to have the separating equilibrium, the proportion of low ability agents needs to be high enough.

Proposition 2: Let $(\tilde{F}; \tilde{I})$ be the pooling contract offered by the bank; $V^{P}_{\overline{\theta}}(.)$ the indirect utility function of a talented borrower applying to the pooling contract and $V^{S}_{\overline{\theta}}(.)$ the indirect utility when he applies to the separating contract. If $\gamma > \hat{\gamma}(b_t = \underline{b})$; with $\underline{b}$ being the lowest possible level of inherited wealth; the following inequality holds :

$$V^{P}_{\overline{\theta}}(\tilde{F}(\gamma); \tilde{I}(\gamma); p(\overline{\theta}; \tilde{I}(\gamma)); b^{j}_{t}) < V^{S}_{\overline{\theta}}(F'_{\overline{\theta}}; I'_{\overline{\theta}}(b^{j}_{t}); p(\overline{\theta}; I'_{\overline{\theta}}); b^{j}_{t});$$

for $b_t^i \in [\underline{b}, I_\theta^*)$ and thus, the equilibrium is the separating one.

Proof. See appendix.

Notice that this proposition extends the result found by Rothschild and Stiglitz (1976). In their model all agents have the same amount of initial wealth. They show that when the proportion of low ability borrowers is higher than a certain threshold level, the separating equilibrium exists. By contrast, in our model agents differ also in the inherited wealth which is endogenously provided. Consequently, our threshold level of low ability borrowers depends on the inherited wealth, $\hat{e}(b_t)$. Moreover, this threshold level decreases with the inherited wealth.[31] Therefore, if we guarantee the existence of equilibrium for the lowest level of bequest we have equilibrium for higher levels.

1.3.3 Discussion

Our result of having overinvestment is in contrast to the conventional underinvestment outcome implicit in the microeconomic literature that analyses adverse selection between banks and borrowers.

It is worthwhile to consider the differences in terms of assumptions and results between the work by Stiglitz and Weiss (1981) and our paper. In their paper credit rationing appears since the expected return received by the bank does decrease at some point with the rate of interest charged to borrowers. It is due to adverse selection effect which occurs when a rise in interest rate change the mix of applicants adversely since safe potential borrowers drop out of the market, lowering the average borrowers quality. In our model by

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31 See appendix B.6. for a proof.

contrast, an increase in interest rates will decrease (instead of increase) the average risk (or similarly increase the average ability) of the population of borrowers. The reason is that in our model the marginal project financed (which is given by the borrower being indifferent between applying to the capital market or becoming self financed) has the lowest success probability, while in the Stiglitz and Weiss model he has the highest: Therefore, in Stiglitz and Weiss' model the bank may prefer to reject some borrowers instead of increasing the interest rate. They obtain a pure credit rationing since some individuals receive loans, while apparently identical individuals, who are willing to borrow at precisely the same terms, do not.

One crucial assumption in order to obtain the underinvestment result is that in Stiglitz and Weiss all borrowers have the same expected profits but the dispersion of the profits is different, whereas in our model the expected profits differ between borrowers (in fact, talented borrowers have higher expected utility than less able ones at any b_t). Another important assumption for having credit rationing is that in their model debt contracts are imposed exogenously and then the contract does not allow for any sorting mechanism constructed in such a way that each type of borrower will choose a specific type of contract. By contrast, in our model self-selection of borrowers will result from product differentiation because the loan size differs among agents, and thus it could be used to separate out agents. And if separation is complete, rationing can no longer occur.

Our overinvestment result depends on a number of assumptions but, if there is a central presumption, it appears to be the complementarity between ability and the investment as well as the assumption that ability affects positively the returns from the investment in education. There are some papers where borrowers obtain overinvestment in equilibrium. Besanko and Thakor (1987a) find that lower risk borrowers get more credit in equilibrium than they would with full information. Their basic assumption obtaining this result is that the marginal rate for substitution between investment and interest rate is an increasing function of the success probability. Our fundamental assumptions imply exactly the same. De Meza and Webb (1987) also obtain that borrowers invest in excess of the socially efficient level. They assume that banks cannot determine whether an individual consumer holds loans from other banks, as a consequence the equilibrium will be a pooling equilibrium rather than a separating one.[32] Overinvestment is obtained because in their model an increase in interest rate would decrease the average risk of the population of borrowers, and consequently credit rationing would never occur at the equilibrium interest rate.

We have characterized the equilibrium and we have found under which conditions this equilibrium exists. Concerning the existence problems another two paths have been followed in the literature. One approach followed by Dasgupta and Maskin (1986) allows for the presence of mixed strategies. The other approach followed by Wilson (1997), Riley (1979), and Hellwig (1987) highlight the need of dynamic reactions to new contact offers. Wilson adds the requirement that banks are able to withdraw unprofitable contracts from the market, in order to make deviations less attractive. They show that introducing this kind of reactions eliminates the nonexistence problem.

[32] The Rothschild and Stiglitz's (1976) proof that there can not be a pooling equilibrium depends on the assumption that borrowers can buy only one contract (assumption which of course holds also in our model). The implication of this assumption is, in effect, that the bank specifies both the prices and quantities in the contract. There exists, therefore, price and quantity competitions among banks. As Rothschild and Stiglitz point out the assumption that borrowers can buy only one contract is an objectionable one. By arguing that there is absence of monitoring puchases from banks De Meza and Webb use a price competion framework, and thus borrowers are allowed to buy arbitrary multiples of contracts offered.

1.4 Education, Inequality and Mobility

1.4.1 Full Information

The distribution of bequest in period t is given by $G_t(b)$. As we have normalized the mass of population to one, $G_t(b)$ also represents the fraction of the population with current wealth below b. We will show that the distribution of wealth converges to a unique steady state distribution, independently of the initial conditions. So historical endowments do not matter in the long run. In order to do that, we need to define the way how bequests evolve.

The agent's optimal decisions (see subsection 1.3.1) and the stochastic process for the shocks (ability and investment shocks) determine the Markov process for bequest. With full information the bequest follows a linear Markov process taking the form $b_{t+1} = \alpha y_{t+1}$, where the realized income is given by the equations written below. The investment in education can be successful (an event that occurs with probability $\bar{p} = p(\bar{\theta}; I^*_{\bar{\theta}})$ if agents are of high ability), or can be unsuccessful (that occurs with probability $1 - \bar{p} = (1 - p(\bar{\theta}; I^*_{\bar{\theta}}))$ if agents are of high ability). The law of motion for bequest is given by the following equations. If the agent is of high ability and succeeds

$$b_{t+1} = g(b_t; \bar{\theta}; \bar{p}) = \begin{cases} \alpha[h^e G_{\bar{\theta}} + R(b^j_t - I^*_{\bar{\theta}})] & \text{if } b^j_t \geq I^*_{\bar{\theta}} \text{ with } (1-\gamma)\bar{p} \\ \alpha[h^e G_{\bar{\theta}} - F^*_{\bar{\theta}}(I^*_{\bar{\theta}} - b^j_t)] & \text{if } b^j_t < I^*_{\bar{\theta}} \text{ with } (1-\gamma)\bar{p}. \end{cases} \tag{1.10}$$

where the third argument in the function $g()$ indicates that the agent has succeeded. If the agent is of high ability and defaults, he obtains

$$b_{t+1} = g(b_t; \bar{\theta}; 1 - \bar{p}) = \begin{cases} \alpha[h^u + R(b^j_t - I^*_{\bar{\theta}})] & \text{if } b^j_t \geq I^*_{\bar{\theta}} \text{ with } (1-\gamma)(1-\bar{p}) \\ \alpha h^u & \text{if } b^j_t < I^*_{\bar{\theta}} \text{ with } (1-\gamma)(1-\bar{p}). \end{cases} \tag{1.11}$$

where the third argument in the function $g()$ indicates that the agent has not succeeded. If the agent is of low ability and has succeeded, the bequest to his child is

$$b_{t+1} = g(b_t,\underline{\theta},\underline{p}) = \begin{cases} \alpha[h^e G_{\underline{\theta}} + R(b_t^j - I^*_{\underline{\theta}})] & \text{if } \; b_t^j \geq I^*_{\underline{\theta}} \text{ with } \gamma\underline{p} \\ \alpha[h^e G_{\underline{\theta}} - F^*_{\underline{\theta}}(I^*_{\underline{\theta}} - b_t^j)] & \text{if } \; b_t^j < I^*_{\underline{\theta}} \text{ with } \gamma\underline{p}, \end{cases} \tag{1.12}$$

and low ability agent who defaults, he bequeaths

$$b_{t+1} = g(b_t,\underline{\theta},1-\underline{p}) = \begin{cases} \alpha[h^u + R(b_t^j - I^*_{\underline{\theta}})] & \text{if } \; b_t^j \geq I^*_{\underline{\theta}} \text{ with } \gamma(1-\underline{p}) \\ \alpha h^u & \text{if } \; b_t^j < I^*_{\underline{\theta}} \text{ with } \gamma(1-\underline{p}). \end{cases} \tag{1.13}$$

Notice that the functions g are time independent.

[Insert Figure 4]

The graph of the law of motion of the bequest with full information is given in Figure 4. We have drawn the transition function for a high (Eqs. (1.10) and (1.11)) and a low type agent (Eqs. (1.12) and (1.13)). In the horizontal axis we have the inherited wealth, b_t and in the vertical axis the bequest given to the child, b_{t+1}. We assume that

$$\alpha R < 1. \tag{A2}$$

The highest sustainable wealth for a high type is $\bar{b} = \frac{\alpha}{1-\alpha R}[h^e G_{\bar{\theta}} - R I^*_{\bar{\theta}}]$.[33] The lowest sustainable wealth is given by $\underline{b} = \alpha h^u$. Because A2 holds, if the inherited wealth is smaller or equal to $\bar{b}$ it can never exceed $\bar{b}$ at any time. Likewise, if the inherited wealth is greater or equal to $\bar{b}$ the dynasty wealth will become less or equal to $\bar{b}$. Therefore, we restrict our analysis to the interval $\beta = [\underline{b},\bar{b}]$ and define the support of the distribution of bequest in this interval.

[33] Similarly, the highest bequest for a low type is $\bar{b}_{\underline{\theta}} = \frac{\alpha}{1-\alpha R}[h^e G_{\underline{\theta}} - R I^*_{\underline{\theta}}]$. Notice that in order to have $b_{\underline{\theta}} > I^*_{\underline{\theta}}$ and $b_{\bar{\theta}} > I^*_{\bar{\theta}}$, we need that $\alpha h^e G_{\underline{\theta}} > I^*_{\underline{\theta}}$ and $\alpha h^e G_{\bar{\theta}} > I^*_{\bar{\theta}}$ hold.

Given that there are a continuum of agents and both the ability and the returns from the investment are $i.i.d.$ random variables, the distribution function of the aggregate wealth can be interpreted as a deterministic variable by the law of large numbers. The bequest distribution G_{t+1} in period $t+1$ is obtained from the distribution in period t by adding up the total mass of agents who end up with bequest less than b_{t+1}. Therefore, the distribution of bequest $G_{t+1}(b)$ evolves along time as dictated by the following functional equation:

$$\begin{aligned} G_{t+1}(b) &= \gamma\left[(1-\underline{p})\int_{\underline{b}}^{\chi(b;\underline{\theta};0)} dG_t(b) + \underline{p}\int_{\underline{b}}^{\chi(b;\underline{\theta};1)} dG_t(b)\right] \\ &\quad +(1-\gamma)\left[(1-\overline{p})\int_{\underline{b}}^{\chi(b;\overline{\theta};0)} dG_t(b) + \overline{p}\int_{\underline{b}}^{\chi(b;\overline{\theta};1)} dG_t(b)\right]; \qquad (1.14) \end{aligned}$$

where $\chi(b_{t+1};\overline{\theta};1) = g^{-1}(\cdot;\overline{\theta};1)$. More precisely, $\chi(b;\theta;\delta) = \{b \geq 0 \text{ such that } g(b_t;\theta;\delta) \leq b\}$.

We can proof the existence, uniqueness and convergence of the invariant distribution with full information by using Hopenhayn-Prescott's (1992). Picture 4 give us an intuition for this result. In our model the fact that everybody can access to the capital market as well as that everybody can fail the project with positive probability will allow the individuals within a dynasty to move along the different values of the wealth distribution. When the dynasty wealth may move from any measurable subset $[\underline{b};\overline{b}]$ to any other measurable subset of $[\underline{b};\overline{b}]$ the Markov process will have a unique invariant distribution.

Proposition 3: *There exists a unique invariant distribution G^{FI} for the Markov process corresponding to $P(b;A)$. For any given G_0^{FI}, the sequence $(T^*)^n G_{0;}^{FI}$ converge to G^{FI}, where T^* is the operator defined by Eq. (1.14).*

Proof. See appendix.

Since shocks on individual investments are idiosyncratic, there will be some inequality in the long-run, but this inequality will be independent of the initial inequality $G_0(b)$. Thus even though wealth inequality cannot be completely eliminated, in the long run all dynasties fare equally well on average.

Define the highest wealth that an uneducated agent has by $x = \alpha[h^u + R(\bar{b} - I^*_{\underline{\theta}})]$. It is the second period wealth that a low ability agent, with the highest inherited wealth $\bar{b}$, invests in education $I^*_{\underline{\theta}}$ as well as in the capital market $(\bar{b} - I^*_{\underline{\theta}})$, but he fails the investment in education. Similarly, let define lowest wealth that educated people could have by $z = \alpha[h^e G_{\underline{\theta}} - F^*_{\underline{\theta}}(I^*_{\underline{\theta}} - \underline{b})]$. We assume that x is smaller than z. This assumption will be very useful when we calculate analytically the probability of upward and downward mobility, as well as the number of educated and uneducated agents. In our model a sufficient condition for this assumption to hold is that

$$\frac{G_{\bar{\theta}}}{G_{\underline{\theta}}} < \frac{1}{\alpha R} - 1; \text{ and } \alpha R + B(\underline{\theta})\left(1 - \frac{R}{B(\underline{\theta})(h^e G_{\underline{\theta}} - h^u)}\right) > 1; \qquad \text{(A3)}$$

We can easily compute the number of educated and uneducated people. Anybody with final wealth below x are uneducated. From the Eq. (1.14) the number of uneducated agents is given by

$$\begin{aligned} G(x) &= \gamma(1 - \underline{p})\left[\int_{\underline{b}}^{I^*_{\underline{\theta}}} dG_t(b) + \int_{I^*_{\underline{\theta}}}^{\bar{b}} dG_t(b)\right] + (1-\gamma)(1-\bar{p})\left[\int_{\underline{b}}^{I^*_{\bar{\theta}}} dG_t(b) + \int_{I^*_{\bar{\theta}}}^{\bar{b}} dG_t(b)\right] \\ &= (1-\gamma)(1-\bar{p}) + \gamma(1-\underline{p}) = p(U_{t+1}). \end{aligned} \qquad (1.15)$$

Similarly, the number of educated is

$$1 - G(x) = (1 - \gamma)\overline{p} + \gamma\underline{p} = 1 - p(U_{t+1}) = p(E_{t+1}). \tag{1.16}$$

We define intergenerational mobility among the two different classes of human capital, educated or/and uneducated. Intergenerational mobility is measured by computing the transition matrix between these two classes, say $p(j/i)$, $i = e, u; j = e, u$; where $p(U_{t+1}/E_t)$ is the probability that an individual, whose parent was uneducated, becomes educated. There is downward mobility when a child of an educated parent becomes uneducated. Under full information this probability is

$$p(U_{t+1}/E_t) = (1 - \gamma)(1 - \overline{p}) + \gamma(1 - \underline{p}). \tag{1.17}$$

Similarly, upward mobility is the probability that children of noneducated parents become educated, which is given by

$$p(E_{t+1}/U_t) = (1 - \gamma)\overline{p} + \gamma\underline{p}. \tag{1.18}$$

If capital markets function perfectly, individuals invest in education until the expected rate of returns equalize the rate of return on physical capital no matter what their family background are. Namely, independtly of how wealth is distributed, poor and rich people with the same ability will invest the same amount. Therefore, there is no connection between inherited wealth and education, and thus the events U_t and E_{t+1} are stochastically independent. Hence, the inherited wealth does not affect the probability of becoming educated $p(E_{t+1})$, i.e. $p(E_{t+1}/U_t) = p(E_{t+1}/E_t) = p(E_{t+1})$, and likewise $p(U_{t+1}/U_t) = p(U_{t+1}/E_t) = p(U_{t+1})$.

1.4.2 Asymmetric Information

With asymmetric information the distribution of wealth matters for analyzing mobility. So it appears that aggregate statistic (output and aggregate human capital) do not depend only on the type of agents and the investment cost on education, but also on the financial situation of the agents (captured here by the distribution of the inherited wealth). What is important now is how wealth is distributed among agents. It is worth to remember that the low type receives the first best contract, and thus the evolution of bequest for them is given by Eqs. (1.12) and (1.13). The law of motion of the bequest for clever agents under success is given by

$$g(b;\bar{\theta};\cdot) = \begin{cases} \alpha[h^e G_{\bar{\theta}} + R(b_t^j - I^*_{\bar{\theta}})] & \text{if } b_t^j \geq I^*_{\bar{\theta}} \text{ with } (1-\gamma)\bar{p} \\ \alpha[h^e G_{\bar{\theta}} - F^*_{\bar{\theta}}(I^*_{\bar{\theta}} - b_t^j)] & \text{if } I^*_{\underline{\theta}} \leq b_t^j < I^*_{\bar{\theta}} \text{ with } (1-\gamma)\bar{p} \\ \alpha[h^e G_{\bar{\theta}} - F^0_{\bar{\theta}}(I^0_{\bar{\theta}} - b_t^j)] & \text{if } b_t^j < I^*_{\underline{\theta}} \text{ with } (1-\gamma)p(\bar{\theta}; I^0_{\bar{\theta}}). \end{cases} \tag{1.19}$$

When educational investment are not successful, bequest evolve according to

$$g(b;\bar{\theta};\cdot) = \begin{cases} \alpha[h^u + R(b_t^j - I^*_{\bar{\theta}})] & \text{if } b_t^j \geq I^*_{\bar{\theta}} \text{ with } (1-\gamma)(1-\bar{p}) \\ \alpha h^u & \text{if } b_t^j < I^*_{\bar{\theta}} \text{ with } (1-\gamma)(1-p(\bar{\theta}; I^0_{\bar{\theta}})). \end{cases} \tag{1.20}$$

When credit markets are less than perfect, the equality between the marginal product of human capital and the interest rate does not hold. As we will see below, the correlation between inherited wealth and ability will in fact have an important effect on intergenerational mobility. The individual transitions (given by Eqs. (1.19) and (1.20) and for the low type Eqs. (1.12) and (1.13)) define a non-linear aggregate transition function $G_{t+1}(G_t)$:[34]

The graph of the law of motion of the bequest with asymmetric information is very similar to the one under full information.[35] The only difference is the bequest function for

[34] Since among $\bar{\theta}$ type borrowers $\frac{db_{t+1}}{db_t} > 0$ and $\frac{d^2 b_{t+1}}{db_t^2} < 0$.

[35] Remember that $\underline{\theta}$ type receives the full information contract and that rich agents invest the first best amount. Hence, the law of motion of the bequest does not change for rich agents (regardless of their type)

clever agents with wealth $b_t^j < I^*_{\underline{\theta}}$. This new bequest function is below the full information one. Since the distortion is higher at low level of inherited wealth, the gap between the bequest function with full and asymmetric information is higher in this range. Among talented applicants the bequest function is upward sloping but steeper with asymmetric information.

The aggregate distribution of bequest satisfies

$$\begin{aligned} G_{t+1}(b) &= \gamma\left[(1-\underline{p})\int_{\underline{b}}^{\phi(b;\underline{\theta};0)} dG_t(b) + \underline{p}\int_{\underline{b}}^{\phi(b;\underline{\theta};1)} dG_t(b)\right] \\ &\quad + (1-\gamma)\left[\int_{\underline{b}}^{\phi(b;\overline{\theta};0)} (1-\overline{p}')dG_t(b) + \int_{\underline{b}}^{\phi(b;\overline{\theta};1)} \overline{p}' dG_t(b)\right] \qquad (1.21) \end{aligned}$$

with $\phi(b;\theta;0) = \{b \geq 0$ such that $g(b_t;\theta;0) \leq b\}$ and $\overline{p}' = p(\overline{\theta}; I'_{\overline{\theta}})$.

Using the same argument that with full information, we can proof the existence of an invariant distribution of bequest G^{AI}; where AI means asymmetric information.

Proposition 4: There exists a unique invariant distribution G^{AI} for the Markov process corresponding to $P(b; A)$: For any given G_0^{AI}; the sequence $(T^*)^n G_0^{AI}$ converge to G^{AI}; where T^* is the operator defined by Eq: (1:21):

Proof. See appendix.

With asymmetric information the number of educated individuals can be computed by using the Eq. (1.21). Remember that now, talented agents with an inherited wealth $b_t < I^*_{\underline{\theta}}$ will become borrowers and their success probability will be different than in the full information case. Consequently, the events U_t and E_{t+1} are not independent and thus $p(E_{t+1}/U_t) \neq p(E_{t+1})$.

and for $\underline{\theta}$ type borrowers (regardless of their wealth).

The number of educated agents is

$$p(E_{t+1}) = (1 - \gamma)\left[\int_{b}^{I_{\underline{\theta}}^{*}} p(\overline{\theta}; I_{\theta}'(b_t))\, dG^{AI}(b) + \overline{p}(1 - G^{AI}(I_{\underline{\theta}}^{*}))\right] + \gamma \underline{p}. \quad (1.22)$$

We may compute the number of uneducated as,

$$p(U_{t+1}) = (1 - \gamma)\left[\int_{\underline{b}}^{I_{\underline{\theta}}^{*}} (1 - p(\overline{\theta}; I_{\theta}'(b_t)))\, dG^{AI}(b) + (1 - \overline{p})(1 - G^{AI}(I_{\underline{\theta}}^{*}))\right] + \gamma \underline{p}. \quad (1.23)$$

Comparing the probabilities of becoming educated under full and asymmetric information, we conclude that since low ability agents receive the full information contract and high ability agents are the one who are "distorted", the probability of becoming educated will be higher. Consequently, the level of human capital in equilibrium is higher under asymmetric information.

Proposition 5: *At the steady state the number of educated agents is higher with asymmetric information than with full information.*

Proof. See appendix.

In terms of educational outcomes, in a more mobile society the probability of being educated is higher than in a less mobile one. In our paper the asymmetry of information in the capital market causes a distortion among talented agents since they invest in education in excess of the socially efficient level. This overinvestment enhances probability of success and causes higher upward mobility and lower downward mobility than with full information. More specifically, the next proposition tell us that the asymmetry of information promotes upward mobility among talented borrowers. Notice that a formal proof of this results is not a simple task because the distribution of wealth is endogenous and thus it differs in an economy with full or with asymmetric information.

Proposition 6: At the steady state upward mobility is higher with asymmetric information than with full information; whereas downward mobility is lower with asymmetric information:

Proof. See appendix.

In steady state we know that upward mobility cancels out with downward mobility since $E_t = E_{t+1}$ for all t. Thus, the equation $p(E_{t+1}=U_t)p(U_t) = p(U_{t+1}=E_t)p(E_t)$ holds under asymmetric and full information.

Concerning inequality, we can say that there are opposite effects, so that inequality is dif cult to evaluate. Since uneducated agents are the ones with a very low income, and with asymmetric information the probability of becoming uneducated is lower, we can conclude that there is a small number of people in the lower bound of the wealth distribution. Moreover, talented agents are affected by the existence of CMI in two opposite ways. On the one hand, since the success probability is higher under asymmetric information there are more people being educated. On the other hand, these talented borrowers have a lower wealth. That is, since there is overinvestment the debt repayment is excessively high relative to full information and the aggregate wealth is lower than with full information.

The next proposition compares the two distributions according to the levels of returns.

Proposition 7: The steady state distribution under asymmetric information; $G^{AI}(b_t)$ first ¡ order stochastically dominates the steady state distribution under full information; $G^{FI}(b_t)$.

Proof. See appendix.

Because the distribution G^{AI} first-order stochastically dominates the distribution G^{FI}, and we assume risk neutral agents it follows that the mean of b_t under G^{AI}, $B^{AI} = \int_{\underline{b}}^{\bar{b}} b_t dG^{AI}(b_t)$ exceeds that under G^{FI}; $B^{FI} = \int_{\underline{b}}^{\bar{b}} b_t dG^{FI}(b_t)$:

Corollary 1: At the steady state the average wealth is higher with asymmetric information:

Hence, with asymmetric information, upward mobility is higher, downward mobility is lower too. Moreover, the number of uneducated people is lower with asymmetric information. As a consequence of this, aggregate wealth, which is also the average wealth is higher with asymmetric information.

1.4.3 Empirical Evidence on Credit Constraints

What empirical evidence do we have about the extent to which credit constraints contribute to make inequality more persistent across generations? In order to answer this question we need empirical evidence that gives a precise estimate of how much credit constraints are likely to affect aggregate intergenerational mobility at the macro level.

Unfortunately, the empirical evidence that is currently available to shed light of the importance of credit constraints in intergenerational mobility is sparse. Moreover, more of the studies about credit constraints concerns if borrowing constraints affect educational attainment. Clearly, if borrowing constraints are binding, then youths from families with less financial resources (those with less educated parents) will face a higher implicit schooling cost. The empirical evidence is very contradictory. The typical view (see Kane (1994) and Ellwood and Kane (2000)) stresses the importance of credit constraints for educational attainment. The positive correlation between family income and schooling has been widely interpreted as evidence supporting the idea that borrowing constraints hinder educational choices.

There are, however, a number of potential problems with this empirical work.[36] Recent works by Cameron and Heckman (1998), Cameron and Taber (2001), Keane and Wolpin (2001), Heckman (2002) and Shea (2002) have attempt to better understand the determinants of schooling choices. Using very different methods, these researchers have found little evidence that favors the idea that borrowing constraints hinder college-going or any other schooling choice.[37]

James Heckman (2002) examines arguments about the strength of credit constraints in schooling that are made in the literature, evaluating the available evidence and presenting new facts using American date. Heckman studies the family income college enrollment relationship and the evidence on credit constraints in post-secondary schooling. He distinguishes short-run liquidity constraints, which affects the resources required to nance college education, from the long-term factors that promote cognitive and noncognitive ability.[38] This second interpretation emphasizes more long-run factors associated with higher family income and is consistent with another type of credit constraint: the inability of the child to buy the parental environment and genes that form the cognitive and noncognitive

36 See Heckman (2002) for an evaluation about the available evidence.

37 It is important to keep in mind that this does not necessarily mean that credit market constraints would not exist in the absence of the programs currently available. It implies instead that given the large range of subsidies to education that currently exist, there is no evidence of inef ciencies in the schooling market resulting from borrowing constraints.

38 Examples of noncognitives abilities are motivation, tenacy, trustworthiness, perseverance, among others.

abilities required for success in school. His conclusions is that long run factors are more important, even though he identifies a group of people (at most 8% of the population) who seen to be facing short-run credit constraints.

Our model tell us that, once we endogenize credit constraints, we find that, contrary to the “classical” view, credit constraints is not a barrier to investment in education, and thus to intergenerational mobility. Our conclusions, therefore, are consistent with the new assessment of the limited role of short-run credit constraint. However, a further empirical work in the future using richer panel data sets should allow us to make progress on such issues.

1.5 Conclusion

There is a conventional view that CMI are a barrier for intergenerational mobility. Their familiar story goes something like this: since becoming a borrower is expensive with imperfect capital markets, poor agents are less likely to invest in education and therefore, their future generations will remain poor.

However, this branch of the literature assume that CMI are exogenous, that is there is not any microfoundation about the imperfections in the capital market. In contrast to these analyses this paper argue that under certain plausible conditions CMI may promote intergenerational mobility among talented people. Recognizing that modern financial markets are characterized by a wide variety of informational imperfections, we endogenize CMI by assuming an adverse selection problem between borrowers and banks where credit constraints are endogenous.

In short, the major results of this paper might be summarized as follows: endogenous capital market imperfections may promote intergenerational mobility among talented individuals, since talented children from poor families get educated even more than they wish, so that both income mobility and human capital accumulation are larger than in the first best world. In this way low ability individuals do not pose as high ability ones. Moreover, human capital investment is higher that in the first best world in the steady state.

This paper contributes to the theoretical understanding of the linkage between income distribution and CMI and demonstrate that the nature of CMI is crucial for understanding its effects on inequality and mobility. Therefore, a deeper treatment of the interaction with income, mobility and CMI tell us that under certain reasonable conditions more imperfections leads to higher mobility.

1.6 Appendix

Appendix A : Proof of propositions:

Proof of Proposition 1:

First, we have to proof that in any separating equilibrium the low ability borrower receives the full information efficient contract, i.e. $\xi^*_{\underline{\theta}} = (F^*_{\underline{\theta}}, I^*_{\underline{\theta}})$. Since we assume perfect competition among banks, the contract must be on the zero profit line, and thus $F^*_{\underline{\theta}} = \frac{R}{p(\underline{\theta}, I)}$. Any $I_{\underline{\theta}} \neq I^*_{\underline{\theta}}$ is strictly worse for the agent, and therefore it would be possible for the bank to Pareto improve it. Therefore, the only equilibrium contract for the low type is $\xi^*_{\underline{\theta}} = (F^*_{\underline{\theta}}, I^*_{\underline{\theta}})$.

Secondly, in any separating equilibrium, high ability borrowers accept the contract $\xi^{\star}_{\bar{\theta}} = (F^{\star}_{\bar{\theta}}, I^{\star}_{\bar{\theta}})$ where $I^{\star}_{\bar{\theta}}$ satisfies the incentive compatibility constraint for a low type with equality.

The contract $\xi^{\star}_{\bar{\theta}}$ is found at the intersection of the $\underline{\theta}$ indifference curve that passes through $\xi^{*}_{\underline{\theta}}$ and the line $\pi_{\bar{\theta}} = 0$ (that is, $F^{0}_{\bar{\theta}} = \frac{R}{p(\bar{\theta}; I)}$). There is also no contract that could make the borrower of type $\bar{\theta}$ better off than $\xi^{0}_{\bar{\theta}}$ without either rendering losses to the bank or attracting the borrower of type $\underline{\theta}$ from $\xi^{*}_{\underline{\theta}}$. Hence, any equilibrium must satisfy the conditions of the Proposition 1.

Q.E.D.

Proof of Proposition 2:

The only possibility to disturb the contract is by offering a pooling one. Such a contract must obviously earn non-negative profits, i.e. $\hat{F} \geq \frac{R}{p(\hat{\theta}; I)}$ with $p(\hat{\theta}; I) = \gamma B(\underline{\theta}) + (1 - \gamma) B(\bar{\theta})$. And it must also attract type $\bar{\theta}$ agents, so that there exists an amount of investment $\hat{I}$ satisfying

$$V^{P}_{\bar{\theta}}(\hat{F}; \hat{I}; p(\bar{\theta}; \hat{I}); b^{j}_{t}) \geq V^{S}_{\bar{\theta}}(F^{0}_{\bar{\theta}}; I^{0}_{\bar{\theta}}(b^{j}_{t}); p(\bar{\theta}; I^{0}_{\bar{\theta}}); b^{j}_{t}).$$

The most preferred pooling contract, from the point of view of a type $\bar{\theta}$, that is consistent with nonnegative expected profits for the bank has $\hat{F} = \frac{R}{p(\hat{\theta}; I)}$ and selects $\hat{I}$ such that

$$\hat{I} = \arg\max_{\hat{I}} \{ p(\bar{\theta}; \hat{I})[h^{e} G_{\bar{\theta}} - \hat{F}(\hat{I} - b^{j}_{t})] + (1 - p(\bar{\theta}; \hat{I})) h^{u} \}.$$

By FOC the amount of investment is,

$$\hat{I} = \ln \left(\frac{[\gamma B(\underline{\theta}) + (1 - \gamma) B(\bar{\theta})](h^{e} G_{\bar{\theta}} - h^{u})}{R} \right). \tag{1.24}$$

Then, there is no pooling contract that attracts all borrowers and earns a nonnegative expected pro t if

$$V^P_{\bar{\mu}}(\mathbf{Ie}; \mathbf{P}; p(\bar{\mu}; \mathbf{P}); b^j_t) \quad V^S_{\bar{\mu}}(F^0_{\bar{\mu}}; \mathbf{I}^0_{\bar{\mu}}(b^j_t); p(\bar{\mu}; \mathbf{I}^0_{\bar{\mu}}); b^j_t):$$

When $\mathbf{Ie} = \frac{R}{p(\hat{\mu}; I)}$ the function $V^P_{\bar{\mu}}$ is decreasing in the proportion of low ability, $°$:[39] The reason is because in a pooling contract the higher is the number of low ability individuals the more losses the banks will have. Therefore, the higher is $°$; the less probable is to distort the separating equilibrium. We need to nd the $\hat{\mathbf{e}}$ that equates both indirect utilities for any $b_t \; 2 \; [\underline{b}; \mathbf{I}^{¤}_{\underline{\mu}})$,

$$V^P_{\bar{\mu}}(\mathbf{Ie}(\hat{\mathbf{e}}); \mathbf{P}_{\bar{\mu}}(\hat{\mathbf{e}}); p(\bar{\mu}; \mathbf{P}); b^j_t) = V^S_{\bar{\mu}}(F^0_{\bar{\mu}}; \mathbf{I}^0_{\bar{\mu}}(b^j_t); p(\bar{\mu}; \mathbf{I}^0_{\bar{\mu}}); b^j_t):$$

Since $V^P_{\bar{\mu}}$ is decreasing in the proportion of low ability, $°$ we may argue that when the proportion of the low ability is high enough i.e. $° > \hat{\mathbf{e}}$; type $\bar{\mu}$ borrowers are better in a separating contract $V^P_{\bar{\mu}} < V^S_{\bar{\mu}}$, and the separating contract will be the equilibrium. Conversely, when $° < \hat{\mathbf{e}}$, i.e. most of the agents are of high ability, $V^P_{\bar{\mu}} > V^S_{\bar{\mu}}$ holds and there is no equilibrium:

The function $\hat{\mathbf{e}}$ is decreasing in the level of bequest (see appendix B.6), so that the lower is the inherited wealth the higher the number of low ability agents necessary to obtain a separating equilibrium. As a result, we need that the maximum level of $\hat{\mathbf{e}}$ (which is given by $V^P_{\bar{\mu}}(¢; ¢; ¢; \underline{b}) = V^S_{\bar{\mu}}(¢; ¢; ¢; \underline{b}))$ be $0 < \hat{\mathbf{e}} < 1$: Therefore, if $° > \hat{\mathbf{e}}(b^j_t = \underline{b})$ the unique equilibrium is the separating one since for $° > \hat{\mathbf{e}}(b^j_t = \underline{b})$ the break-even line, $¼_{\bar{\mu}\underline{\mu}}$ (that is

[39] See the proof in Appendix B.4.

$ê = \frac{R}{p(\hat{\mu}; I)}$) line does not touch the pooling area (the pooling region is situated below the indifference curves of $\overline{\mu}$ and $\underline{\mu}$ that pass through the points $»_{\overline{\mu}}^{¤}$ and $»_{\underline{\mu}}$).

If we increase the bequest *ceteris paribus*, the break-even line $¼_{\overline{\mu}\underline{\mu}}$ (with $° > ê(b = \underline{b}))$ does not touch the pooling area neither. When the wealth increases, the indifferences curves of both agents become steeper, and the level of utility increases (you are closer to the full information solution). As a consequence, the pooling area turns out to be smaller. And thus the separating contract is still the equilibrium. In short, the condition that is needed in order to have a separating equilibrium is that $° > ê(b_t^j = \underline{b})$ holds.

Now we need to proof that there exist a $0 < ê < 1$ when $b_t^j = \underline{b}$: In order to nd the $ê$ the following equation (which is $V_{\overline{\mu}}^s ¡ V_{\overline{\mu}}^p = 0$ evaluated at $b_t^j = \underline{b}$) have to holds

$$p(\overline{\mu}; I_{\overline{\mu}}^0)(h^e G_{\overline{\mu}} ¡ h^u) ¡ R I_{\overline{\mu}}^0 + R\underline{b} ¡ f p(\overline{\mu}; ê)[(h^e G_{\overline{\mu}} ¡ h^u) ¡ ê(ê ¡ \underline{b})]g = 0:$$

1. If $ê = 0$; then $\lim_{ê \,!\, 0} ê = I_{\overline{\mu}}^{¤}$ and $V_{\overline{\mu}}^s ¡ V_{\overline{\mu}}^p < 0$: This is so because, $V_{\overline{\mu}}^p ´ V_{\overline{\mu}}^{¤}$ and the indirect utility under full information is always higher than the one under asymmetric information.

2. Now we want to show that when $ê = 1$ we obtain $V_{\overline{\mu}}^s ¡ V_{\overline{\mu}}^p > 0$:

If statement 1 and 2 are true, we may conclude that there exist a $0 < ê < 1$: Let me show that statement 2 holds. If $ê = 1$; $\lim_{ê \,!\, 1} ê = \ln(\frac{B(\underline{\mu})(h^e G_{\overline{\mu}} ¡ h^u)}{R}) = ê_{\overline{\mu}}$: In other $V^s ¡ V^p > 0$ be true, we need that

$$[h^e G_{\underline{\mu}} ¡ h^u] B(\overline{\mu})(e^{¡ ê_{\overline{\mu}}} ¡ e^{¡ I_{\overline{\mu}}^0}) > +R(I_{\overline{\mu}}^0 ¡ \underline{b}) ¡ \frac{B(\overline{\mu})}{B(\underline{\mu})} R(ê_{\overline{\mu}} ¡ \underline{b}); \quad (1.25)$$

from Eq. (1.9) we know that $R(l'_{\bar\theta} - \underline{b}) = B(\bar\theta)(h^eG_{\underline\theta} - h^u)\{e^{-l'_{\bar\theta}} - e^{-l^*_{\underline\theta}}\} + \frac{B(\bar\theta)}{B(\underline\theta)}R(l^*_{\underline\theta} - \underline{b}).$ If we substitute this value in the Eq. (1.25) then we obtain

$$B(\bar\theta)(h^eG_{\bar\theta} - h^u)\{e^{-\tilde{l}_{\bar\theta}} - e^{-l'_{\bar\theta}}\} + \frac{B(\bar\theta)}{B(\underline\theta)}R(\tilde{l}_{\bar\theta} - l^*_{\underline\theta}) > B(\bar\theta)(h^eG_{\underline\theta} - h^u)\{e^{-l^*_{\underline\theta}} - e^{-l'_{\bar\theta}}\},$$

if we substitute the optimal values of $l^*_{\underline\theta} = \ln(\frac{B(\underline\theta)[h^eG_{\underline\theta} - h^u]}{R})$ and $\tilde{l}_{\bar\theta} = \ln(\frac{B(\underline\theta)(h^eG_{\bar\theta} - h^u)}{R})$, the inequality above holds true if and only if

$$e^{l'_{\bar\theta}} > \frac{B(\underline\theta)h^e(G_{\bar\theta} - G_{\underline\theta})}{R[\ln(\frac{h^eG_{\bar\theta} - h^u}{h^eG_{\underline\theta} - h^u})]}. \qquad (1.26)$$

The RHS of equation 1.26 is increasing with $l'_{\bar\theta}$. Therefore, if we proof that the inequality holds for the lowest distortion, for sure it holds for higher levels. The lower distortion to talented borrowers is given to agents with the highest inherited wealth $b_t = l^*_{\underline\theta}$, and thus $l'_{\bar\theta} \approx l^*_{\bar\theta}$. But then $e^{l^*_{\bar\theta}} = \frac{B(\bar\theta)[h^eG_{\bar\theta} - h^u]}{R}$, and inequality 1.26 holds true if and only if

$$B(\bar\theta)\ln(\frac{h^eG_{\bar\theta} - h^u}{h^eG_{\underline\theta} - h^u}) > B(\underline\theta)[1 - \frac{h^eG_{\underline\theta} - h^u}{h^eG_{\bar\theta} - h^u}].$$

And the expression above always holds because first $B(\bar\theta) > B(\underline\theta)$, and second $G_{\bar\theta} > G_{\underline\theta}$.

Q.E.D.

Proof of Proposition 3:

Let Σ denote the set of Borel subsets of $\beta = [\underline{b}, \bar{b}]$. The law of motion of the bequest defines a Markov chain with a transition function P. We shall describe the long run dynamic behavior implied by $P(\cdot, \cdot)$ by determining the existence of a unique invariant distribution G. Before that, we define the transition function.

Definition 1: A transition function on a measurable interval A is a mapping such that $P : \Sigma \times \beta \to [0,1]$. That is

$$P(b, A) = P(b_{t+1} \in A / b_t = b), \quad \text{for all Borel subsets } A \in \Sigma$$

where $b_{t+1} = g(b_t, \bar{\theta}, \delta)$ and $P(b, A)$ is the probability that the next period's bequest lies in the set A given that the current bequest is b_t. With full information the transition function takes the form

$$\begin{aligned} p(b, A) \;=\;& \gamma[(1-\underline{p})I_A(g(b, \underline{\theta}, 0)) + \underline{p}I_A(g(b, \underline{\theta}, 1))] + \\ & (1-\gamma)[(1-\bar{p})I_A(g(b, \bar{\theta}, 0)) + \bar{p}I_A(g(b, \bar{\theta}, 1))], \end{aligned} \tag{1.27}$$

where

$$I_A(i) = \begin{cases} 1 & \text{if} \quad i \in A \\ 0 & \text{otherwise.} \end{cases}$$

Following theorem 8.1 of Stokey and Lucas (1989), associated with any transition function on a measurable space, (A, Σ) there is an operator on probability measure. For any probability measure μ on (A, Σ) define $T^*\mu$ by

$$(T^*\mu)(A) = \int P(b, A)\mu(db), \quad \text{all } A \in \Sigma.$$

Notice that the equation above can be rewritten as $T^*G(A) = \int P(b, A)dG(b)$. The operator T maps probability measure into itself, $T^*\mu$ is the probability measure over the state of next period if μ is the probability measure over the current state. The sequence of distribution functions of the bequest $\{G\}_{t=1}^{\infty}$ is given inductively by equation (1.14), where the distribution G_0 is simply a mass point at the beginning of the time. We want to know if the mapping T is a contraction mapping, having a fixed point. But before that, we define a stationary distribution of wealth.

Definition 2: A wealth distribution $G(b)$ on β is invariant for P if for all Borel subsets $A \subset \Sigma$, one has the equality

$$T^{*}G(A) = G(A).$$

We apply Hopenhayn and Prescott's (1992) analysis of existence, uniqueness and convergence properties of monotonic stochastic processes.

A. Existence:

Proof. The existence of an invariant distribution G for the Markov process follows immediately from the monotonicity of P established in Hopenhayn-Prescott's Corollary 4.

First, notice that the only condition that has to hold is the monotonicity of the transition probability $P(b, .)$. Monotonicity means that $b^j_{t+1}(b^j_t)$ dominates $b^j_{t+1}(b^{j\prime}_t)$ in the first order stochastic sense if $b^j_t > b^{j\prime}_t$ (see equation 10-13). People's bequest will increase from the present to the future as the project succeeds and the ability takes the higher value. The transition function $p(b, A)$ is increasing in its first argument b in the following first-order stochastic dominance sense: for all $(b, b') \in \beta^2$, $b \leq b'$ implies for any $x \in B$,

$$p(b'; [\underline{b}; x]) \leq p(b; [\underline{b}; x]).$$

$$p(b'; [\underline{b}; x]) - p(b; [\underline{b}; x]) \leq 0,$$

which is negative since $g(b', ., .) \geq g(b, ., .)$, and thus $l(g(b', ., .)) - l(g(b, ., .))$ takes either the value of -1 or 0.

Q.E.D.

B. Uniqueness and Convergence:

Proof. This follows from the Hopenhayn-Prescott's theorem 2. The linear Markov process satisfies the following "concavity property": One can find a point $b \in [\underline{b}, \bar{b}]$ such that there exists a $n > 1$ and $\epsilon > 0$, such that in n good realization of the shock $p(\underline{b}, [b^*, \bar{b}])^n > \epsilon$ and in n bad realization of the shock $p(\bar{b}, [b^*, \underline{b}])^n > \epsilon$. In our case we find $n = 1$ and $0 < \epsilon < 1$ such that

$$p(\underline{b}, [b^*, \bar{b}]) = (1-\gamma)\underline{p} \quad \text{for the low type and}$$
$$p(\underline{b}, [b^*, \bar{b}]) = \gamma\bar{p} \quad \text{for the high type.}$$

Similarly,

$$p(\bar{b}, [b^*, \underline{b}]) = (1-\gamma)(1-\underline{p}) \quad \text{for the low type and}$$
$$p(\bar{b}, [b^*, \underline{b}]) = \gamma(1-\bar{p}) \quad \text{for the high type.}$$

And we know that by definition $\underline{p}$ and $\bar{p}$ are probabilities and thus $\lim_{I\to 0} p = B(\theta) < 1$ and $\lim_{I\to\infty} p = 0$ and these properties hold for $\underline{p}$ and $\bar{p}$.

Q.E.D.

Proof of Proposition 4:

In order to compute the transition probability under asymmetric information, we need to take into account that for any wealth $b_t < I^*_{\underline{\theta}}$ the probability of failure the investment of a clever agent with wealth b_t is equal to $(1 - p(\bar{\theta}, I'_{\bar{\theta}}(b_t)))$ and the success probability is $p(\bar{\theta}, I'_{\bar{\theta}}(b_t))$. For higher levels of bequest the probabilities are the same as in full information.

Hence for any $b_t < I^*_{\underline{\theta}}$ with asymmetric information our transition function takes the form

$$\begin{aligned} p(b;A) &= \gamma[(1-\underline{p})I_A(g(b;\underline{\theta};0)) + \underline{p}I_A(g(b;\underline{\theta};1))] \\ &\quad +(1-\gamma)[(1-\overline{p}')I_A(g(b;\overline{\theta};0)) + \overline{p}'I_A(g(b;\overline{\theta};1))]; \end{aligned}$$

where

$$I_A(i) = \begin{cases} 1 & \text{if } i \in A \\ 0 & \text{otherwise;} \end{cases}$$

and $\overline{p}' = p(\overline{\theta}; I'_{\overline{\theta}}(b))$. If the wealth is $b \geq I^*_{\underline{\theta}}$, the transition function coincides with the full information one (see Eq. (1.27)).

Condition M is necessary and sufficient to establish the strong convergence of the sequence of probability measures to a unique limit, independent of the initial sequence of probability measures.

The complementary of A is denoted by A^c. If $\underline{b} \in A$,

$$P(b;A) = (1-\gamma)(1-p(\overline{\theta}; I'_{\overline{\theta}}(b_t))) + \gamma(1-p(\underline{\theta}; I^*_{\underline{\theta}})) = \varepsilon_1 \text{ if } b \leq I^*_{\underline{\theta}};$$

and

$$P(b;A) = (1-\gamma)(1-p(\overline{\theta}; I^*_{\overline{\theta}})) + \gamma(1-p(\underline{\theta}; I^*_{\underline{\theta}})) = \varepsilon_2 \text{ if } b > I^*_{\underline{\theta}}.$$

Similarly, if $\underline{b} \in A^c$,

$$P(b;A^c) = (1-\gamma)(1-p(\overline{\theta}; I'_{\overline{\theta}}(b_t))) + \gamma(1-p(\underline{\theta}; I^*_{\underline{\theta}})) = \varepsilon_1 \text{ if } b \leq I^*_{\underline{\theta}};$$

and

$$P(b;A^c) = (1-\gamma)(1-p(\overline{\theta}; I^*_{\overline{\theta}})) + \gamma(1-p(\underline{\theta}; I^*_{\underline{\theta}})) = \varepsilon_2 \text{ if } b > I^*_{\underline{\theta}}.$$

Let $\varepsilon = \max(\varepsilon_1, \varepsilon_2) = \varepsilon_1$, we have that Condition M in Section 11.4 of Stokey and Lucas (1989) holds, and Theorem 11.12 (which tell us about the convergence of the probability measures) is also satisfied.

Q.E.D.

Proof Proposition 5:

Since $p(E_{t+1})^{AI}$ is given by the equation (1.22) and $p(E_{t+1})^{FI}$ is given in the equation (1.16), we can compute

$$p(E_{t+1})^{AI} - p(E_{t+1})^{FI} = (1-\gamma)\int_{\underline{b}}^{l^*_{\underline{\theta}}} [p(\bar{\theta}, l'_{\bar{\theta}}(b_t)) - \bar{p}]dG^{AI}(b) > 0.$$

Using a similar argument, we find that $p(U_{t+1})^{AI} < p(U_{t+1})^{FI}$.

Q.E.D.

Proof of Proposition 6:

In order to proof that upward mobility is higher with asymmetric information: We compute

$$p(E_{t+1}/U_t)^{AI} = \frac{1}{G^{AI}(x)}[(1-\gamma)\int_{\underline{b}}^{x} p(\bar{\theta}, l'_{\bar{\theta}}(b))dG^{AI}(b) + \gamma\underline{p}G^{AI}(x)].$$

$$p(E_{t+1}/U_t)^{FI} = \frac{1}{G^{AI}(x)}[(1-\gamma)\bar{p} + \gamma\underline{p}]G^{AI}(x).$$

And, the difference is

$$p(E_{t+1}/U_t)^{AI} - p(E_{t+1}/U_t)^{FI} = \frac{(1-\gamma)}{G^{AI}(x)}[\int_{\underline{b}}^{x} \{p(\bar{\theta}, l'_{\bar{\theta}}(b)) - \bar{p}\}dG^{AI}(b)] > 0.$$

Similarly, we can see that downward mobility is lower with asymmetric information.

$$p(U_{t+1}/E_t)^{AI} = -[\int_{x}^{l^*_{\underline{\theta}}} (1 - p(\bar{\theta}, l'_{\bar{\theta}}(b)))dG^{AI}(b) + (1-\bar{p})(1 - G^{AI}(l))] + \gamma(1-\underline{p})(1 - G^{AI}(x));$$

where $\Omega = \frac{(1-\gamma)}{1-G^{AI}(x)}$: Under full information we have,

$$p(U_{t+1}/E_t)^{FI} = (1-\gamma)(1-\bar{p}) + \gamma(1-\underline{p}).$$

And $p(U_{t+1}/E_t)^{AI} - p(U_{t+1}/E_t)^{FI} < 0$.

Q.E.D.

Proof of Proposition 7:

The support of the distribution under full and asymmetric information is $[\underline{b}, \bar{b}]$. We want to show that $G^{FI}(b) \geq G^{AI}(b)$ for any b_t. First, take an initial distribution, for example, $G^{AI}(b)$ and apply the Markov transformation under asymmetric information T^{*}_{AI} and under full information T^{*}_{FI}.

With asymmetric information we have

$$\begin{aligned} T^{*}_{AI}G^{AI}(b) &= \gamma[(1-\underline{p})\int_{\underline{b}}^{\phi(b;\underline{\theta};0)} dG^{AI}_t(b) + \underline{p}\int_{\underline{b}}^{\phi(b;\underline{\theta};1)} dG^{AI}_t(b)] \\ &\quad +(1-\gamma)[\int_{\underline{b}}^{\phi(b;\bar{\theta};0)}(1-\bar{p}^{0})dG^{AI}_t(b) + \int_{\underline{b}}^{\phi(b;\bar{\theta};1)}\bar{p}^{0}dG^{AI}_t(b)], \end{aligned}$$

where $\bar{p}^{0} = p(\bar{\theta}; l^{0}_{\bar{\theta}}(b_t))$. Under full information we have

$$\begin{aligned} T^{*}_{FI}G^{AI}(b) &= \gamma[(1-\underline{p})\int_{\underline{b}}^{\phi(b;\underline{\theta};0)} dG^{AI}_t(b) + \underline{p}\int_{\underline{b}}^{\phi(b;\underline{\theta};1)} dG^{AI}_t(b)] \\ &\quad +(1-\gamma)[(1-\bar{p})\int_{\underline{b}}^{\phi(b;\bar{\theta};0)} dG^{AI}_t(b) + \bar{p}\int_{\underline{b}}^{\phi(b;\bar{\theta};1)} dG^{AI}_t(b)]. \end{aligned}$$

By operating we obtain

$$T^{*}_{AI}G^{AI}(b) - T^{*}_{FI}G^{AI}(b) = (1-\gamma)\int_{\phi(b;\bar{\theta};1)}^{\phi(b;\bar{\theta};0)}(\bar{p}-\bar{p}^{0})dG(b) < 0$$

since $T^*_{AI}G^{AI}(b) = G^{AI}(b)$; we have proved that $G^{AI}(b) \leq T^*_{FI}G^{AI}(b)$.

Since T^*_{FI} is increasing, $T^*_{FI}G^{AI}(b) \leq T^*_{FI}(T^*_{FI}G^{AI}(b))$ holds also. More generally, $G^{AI}(b) \leq T^*_{FI}G^{AI}(b) \leq \dots \leq (T^*_{FI})^nG^{AI}(b)$; and notice that $(T^*_{FI})^nG^{AI}(b)$ converges to $G^{FI}(b)$. Thus, we have shown that $G^{AI}(b) \leq G^{FI}(b)$.

Q.E.D.

Appendix B:

B.1: Indifferences curves are concave in the plane $(I; F)$.

The expected utility of the borrower is given by

$$U_\theta(I; F) = p(\theta; I)[h^eG_\theta - F(I - b_t^j)] + (1 - p(\theta; I))h^u.$$

The slope of the indifference curve for a borrower is

$$\frac{dF}{dI} = -\frac{\frac{dU}{dI}}{\frac{dU}{dF}} = -\frac{\frac{dp(\theta;I)}{dI}[(h^eG_\theta - h^u) - F(I - b_t)] - p(\theta; I)F}{-p(\theta; I)(I - b_t^j)}. \qquad (1.28)$$

Notice that when $I = b_t^j$ the slope is not defined. The demand curve ($I = I(F)$; which is decreasing in the plane $(F; I)$) is given by

$$\frac{dp(\theta; I)}{dI}[(h^eG_\theta - h^u) - F(I - b_t)] - p(\theta; I)F = 0.$$

The slope of the indifference curve will be zero if and only if the point satisfies the demand function. To obtain information on the shape of the indifference curve for points not on the demand curve, we differentiate Eq. (1.28) with respect to I and arrange terms:

$$\frac{d^2F}{dI^2} = \frac{[-B(\theta)e^{-I}((h^eG_\theta - h^u) - F(I - b_t^j)) - 2B(\theta)e^{-I}F]}{p(\theta; I)^2(I - b_t^j)^2} - \frac{[\frac{dp(\theta;I)}{dI}((h^eG_\theta - h^u) - F(I - b_t^j)) - p(\theta; I)F][B(\theta)e^{-I}(I - b_t^j) + P(\theta; I)]}{p(\theta; I)^2(I - b_t^j)^2}.$$

The denominator is positive, so the sign is determined by the two terms in the numerator. Because of $p_{ll} < 0$, the first term is negative. The second term is of uncertain sign, but includes the slope of the indifference curve as a multiplicative element. Consequently, we know that where the indifference curve has zero slope, or equivalently where it intersects the demand function, it must have a negative second derivative. Thus, in the neighborhood of the demand function, the second term cancels out and the indifference curve is concave. We know, however, that the slope of the indifference curve can change sign only at the point of intersection with the demand curve. The result, therefore, is that the indifference curves are monotonically rising until they reach the demand function and monotonically falling thereafter (see Figure 1).

It is worth noticing that $\frac{dF}{dl}|_{\bar{\mu}} > \frac{dF}{dl}|_{\underline{\mu}}$ holds for every $b_t^j < l^{*}_{\mu}$.[40] In section 1.3.2. we will see that in equilibrium, the indifferences curves cross in the area of overinvestment, where the slope of a $\bar{\mu}$ type is less steeper than the one of a $\underline{\mu}$ type (see Figure 2). Specifically, in this region the marginal increase in the interest rate F that a borrower is willing to accept in order to receive a lower l (to be near to the efficient amount) is higher for $\bar{\mu}$ type.

Finally, we can easily check that an increase in the inherited wealth increases the slope of the indifference curves, i.e. $\frac{d}{db_t}(\frac{dF}{dl}) > 0$.

Q.E.D.

$B.2.$ The isoprofit line is a decreasing and convex curve.

40 The single crossing property holds if $\frac{[\frac{dp(\bar{\mu};l)}{dl}(h^e G_{\bar{\mu}} - h^u) - F(l - b_t)] - p(\bar{\mu};l)F}{p(\bar{\mu};l)(l - b_t^j)} > \frac{[\frac{dp(\underline{\mu};l)}{dl}(h^e G_{\underline{\mu}} - h^u) - F(l - b_t)] - p(\underline{\mu};l)F}{p(\underline{\mu};l)(l - b_t^j)}$ which is true if and only if $G_{\bar{\mu}} > G_{\underline{\mu}}$.

The profit of the bank is

$$\Pi = p(\theta; I)F(I - b_t^j) - R(I - b_t^j).$$

Defining the function $F(I)$ we have

$$F = \frac{R(I - b_t^j) + \Pi}{p(\theta; I)(I - b_t^j)}.$$

Because of perfect competition in equilibrium banks make zero profits ($\Pi = 0$); and thus the slope becomes decreasing

$$\frac{dF}{dI} = -\frac{B(\theta)e^{-I}R}{p(\theta; I)^2} < 0.$$

The isoprofit is a convex function,

$$\frac{d^2F}{d^2I} = \frac{B(\theta)e^{-I}Rp(\theta; I)(p(\theta; I) + 2B(\theta)e^{-I})}{p(\theta; I)^4} > 0.$$

The break-even line for clever agents are on the left of $\pi_{\underline{\theta}}$; since talented borrowers have a higher probability of success. Finally, the break-even line $F = \frac{R}{p(\theta;I)}$ satisfies $\lim_{I \to 0} F = \infty$; and $\lim_{I \to \infty} F = \frac{R}{B(\theta)}$.

Q.E.D.

$B.3$: Pareto efficient contract.

The Pareto efficient contract is given graphically by the set of points of $(F; I)$ where the indifference curves for applicant and bank are tangent. For the bank the slope of the break-even line is $\frac{dF}{dI} = -\frac{RB(\theta)e^{-I}}{B(\theta)^2(1-e^{-I})^2}$. For the borrower the slope of the utility function when the bank provides the efficient amount of investment (namely, $B(\theta)e^{-I}(h^e G_\theta - h^u) = R$) is $\frac{dF}{dI} = \frac{-R(\frac{e^{-I}}{1-e^{-I}})}{P(\theta;I)}$. Therefore, we can show that at the efficient contract $\xi_\theta^* = (F_\theta^*; I_\theta^*)$

both curves are tangential. The Pareto efficient contract is found by maximizing the total surplus with respect to the investment I:

$$I \in \arg\max_{I \geq 0} p(\theta;I)[h^eG_\theta - F_\theta(I_\theta - b_t^j)] + (1 - p(\theta;I))h^u + p(\theta;I)F(I - b_t^j) - R(I - b_t^j).$$

Introducing $F = \frac{R}{p(\theta;I)}$ in the equation above, and maximizing w.r.t. I, give us Eq. (1.2).

Q.E.D.

$B.4$: With a pooling contract the indirect utility function of a high type depends negatively on the proportion of low type, i.e. $\frac{dV^P_{\bar\theta}}{d\gamma} < 0.$

If the pooling contract $(\hat F;\hat I)$ is accepted by a clever agent, his utility function is

$$V^P_{\bar\theta} = p(\bar\theta;\hat I)[h^eG_{\bar\theta} - \hat F(\hat I - b_t)] + (1 - p(\bar\theta;\hat I))h^u;$$

we can check (see proof proposition 2) that $\frac{d\hat I}{d\gamma} < 0; \frac{d\hat F}{d\gamma} > 0.$

$$\frac{dV^P_{\bar\theta}}{d\gamma} = B(\bar\theta)[e^{-\hat I}(h^eG_\theta - h^u) - \hat F]\frac{d\hat I}{d\gamma} - B(\bar\theta)\frac{d\hat F}{d\gamma}(\hat I - b_t).$$

By the envelop theorem $\frac{dV^P_{\bar\theta}}{d\gamma} < 0$ since first $e^{-\hat I}(h^eG_\theta - h^u) = \hat F$ so the first terms cancel out, second because $\frac{d\hat F}{d\gamma} = \frac{(-1)R\{(B(\underline\theta) - B(\bar\theta)) + e^{-\hat I}((1-\gamma)B(\bar\theta) + \gamma B(\underline\theta))\frac{d\hat I}{d\gamma}\}}{[(1-e^{-\hat I})((1-\gamma)B(\bar\theta) + \gamma B(\underline\theta))]^2} > 0.$

Q.E.D.

$B.5$: With a separating contract the investment in education depends negatively on the level of inherited wealth, i.e. $\frac{dI'_{\bar\theta}}{db_t} < 0.$

From the equation (1.15), and using the implicit function theorem, it results that

$$\frac{dI'_{\bar\theta}}{db_t} = -\frac{R\left(\frac{B(\bar\theta) - B(\underline\theta)}{B(\bar\theta)}\right)}{-[B(\underline\theta)e^{-I}(h^eG_{\underline\theta} - h^u) - \frac{B(\underline\theta)}{B(\bar\theta)}R]} = \frac{\beta R\left(\frac{B(\bar\theta) - B(\underline\theta)}{B(\bar\theta)}\right)}{(1-\gamma)[B(\bar\theta)(h^eG_{\bar\theta} - h^u) - R]} < 0; \tag{1.29}$$

where β is the multiplier associated to the $IC_{\underline{\theta}}$ which is binding and therefore, $\beta > 0$. In fact,

$$\beta = (1-\gamma)\frac{B(\bar{\theta})e^{-l}(h^e G_{\bar{\theta}} - h^u) - R}{B(\underline{\theta})e^{-l}(h^e G_{\underline{\theta}} - h^u) - R\frac{B(\underline{\theta})}{B(\bar{\theta})}} = (1-\gamma)\frac{B(\bar{\theta})e^{-l}(h^e G_{\bar{\theta}} - h^u) - R}{\frac{B(\underline{\theta})}{B(\bar{\theta})}[B(\bar{\theta})e^{-l}(h^e G_{\underline{\theta}} - h^u) - R]}, \tag{1.30}$$

with overinvestment $B(\bar{\theta})e^{-l}(h^e G_{\bar{\theta}} - h^u) < R$ and $B(\underline{\theta})e^{-l}(h^e G_{\underline{\theta}} - h^u) < R$. Similarly, we can show that $\frac{d^2 l'_{\bar{\theta}}}{db_t^2} < 0$.

Q.E.D.

B.6: The threshold level of the proportion of low ability agents depends negatively on the level of inherited wealth, i.e. $\frac{d\hat{\theta}}{db_t} < 0$.

The value of $\hat{\theta}$ is found by equating $V^s_{\bar{\theta}} - V^P_{\bar{\theta}} = 0$. Let denote this equation by $\ell = V^s_{\bar{\theta}} - V^P_{\bar{\theta}}$; by the implicit function theorem $\frac{d\hat{\theta}}{db_t} = -\frac{\frac{d\ell}{db}}{\frac{d\ell}{d\hat{\theta}}}$. The denominator is positive since $\frac{dV^P_{\bar{\theta}}}{d\gamma} < 0$; and the numerator is given by

$$\frac{d\ell}{db} = R\left(1 - \frac{B(\bar{\theta})}{(1-\gamma)B(\bar{\theta}) + \gamma B(\underline{\theta})}\right) + [B(\bar{\theta})(h^e G_{\bar{\theta}} - h^u) - R]\frac{dl'_{\bar{\theta}}}{db_t}.$$

Taking into account Eq. (1.29) and Eq. (1.30), the equation above can be rewritten as

$$\frac{d\ell}{db} = \frac{R[B(\bar{\theta}) - B(\underline{\theta})]}{[(1-\gamma)B(\bar{\theta}) + \gamma B(\underline{\theta})]B(\bar{\theta})(1-\gamma)}[-\gamma(1-\gamma)B(\bar{\theta}) + \beta\{(1-\gamma)B(\bar{\theta}) + \gamma B(\underline{\theta})\}];$$

where β is the multiplier associated to the $IC_{\underline{\theta}}$ which is binding and $\beta > 0$; and is given by Eq. (1.30). The expression below is positive because

$$\begin{aligned} x &= -\gamma(1-\gamma)B(\bar{\theta}) + \beta((1-\gamma)B(\bar{\theta}) + \gamma B(\underline{\theta})) \\ &= \beta(1-\gamma)B(\bar{\theta}) + (1-\gamma)\gamma B(\bar{\theta})\left\{\frac{B(\bar{\theta})e^{-l}(h^e G_{\bar{\theta}} - h^u) - R}{B(\bar{\theta})e^{-l}(h^e G_{\underline{\theta}} - h^u) - R} - 1\right\} > 0 \end{aligned}$$

And thus, $\frac{d\hat{\theta}}{db_t} < 0$.

Q.E.D.

B.7: With full information Eq. (1.5), $IC_{\bar{\theta}} > 0$ and Eq. (1.6), $IC_{\underline{\theta}} < 0$ hold:

Notice first that $\frac{dIC_{\bar{\theta}}}{db_t} < 0$, and $\frac{dIC_{\underline{\theta}}}{db_t} > 0$. So we just needs to be sure that at the highest level of bequest ($b_t = I^*_{\underline{\theta}}$) both inequalities ($IC_{\bar{\theta}} > 0$ and $IC_{\underline{\theta}} < 0$) holds. From the incentive compatibility of the high type we have

$$p(\bar{\theta}; I^*_{\bar{\theta}})(h^e G_{\bar{\theta}} - h^u) - R(I^*_{\bar{\theta}} - I^*_{\underline{\theta}}) > p(\bar{\theta}; I^*_{\underline{\theta}})(h^e G_{\bar{\theta}} - h^u) - \frac{B(\bar{\theta})}{B(\underline{\theta})} R(I^*_{\underline{\theta}} - I^*_{\underline{\theta}});$$

by substituting Eq. (1.3), the inequality above becomes $1 + \ln(\frac{a}{d}) < \frac{a}{d}$ where $a = B(\bar{\theta})(h^e G_{\bar{\theta}} - h^u)$ and $d = B(\underline{\theta})(h^e G_{\underline{\theta}} - h^u)$; which is always true because $a > d$.

Using a similar argument we can show that $IC_{\underline{\theta}} < 0$ implies $1 + \frac{aB(\underline{\theta})}{dB(\bar{\theta})} \ln(\frac{a}{d}) > \frac{a}{d}$; which is always true.

Q.E.D.

B.8: With asymmetric information $IC_{\bar{\theta}} > 0$, and high ability agents prefer to become borrowers rather than self-financed.

First, since talented borrowers are the one who are distorted, they can have incentives to become self-financed. Moreover, the higher is their wealth, the lower is the distortion. So we just need to analyze $\bar{\theta}$ agents with the highest wealth $b_t = I^*_{\underline{\theta}}$. If we proof that they don´t have incentives to become self-finance, for sure poorer and $\bar{\theta}$ type agents will decide to become borrowers too. They would have incentives to become borrowers instead of self-financed if,

$$p(\bar{\theta}; I'_{\bar{\theta}})(h^e G_{\bar{\theta}} - h^u) - R(I'_{\bar{\theta}} - I^*_{\underline{\theta}}) > p(\bar{\theta}; I^*_{\underline{\theta}})(h^e G_{\bar{\theta}} - h^u).$$

Moreover, under asymmetric information talented borrower do not have incentives to lie, which means that the following inequality needs to holds,

$$p(\bar{\theta}; I'_{\bar{\theta}})(h^e G_{\bar{\theta}} - h^u) - R(I'_{\bar{\theta}} - b_t) \geq p(\bar{\theta}; I^*_{\underline{\theta}})(h^e G_{\bar{\theta}} - h^u) - \frac{B(\bar{\theta})}{B(\underline{\theta})} R(I^*_{\underline{\theta}} - b_t).$$

The inequality above become more difficult to hold when the inherited wealth is at the highest level (the $IC_{\bar{\theta}}$ is decreasing in bequest). So in order to be sure that this inequality holds, we needs to evaluate the equation above at $b_t = I^*_{\underline{\theta}}$. Notice that the two inequalities become the same, so we just needs to be sure that the following inequality holds,

$$p(\bar{\theta}; I'_{\bar{\theta}})(h^e G_{\bar{\theta}} - h^u) - R(I'_{\bar{\theta}} - I^*_{\underline{\theta}}) \geq p(\bar{\theta}; I^*_{\underline{\theta}})(h^e G_{\bar{\theta}} - h^u), \tag{1.31}$$

>From Eq. (1.9) we know that $-R(I'_{\bar{\theta}} - I^*_{\underline{\theta}}) = B(\bar{\theta})(h^e G_{\underline{\theta}} - h^u)\{e^{-\lambda I'_{\bar{\theta}}} - e^{-\lambda I^*_{\underline{\theta}}}\}$. If we substitute this value in the Eq. (1.31) then we obtain

$$B(\bar{\theta})(h^e G_{\bar{\theta}} - h^u)\{(1 - e^{-\lambda I'_{\bar{\theta}}}) - (1 - e^{-\lambda I^*_{\underline{\theta}}})\} \geq B(\bar{\theta})(h^e G_{\underline{\theta}} - h^u)\{(1 - e^{-\lambda I'_{\bar{\theta}}}) - (1 - e^{-\lambda I^*_{\underline{\theta}}})\},$$

which holds always true since $G_{\bar{\theta}} > G_{\underline{\theta}}$. Therefore, under asymmetric information $IC_{\bar{\theta}} > 0$, and high ability agents prefer to become borrowers rather than self-financed.

Q.E.D.

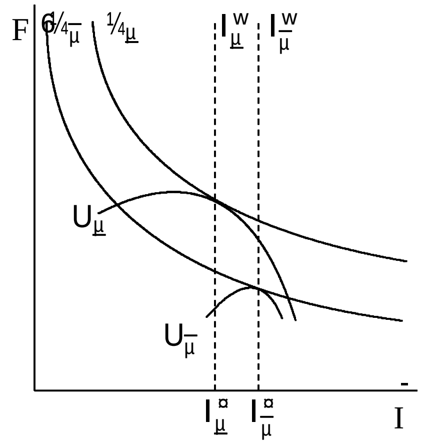

Figure 1: Equilibrium with full information

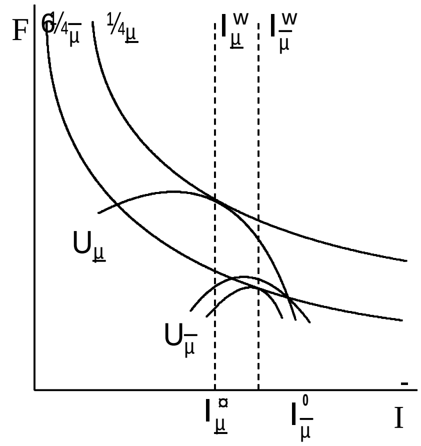

Figure 2: Equilibrium with asymmetric information

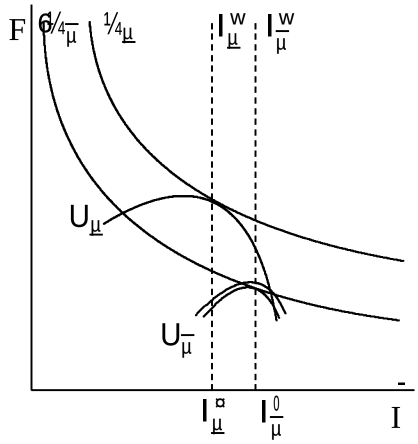

Figure 3: Equilibrium with asymmetric information

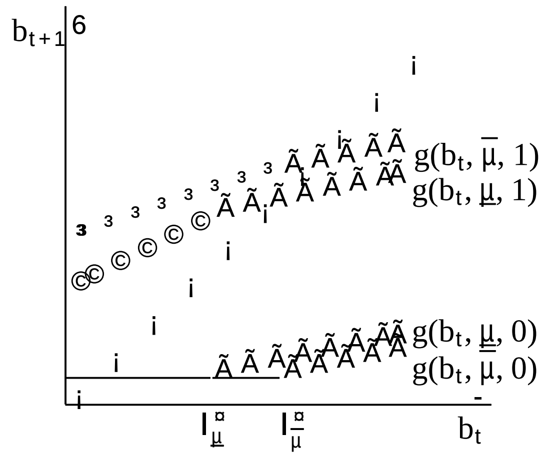

Figure 4: Individual transition function with full information

Chapter 2
On Capital Market Imperfections as an Origin of Low TFP and Economic Rents

2.1 Introduction

One of the most important research questions faced by economists is why poor countries use productive resources inef ciently. In this paper we propose a theory where capital market imperfections are at the origin of cross-country differences in total factor productivity (TFP). In our theory, entrepreneurs need external nancing and have private information about the multifactor productivity of their technology. We study how the contracting environment, as described by the ability to enforce contracts, affects the provision of incentives and, thus, resource allocation to and across entrepreneurs. We show that capital market imperfections lead to the use of low productivity technologies and allow entrepreneurs to extract economic rents. Our theory has implications for the allocation of resources across industries that differ in their needs of external funds and provide some insights into why poor countries face large differences in productivity across sectors. Our theory also implies that income taxation can be more detrimental for economic activity when capital markets are imperfect.

Our research is motivated by recent evidence suggesting that capital markets tend to perform worse in poor than in rich countries and that indicators of nancial development are positively and robustly correlated with productivity across countries (see Levine (1997) for a survey). Our focus on the implications of limited enforcement for the contracting environment and cross-country income differences is motivated by the work of Laporta et al. (1998). These authors present evidence that countries differ substantially on the legal protection of investors and in the quality of law enforcement. They conclude that richer countries have higher quality of law enforcement and higher accounting standards.

We develop a growth model where entrepreneurs are endowed with a technology to produce an intermediate good that is an input in the production of final goods. Entrepreneurs need external funds in order to operate their productive technology. External financing is complicated by two problems: First, the productivity of the entrepreneurial technology can not be observed by lenders. Second, entrepreneurs can commit to pay, at most, a fraction Á of the resources available after production. In equilibrium, entrepreneurs form coalitions (or financial intermediaries) as an incentive-compatible mechanism for allocating resources to their most productive use. In our economy, the degree of enforcement (Á) determines the contracting environment and, as a result, the optimal way to provide incentives. We assume that countries in our model economy are identical but differ in their capacity to enforce contracts (Á) and study how the level of enforcement affects incentive provision, aggregate resource allocation to entrepreneurs, and the distribution of resources across entrepreneurs that differ in their multifactor productivity.

We find that enforcement critically affects resource allocation in our contracting environment. When enforcement is sufficiently high only entrepreneurs with the highest productivity find it profitable to operate their technologies in equilibrium. As a result, low quality entrepreneurs choose not to operate their technologies and become workers. As enforcement (Á) decreases, the incentives for lower quality entrepreneurs to operate their technologies increase. Intuitively, a decrease in enforcement means a lower punishment for misreporting entrepreneurial type. We show that when enforcement is below certain threshold value, low productivity entrepreneurs operate their technology. In fact, low quality entrepreneurs may operate their technology even when their operation is not pro table. This happens when low productivity entrepreneurs pay only a fraction of their production costs as a result of being subsidized in their business operation. Subsidies, for some low levels of enforcement, minimize the amount of resources transferred to inef cient entrepreneurs by providing them incentives to reveal their type truthfully.

General equilibrium effects amplify the forces just described. As enforcement decreases, the incentives of low type entrepreneurs to operate their technology further increase. As a result, entrepreneurs face a decrease in the amount of external funds that they are able to raise and the aggregate supply of intermediate goods decreases. This decrease, in turn, translates into two general equilibrium price effects: First, the price of intermediate goods increases and, second, the wage rate decreases as the marginal product of labor is negatively affected by the decrease in intermediate goods. The changes in relative prices just described raise the incentives of low type entrepreneurs to operate their technology (instead of working for someone else). To sum up, a decrease in enforcement leads to a higher ratio of low to high quality projects being operated through incentive and general equilibrium price effects.

Since the work of Kuznets (1966), it is well know that developing countries face substantial differences in labor productivity across sectors in the economy. We show that capital market imperfections may play a role in understanding this observation. In our theory, industries differ in their needs of external financing. Imperfect enforcement affects industry productivity through entrepreneurial selection and general equilibrium price effects. We find that when enforcement is sufficiently high, labor productivity and TFP does not differ across sectors. When capital markets are imperfect, however, productivity varies across industries. Factor inputs can not move to the most productive industries because of enforcement problems. As a result, poor countries in our framework allocate a large fraction of its productive resources to industries with low productivity.

While we do not model the reasons for why enforcement differs across countries, our theory does offer some interesting clues. We show that entrepreneurs make positive profits if and only if enforcement is limited and that entrepreneurial profits, relative to GDP, decrease with enforcement. This finding is explained as follows. When external financing is not limited by enforcement problems (Á close to 1); the highest productivity entrepreneurs are indifferent between operating their technology or becoming workers. In equilibrium the number of entrepreneurs operating their technology adjust so that the market for intermediate goods clears. Entrepreneurs make zero profits in the sense that their earnings are equal to the opportunity cost of their time (wage rate). When enforcement limits the amount of external funds that entrepreneurs can raise, the aggregate supply of intermediate goods is constrained by external financing. In this case, prices of intermediate goods increase relative to the full enforcement case so that its demand decreases and the market clears. The increase in price of intermediate goods, which in general equilibrium is associated with a decline in real wages, implies that high productivity entrepreneurs are strictly better off operating their technology. In this case, entrepreneurs extract economic rents from the factor services that they hire. This is because, as enforcement decreases, the marginal product of factor services in the intermediate goods sector increases relative to the final goods sector and this surplus is captured by entrepreneurs. Our theory does suggest that entrepreneurs may have a vested interest in maintaining a status quo with low enforcement. For a political economy theory of technological change see Krusell and Ríos-Rull (1996).

We view our contribution as complementary to the line of inquiry advocated in Hall and Jones (1999) and Parente and Prescott (1999, 2000). These authors argue that a theory of TFP is crucial for understanding the economic development problem. Parente and Prescott (2000) build a theory where specialized suppliers of inputs to a particular production process have a vested interest in protecting their monopoly rents and block the adoption of more advanced technologies. We obtain similar results but in a framework without monopoly type of arrangements. There is a large literature discussing how financial intermediaries can improve resource allocation in economies with asymmetric information (see, for instance, Bencivenga and Smith (1991), Boyd and Prescott (1986), and Levine (1997) for a survey). A contribution of our paper is to study how enforcement problems affect the optimal way of providing incentives when dealing with imperfect information problems.

Recent literature has emphasized the importance of understanding differences in productivity across sectors in the economy. Hsieh and Klenow (2002) argue that poor countries have low real investment rates because they are plagued by low efficiency in the production of investment goods, which lead to a high relative price of capital. Golin et al. (2002) argue that understanding the low productivity of poor countries in agriculture (relative to non-agricultural sector) is central for understanding economic development. Restuccia et al. (2003) document that the ratio of productivity in agriculture to non-agriculture is quite large in poor countries. They report that low usage of intermediate goods in agriculture accounts for the low productivity in this sector and that poor countries tend to allocate a large fraction of its productive resources in agriculture. These observations motivate them to build a framework where labor can not move freely out of agriculture because of “barriers to labor mobility”. Our theory points that capital market imperfections can provide a rationale for both sectorial productivity differences and barriers to factor mobility. Rajan and Zingales (1998) provide empirical evidence supporting that industries are affected differently by capital market imperfections. Using cross country data, they nd that low levels of nancial development affect more negatively industries that depend heavily on external nancing.

In a well known paper, Easterly and Rebelo (1993) nd that the cross country evidence does not support the contention that taxation has signi cant effects on economic activity, in stark contrast with the implications of growth theory. Our theory points that the effects on taxes for economic activity may be harder to sort out empirically than the standard neoclassical growth model suggests. We show that the effects of taxes on economic activity vary across economies depending on the functioning of their capital markets. In fact, a given tax rate in a poor country could be more detrimental of economic activity than a higher tax rate in a country with well developed nancial markets.

The paper is organized as follows. In Section 2 we present the model economy. In Section 3 we discuss how entrepreneurs form coalitions as an incentive compatible mechanism for allocating resources. In Section 4 we study the general equilibrium of our economy, we analyze the cross-industry implications of limited enforcement, and show that income taxation is more detrimental for economic activity when capital markets do not function well. Section 5 concludes.

2.2 The Economy

Agents

The economy is populated by two period lived overlapping generations of entrepreneurs and by households. Entrepreneurs are endowed with 1 unit of labor in each period of their lives and with a production technology when old. At age 2, entrepreneurs choose whether to operate their technology or work for someone else. Entrepreneurs are assumed to be risk neutral and to consume by the end of their second period of life. We assume that households are infinitely lived and that they make consumption and savings decisions as in the standard Ramsey growth model. This assumption is made so that the steady state interest rate is equal to the households' rate of time preference. Alternatively, we could obtain similar results assuming that there is a storage technology or modeling a small open economy that takes the interest rate as given. The assumptions made imply that the aggregate labor supply is given by the sum of households, young entrepreneurs, and the old entrepreneurs that decide to work for a wage. For simplicity, we assume that there is no population growth. We normalize the mass of infinitely lived households by 1 and the size of each cohort of entrepreneurs by [1]:

Production

At each point in time, there are $n+1$ produced goods: a final good and n intermediate goods. The output good is produced by combining capital K, labor N; and intermediate goods inputs Z according to a $c.r.s.$ technology

$$Y = F(K_y; Z_y; N_y) = A_y(K_y^{\alpha} L_y^{1-\alpha})^{1-\gamma} Z_y^{\gamma}; \tag{2.32}$$

where $Z_y \equiv \left(\sum_{j=1} a_j Z_j^{\rho} \right)^{1/\rho}$ is a C.E.S. aggregator of intermediate goods. We assume that firms in the final goods sector take prices as given. Then, our assumptions imply that firms will make zero profits in equilibrium. For simplicity, and $w.l.o.g.$, we normalize the number of firms in the final goods sector to $1.$ We also assume that capital depreciates at a rate $\delta.$

Intermediate goods are produced combining fixed and variable inputs. The fixed inputs are given by the entrepreneurial time and a fixed amount of consumption goods, which varies across industries. The variable inputs are given by capital and labor services. An entrepreneur that incurs the fixed production costs and uses capital K_j and labor N_j in industry j produces an amount of goods given by $Z_j = \min\left\{ A_i K_j^{\alpha} N_j^{1-\alpha}; \bar{z} \right\}$, where A_i can take the values $\{A_h; A_l\}$ representing low and high productivity technologies ($A_h > A_l$), respectively, and $\bar{z}$ represents the maximum scale of operation of the entrepreneurial technology.

We will consider a market structure such that entrepreneurs take prices as given. Then the production technology for intermediate goods implies that entrepreneurs will face a constant marginal cost of production and, due to the fixed inputs, a decreasing average cost. The marginal cost of producing one unit of output (in terms of consumption goods) by type i entrepreneurs is obtained from the following cost minimization problem

$$y_i \equiv \min_{K;N} \{rK + wN\}$$

$$s.t.\ A_i K^{\alpha} N^{1-\alpha} = 1;$$

where $i \in \{h; l\}$ and $(r; w)$ are the cost of capital and labor services, respectively. It is easy to show that $y_i = \frac{1}{A_i}(\frac{r}{\alpha})^{\alpha}(\frac{w}{1-\alpha})^{1-\alpha}$: Notice that the marginal cost of production does not depend on the scale of project operation. Moreover, the marginal cost of a low type entrepreneur relative to a high type entrepreneur is equal to the inverse of their relative productivities, that is, $\frac{y_l}{y_h} = \frac{A_h}{A_l}$: These properties will be useful for solving analytically the contracting problem faced by entrepreneurs.

We assume that industries are symmetric but for the fixed cost f_j; which varies across industries. In particular, each entrepreneur is born with a technology to operate in only one industry and the number of high and low productivity entrepreneurs is equally distributed across industries. As a result, in each industry the total number of entrepreneurs is given by μ/n and the fraction of low productivity entrepreneurs is equal to γ: The fixed cost f_j varies across industries and is meant to represent the fact that industries have different cash-flows and needs of external financing, as emphasized by Rajan and Zingales (2001). Industries with a relatively high fixed cost f_j will require a high expenditure and, in equilibrium, they will receive a relatively high revenue. Consequently the financing problem faced by entrepreneurs differs across industries.

Entrepreneurial Coalitions

We now describe how entrepreneurs form coalitions as an incentive compatible mechanism to allocate resources among their members. Entrepreneurs need external financing but their ability to raise funds is complicated by two capital market imperfections: First, there is a limit to how much entrepreneurs can commit to pay back once the returns of the project are realized. Second, the ability of entrepreneurs is not known by the lenders. We follow Boyd and Prescott (1986), and assume that entrepreneurs form coalitions that raise funds from households and organize production among its members. We assume that there is a large number of coalitions so that coalitions take prices as given. The allocation chosen by entrepreneurial coalitions can also be viewed as arising from competitive intermediaries bidding for loan contracts and with free entry in the intermediation business.

We assume that coalitions are formed before entrepreneurs learn their type. This assumption implies that private information is revealed after contracting and it is made in order to avoid the problems of inexistence of equilibria that arise with adverse selection (see, for instance, Prescott and Townsend (1982)).[41] Coalitions announce production plans and repayment schedules for each type of entrepreneurs. Because coalitions face a similar problem across industries, we focus in one industry. To simplify notation we do not index allocations and intermediate goods prices by the industry index, though it should be understood that these objects will vary across industries. We also normalize the number of members in each coalition to 1 in order to keep notation simple. Production plan specifies, for each type of entrepreneur, the fraction of entrepreneurs that work for a wage, the fraction of entrepreneurs that get to operate their technology, the resources available for operating the technology (capital and labor services), and repayment schedules. Payments are

[41] As we shall later show, the efficient allocation of resources among entrepreneurs in our framework requires cross-subsidies across different types of entrepreneurs. Consequently, efficiency requires that intermediaries make positive profits with some entrepreneurs and negative profits with others. This outcome can not be supported as an equilibrium with free entry.

constrained by enforcement problems since we assume that entrepreneurs can commit to pay at most a fraction $\phi < 1$ of output. The timing of events can be summarized as follows:

1. Entrepreneurs decide whether they want to participate in a coalition or not.

2. Entrepreneurial coalitions are formed. Entrepreneurs join the coalition by putting their net worth as equity. Coalitions write contracts in order to organize the production of intermediate goods and raise external funds. Contracts are represented by a $8-$tuple $\{(e_l; Z_l; L_l); (e_h; Z_h; L_h); E; \eta\}$. For each ability type i, the contract specifies the fraction of entrepreneurs e_i that operate their production technology while the rest (fraction $1 - e_i$) are assigned to work for a wage. For entrepreneurs that are called to operate their technology, the contract specifies how much output Z_i they should produce and a payment L_i to be made to the coalition after production has taken place. The coalition finances production activities with external funds E and entrepreneurial net worth η.

3. Entrepreneurs learn their ability and report it to the coalition.

4. The coalition selects the entrepreneurs that operate production technologies for each type (presumably by a randomization device). These entrepreneurs incur the production fixed cost f and hire capital and labor services with resources provided by the coalition (type i entrepreneurs in industry j receive an amount of resources worth $y_i Z_i + f_j$). The entrepreneurs that are not chosen to operate their production

technology, do not receive resources and supply their labor services in the labor market for a wage rate.

5. Production takes place. Entrepreneurs that operate their technology sell the output of intermediate goods and make payments to the coalition. Because of limited enforcement, payments can not exceed a fraction Á of the value of output.

We have assumed that coalitions can randomly select who, for each type of entrepreneur, will be called to operate a project. This randomization device could be interpreted as a form of credit rationing. We have allowed for randomization because it is efficient in our environment (given that entrepreneurs are risk neutral). Decreasing average cost of production (due to fixed costs) implies that efficiency requires projects to be operated at maximum scale. Had we rule out randomization, coalitions would have to use the scale of production in order to ration resources across entrepreneurs. This will certainly make capital market imperfections much more detrimental for production efficiency than we are currently considering. In this case, we would have that projects would not be run at an optimal scale and that too many projects would be operated. Our main results about the consequences of capital market imperfections for production efficiency and economic rents do not depend on allowing for randomization.

Coalitions maximize entrepreneur's expected consumptions subject to resource feasibility, enforcement, incentive compatibility, and participation constraints. Below we formally describe the decision problem faced by entrepreneurial coalitions.

Entrepreneurs' Consumption

Consider an entrepreneur of type i. The entrepreneur operates his technology with probability e_i. In this case, the entrepreneur obtains an output of intermediate goods worth $q_z Z_i$ in terms of consumption goods, pays an amount L_i to the coalition, and consumes $q_z Z_i - L_i$. With probability $1 - e_i$ the entrepreneur is assigned to work and consumes an amount equal to the wage rate. The expected consumption of a type i entrepreneur is then given by

$$c_i = e_i \left(q_z Z_i - L_i\right) + (1 - e_i)w. \tag{2.33}$$

Entrepreneurs' expected consumption when they join the entrepreneurial coalition (before knowing their ability) is thus

$$c^e = \nu c_l + (1 - \nu)c_h. \tag{2.34}$$

Participation Constraint

Entrepreneurs are better off by operating their production technologies as members of the coalition rather than on their own. Since they also have the option of supplying their labor services in the market, they will only participate in the coalition if the expected consumption among coalition members is higher than what they would consume by not joining the coalition, $c^e \geq w_t + \eta_t$ ($i.e.$ the sum of the wage rate and entrepreneurial' net worth, which is given by $w_{t-1}(1 + r_t - \delta)$).

Enforcement and Incentive Compatibility

We assume that coalitions have a limited ability to enforce repayments by entrepreneurs. Loan repayment is constrained by

$$L_i \leq \phi q_z Z_i. \tag{Enforcement}$$

Since ability type is not publicly observed, contracts are written so that entrepreneurs have incentives to report their true type. The following incentive compatibility constraints guarantee that it is in their best interest to report truthfully their type

$$c_i = e_i\,(q_z Z_i - L_i) + (1 - e_i)w \geq e_j\, q_z \frac{A_i}{A_j} Z_j (1 - \phi) + (1 - e_j)w; \qquad \text{(incentive compatibility (IC))}$$

for i and $j \in \{l; h\}$. If entrepreneurs type i claims to be type j, they have probability e_j of being assigned an amount of resources $y_j Z_j$ in order to produce Z_j units of output. With this amount of resources, however, type i entrepreneurs will produce $\frac{y_j}{y_i} Z_j = \frac{A_i}{A_j} Z_j$ instead of Z_j (recall that the ratio of per unit cost of production across entrepreneurs is equal to the inverse of their relative productivities). Because the maximum punishment that an entrepreneur can receive for lying is equal to a fraction ϕ of the gross output of the project, a type i entrepreneur that lies will retain an amount of intermediate goods equal to $\frac{A_i}{A_j} Z_j (1 - \phi)$.

In a previous draft of this paper, we allowed the coalition to make lump sum transfers to low productivity entrepreneurs as a way of providing them incentives to reveal their types. In this way, the coalition could minimize the amount of projects operated by entrepreneurs with low productivity. In the current draft of the paper, we have rule out transfers because they would not be feasible under a mild (and reasonable) variation of the economic environment. To make this point clear, consider the case where the economy has a large number of individuals that do not face any opportunity costs of pretending to be a bad type of entrepreneur. Then, if lump sum transfers were part of the optimal contract, these individuals would have incentive to collect a transfer by claiming to be a bad type of entrepreneur and the optimal contract would not be resource feasible. It is also worth pointing out, that our main results still go through if we allow for lump sum transfers. In particular, low type entrepreneurs will operate projects under sufficiently low enforcement. For sufficiently low enforcement, general equilibrium prices will be such that the operation of low productivity projects becomes profitable for the coalition. As a result, low productivity projects would be operated despite the availability of lump sum transfers.

Feasibility

We assume that Entrepreneurial Coalitions are sufficiently large so that, as a result of the law of large numbers, a fraction ν of its members are endowed with projects of low quality. Entrepreneurial coalitions obtain funds from two sources: contributions from its members and external funds from its non-members. Because the financing problem is intra-period, the opportunity cost of funds is given by $1.$ Expenditures are then constrained by

$$\nu e_l (Z_l y_l + f) + (1 - \nu) e_h (Z_h y_h + f) = E + \eta, \qquad (2.35)$$

where E denotes external funds raised by the coalition and η represents entrepreneurs' net worth. Notice that only a fraction e_i of type i entrepreneurs are called to operate their technology. Each of these entrepreneurs receives an amount of resources worth $Z_i y_i + f$ in terms of consumption goods, where y_i denotes the per unit cost of producing one unit of output by type i entrepreneurs. Payments collected at the end of the period should satisfy

$$E \le \nu e_l L_l + (1 - \nu) e_h L_h. \qquad \text{(feasibility)}$$

Notice that we have allowed entrepreneurs to pool their net worth and redistribute the accumulated net worth among those entrepreneurs who operate projects. Because of increasing returns to scale, this is what optimality requires in our framework. In other words, entrepreneurs are better off by playing a "lottery". Its important to emphasize that allowing for this lottery does not play an important role in our results. By allowing entrepreneurs to pool their resources, we are making capital market imperfections less severe.

Entrepreneurial Coalition's Problem

The objective of Entrepreneurial Coalitions is to maximize expected consumption of its members by choosing $\{(c_l; e_l; Z_l; L_l); (c_h; e_h; Z_h; L_h); E\}$ in order to solve

$$\begin{aligned} &\text{Max } \pi c_l + (1 - \pi) c_h \\ &s.t.\ (\text{enforcement})(IC)(\text{feasibility}) - (2.35). \end{aligned}$$

Contracts have to be incentive, resource, participation, and enforcement feasible. Entrepreneurial Coalitions take prices of intermediate goods and factor services as given.

Market Clearing

We end the description of the economic environment with the market clearing conditions. In equilibrium the following markets need to clear for all $t \geq 0$:

1. Labor market

$$L_{yt} + L_{zt} = 1 + \frac{\mu_e}{n} \sum_{j=1} \left[1 + \pi (1 - e_l^j) + (1 - \pi)(1 - e_h^j) \right];$$

where μ_e denotes the measure of entrepreneurs and L_{zt} denotes the labor used in the production of intermediate goods which satisfies

$$L_{zt} = \frac{\mu_e}{n} \sum_{j=1} \frac{(1 - \alpha)}{w_t} \left[\pi y_l e_l^j Z_{lt}^j + (1 - \pi) y_{ht} e_{ht}^j Z_{ht}^j \right].$$

2. Capital market

$$k_t + \mu_e w_{t-1} = K_{ct} + K_{zt},$$

where K_{zt} denotes the capital used in the production of intermediate goods which satisfies

$$K_{zt} = \frac{\mu_e}{n} \sum_{j=1} \left(\frac{\alpha}{r_t}\right) \left[\nu y_l e_l^j Z_{lt}^j + (1-\nu) y_h e_h^j Z_{ht}^j\right].$$

3. Intermediate goods

$$Z_{yt}^j = \mu_e \left[\nu e_l^j Z_{lt}^j + (1-\nu) e_h Z_{ht}^j\right], \text{ for } j = 1, \ldots, n.$$

4. Output good

$$C_t + K_{t+1} - (1-\delta) K_t + \frac{\mu_e}{n} \sum_{j=1} f_j \left[\nu e_l^j + (1-\nu) e_h^j\right] = Y_t,$$

where $C_t = c_t + \frac{\mu_e}{n} \sum_{j=1} c_t^{j,e}$ denotes households' consumption, $c_t^{j,e}$ represents consumption of entrepreneurs in industry j (as defined in expression (2.34)), and $K_t = K_{zt} + K_{yt}$ is the aggregate capital stock in the economy.

2.3 The Optimal Contract

In this section, we characterize, for fixed prices, the allocation that maximizes entrepreneurs' consumption subject to resource feasibility, participation, enforcement, and incentives constraints. Our main result is that capital market imperfections can lead, for sufficiently low enforcement, to the use of inefficient technologies.

2.3.1 Full Information

It is convenient to start by considering the case where entrepreneurs' type is known. In this case, there are no truth telling constraints in the maximization problem of the coalition and the allocation of expenditures is only limited by enforcement and resource feasibility constraints.

Consumption of entrepreneurs is given by the value of intermediate goods produced (net of the cost of external funds) plus the wages received from working: $c^e = \nu e_l q_z Z_l + (1 - \nu) e_h q_z Z_h + [\nu(1 - e_l) + (1 - \nu)(1 - e_h)] w - E.$ Using the feasibility constraint to substitute out for E and plugging the resulting expression in the equation for consumption we obtain

$$c^e = \nu e_l [(q_z - y_l) Z_l - w - f] + (1 - \nu) e_h [(q_z - y_h) Z_h - w - f] + w + \eta.$$

It is important to notice that the entrepreneurial technology features increasing returns to scale. In other words, the per unit cost of production decreases as the scale of production increases (due to the presence of fixed inputs in the production technology). It is thus optimal to operate the entrepreneurial technology at its maximum scale $\bar{Z}$. We prove this formally in Lemma 1 below.

Lemma 1: In an optimal contract projects are only operated at its maximum scale of operation $\bar{Z}$.

Proof. We proceed by contradiction and assume that there exist an optimal contract $(Z_h^1; L_h^1; e_h^1; Z_l^1; L_l^1; e_l^1)$ with $Z_h^1 < \bar{Z}$ (we do not consider $Z_l < \bar{Z}$ since it is optimal to set $e_l = 0$). Then, consider the alternative contract $(Z_h^2; L_h^2; e_h^2; Z_l^1; L_l^1; e_l^1)$ that assigns to high types the following allocation $Z_h^2 = \widehat{Z}; e_h^2 = \frac{Z_h^1 e_h^1}{\widehat{Z}} < e_h^1; L_h^2 = \frac{L_h^1 e_h^1}{e_h^2}$ (notice that the allocation for low types is not changed). Notice that enforceability of contract 1 implies enforceability of contract 2. To see this, multiply the enforcement constraint of the first contract by the ratio $\frac{e_h^1}{e_h^2}$ in order to obtain

$$\frac{L_h^1 e_h^1}{e_h^2} = L_h^2 \leq \phi q_z Z_h^1 \frac{e_h^1}{e_h^2} = \phi q_z \widehat{Z}.$$

Similarly, contract 2 is resource feasible since it requires the same amount of aggregate expenditure in variable inputs, external financing, and payments as contract 1 but less expenditure in fixed inputs (since $e_h^2 < e_h^1$). However, contract 2 gives higher utility to high type entrepreneurs since $c_h^2 - c_h^1 = (e_h^1 - e_h^2)(w + f) > 0$ since $e_h^1 > e_h^2$; contradicting the optimality of contract 1.

Q.E.D.

The entrepreneurial technology is profitable when profits from operation are higher than the value of fixed inputs necessary for production. This value is given by the sum of opportunity cost of entrepreneurs' time and the f units of the output good that are required by the production technology as a fixed input. As a result, $e_i > 0$ only if $(q_z - y_i)\widehat{Z} \geq (w + f)$ for $i = h; l$. The number of entrepreneurs that are selected to operate their technology is determined by the amount of funds that the coalition is able to raise. We will find conditions so that in equilibrium the coalition will only finance a fraction (less than 1) of high quality projects. Then, since low quality projects involve a higher production cost $(y_l > y_h)$; it will not be optimal to operate low quality projects $(e_l = 0)$. In general equilibrium, we shall later see, prices of intermediate goods will adjust so that high quality projects are profitable, $(q_z - y_h)\bar{Z} \geq w$, and there is a positive mass of projects operated $e_h > 0$.

The amount of external funds raised is limited by enforcement problems. The maximum fraction of high quality projects that can be operated is obtained by combining the feasibility, payment, and enforcement constraints (all at equality) and is given by

$$e_h^* = \frac{\eta}{(1-\nu)\{\bar{Z}[y_h - \phi q_z] + f\}}. \tag{2.36}$$

Notice that $e_h^* > 1$ if the enforcement constraint does not bind. In general equilibrium, the enforcement constraint will not bind only if high productivity entrepreneurs make no profits, that is, $(q_z - y_h)\bar{Z} - f = w$. Otherwise, all high productivity entrepreneurs would have incentives to produce at maximum capacity which would be inconsistent with market clearing in the intermediate goods sector (in section 2.4 we find restrictions in the parameter space so that this is the case).

The above discussion is summarized in the following proposition:

Proposition 1: Assume $(q_z - y_h)\bar{Z} \geq (w + f)$ and $y_h > \phi q_z$. Let the maximum fraction of high projects operated $e_h^* = \frac{\eta}{(1-\nu)\{\bar{Z}[y_h - \phi q_z]+f\}} < 1$. The Full Information Contract specifies $e_l = Z_l = L_l = 0$ and for entrepreneurs with projects of high quality it specifies $e_h = e_h^*$, $Z_h = \bar{Z}$, $L_h = \phi q_z \bar{Z}$.

2.3.2 Asymmetric Information

The full information contract is not incentive compatible in the presence of asymmetric information when enforcement is sufficiently low. In this case, we show that the optimal contract prescribes that entrepreneurs with low productivity operate their technology in equilibrium in order to induce them to reveal their type. As enforcement diminishes, the ratio of low productivity to high productivity entrepreneurs technologies being operated increase.

Low quality entrepreneurs have incentives to reveal their type under the full information contract if

$$w \geq e_h^* q_z \frac{A_l}{A_h}(1-\phi)\bar{z} + (1-e_h^*)w.$$

The pay off for lying is a weighted average of two terms: the profit from operating the project and the wage rate. It is easy to see that lying is not optimal if the wage rate is higher than the profits to be made by operating the production technology, that is, $w \geq q_z \frac{A_l}{A_h}(1-\phi)\bar{z}.$ Notice that, for fixed prices, the RHS of this inequality is decreasing in the enforcement parameter $\phi.$ In general equilibrium, as shown in Proposition 3.3, an increase in enforcement ϕ leads to an increase in the wage rate w and a decrease in the price of intermediate goods $q_z.$ The changes in relative prices associated with an increase in enforcement thus further reduce the incentives of low quality entrepreneurs to lie. As a result, we later show that, in general equilibrium, there exists $\phi^* \in (0,1)$ such that the full information contract is incentive compatible if and only if $\phi \geq \phi^*$ (see Proposition 3.3 below).

We now turn to the characterization of the contract for economies with low enforcement ($\phi < \phi^*$); that is, for economies where the incentive compatibility constraint of low productivity entrepreneurs binds. Intuitively, the optimal contract should imitate as much as possible the full information contract. To this end, low productivity entrepreneurs are assigned the minimum possible resources so that they do not lie. This is done by allowing a fraction of low quality entrepreneurs to operate their technology $(e_l > 0)$.

We start by proving that entrepreneurial technologies are only operated at their maximum possible scale.

Lemma 2: In an optimal contract projects are only operated at its maximum scale of operation $\bar{z}$.

Proof. The proof that $z_h = \bar{z}$ in an optimal contract proceeds as in Lemma 1. We are going to assume, as a way of finding a contradiction that there exist an optimal contract $(z_h^1, L_h^1, e_h^1, z_l^1, L_l^1, e_l^1)$ with $z_h^1 < \bar{z}$. Then, we set an alternative contract with $z_h^2 = \bar{z}, e_h^2 = \frac{z_h^1 e_h^1}{\bar{z}} < e_h^1, L_h^2 = \frac{L_h^1 e_h^1}{e_h^2}$. From Lemma 1 we know that this contract 2 satisfies the enforcement and feasibility constraints (see proof of Lemma 1) and delivers higher consumption for high productivity entrepreneurs than contract 1. We only need to argue that contract 2 is incentive compatible for low productivity entrepreneurs. This is trivially so since $e_h^2 < e_h^1$ implies that the payoff for lying is lower under contract 2 than under contract 1 (the decrease in e_h relaxes the incentive compatibility constraint for low types).

Using a similar type of argument, it is easy to show that $e_l > 0$ implies $z_l = \bar{z}$.

Q.E.D.

We now focus on determining the amount that low productivity entrepreneurs are asked to repay when they operate their technology. To this end, lets express the repayment of low type entrepreneurs as $L_l = \chi q_z \bar{z}$, where $\chi \in [0, \varphi]$. The optimal choice of χ involves the following trade-off: On the one hand, increasing the payments by low productivity entrepreneurs, allows the coalition to raise more external funds and increase the number of entrepreneurs that are called to operate their technology. On the other hand, decreasing payments by low productivity entrepreneurs, improves the ratio of good to bad technologies in operation. In order to show this last point, we set the incentive compatibility constraint of low productivity entrepreneurs at equality and use the fact that in an optimal contract projects should be operated at its maximum scale and obtain

$$\frac{e_h}{e_l} = \frac{(1-\chi)q_z\bar{z} - w}{(1-\phi)\, q_z \frac{A_l}{A_h}\bar{z} - w}. \tag{2.37}$$

That the ratio of high to low productivity projects operated decreases with χ should be intuitive. This is because expected consumption of low productivity entrepreneurs *decreases* with the amount they are asked to pay and *increases* with the fraction of low productivity entrepreneurs that are called to operate their technology. Then, incentive compatibility requires than an increase in χ be associated with an increase in e_l, and thus, with a decrease in the ratio of high to low productivity projects that are operated.

In the next Lemma, we show that the aforementioned trade-off is resolved in favour of a corner solution: either $\chi = 0$ or $\chi = \phi$. The proof of the Lemma relies on the fact that the optimal contract can be expressed as a linear programming problem.

Lemma 3: *If $e_l > 0$, then either $L_l = 0$ or $L_l = \phi q_z \bar{z}$.*

Proof. By Lemma 2 we can set $Z_l = Z_h = \bar{z}$. By multiplying the enforcement constraint of agent i by e_i and defining $\hat{e}_i = e_i L_i$ we can express the optimal problem of the coalition as a linear programming problem in $(\hat{e}_l, \hat{e}_h, e_l, e_h)$:

$$\max \pi \left\{ q_z \widehat{Z} e_l - \widetilde{L}_l + (1 - e_l) w \right\} + (1 - \pi) \left\{ q_z \widehat{Z} e_h - \widetilde{L}_h + (1 - e_h) w \right\}$$

s.t.:

$$\begin{aligned}
\widetilde{L}_i &\leq \phi q_z \widehat{Z} e_i \\
q_z \widehat{Z} e_i - \widetilde{L}_i + (1 - e_i) w &\geq q_z \frac{A_i}{A_j} (1 - \phi) \widehat{Z} e_j + (1 - e_j) w \\
v(y_l \widehat{Z} + f) e_l + (1 - \pi)(y_h \widehat{Z} + f) e_h &\leq \pi \widetilde{L}_l + (1 - \pi) \widetilde{L}_h + \eta. \\
0 &\leq e_i \leq 1; \widetilde{L}_i \geq 0.
\end{aligned}$$

Notice that $e_l > 0$ only if the incentive compatibility of low types binds. The enforcement constraint of high type and the feasibility constraint also bind (since $q_z > y_h$). As a result we have three equations to be satisfied. The linearity of the constraints and objective function implies that either $\widetilde{L}_l = 0$ or $\phi q_z \widehat{Z} e_l$. We then have four linear equations in four unknowns.

Q.E.D.

The fraction of low projects operated in equilibrium is obtained by combining feasibility, payment constraints ($L_l = \chi q_z \widehat{Z}$ and $L_h = \phi q_z \widehat{Z}$); and the incentive compatibility constraint for low productivity entrepreneurs (at equality):

$$e_l = \frac{\eta}{\pi \left\{ (y_l - \chi q_z) \widehat{Z} + f \right\} + (1 - \pi) \left\{ (y_h - \phi q_z) \widehat{Z} + f \right\} \left(\frac{(1 - \chi) q_z \widehat{Z} - w}{(1 - \phi) \left(q_z \frac{A_l}{A_h} \widehat{Z} - w \right)} \right)}. \quad (2.38)$$

We can now state the following proposition.

Proposition 2: Assume that the incentive compatibility constraint for entrepreneurs with low productivity binds (that is, $w < q_z \frac{A_l}{A_h}(1 - \phi)\rho$). Then, the optimal contract specifies that e_l and e_h are positive and given by equations 2.38 and 2.37, respectively. Moreover, if the low productivity technology is profitable ($(q_z - y_l) \ast \rho - f > w$), then low productivity entrepreneurs are required to transfer a fraction ϕ of their output to the coalition by the end of the period ($\chi = \phi$). On the other hand, if the low productivity technology is not profitable ($(q_z - y_l) \ast \rho - f < w$), then low productivity entrepreneurs are not required to make a transfer to the coalition at the end of the period ($\chi = 0$).

Proof. See appendix.

We say that the low productivity technology is profitable when the profits from operating this technology are higher than the opportunity cost of the entrepreneur's time, that is, $\rho(q_z - y_l) - f \geq w$. Proposition 2 shows that when the low productivity technology is profitable it is optimal to set $\chi = \phi$ so that the numbers of projects in operation is maximized (even if this involves a decrease in the average productivity of the technologies in operation). On the contrary, when the low productivity technology is not profitable it is optimal to set $\chi = 0$ in order to maximize the average productivity of the technologies in operation (even if this comes at the cost of reducing the number for projects in operation).

It is worth noticing that, for fixed prices, an increase in enforcement leads to an increase in the ratio of good to bad projects being operated (see equation 2.37). In the next section of the paper we show that this effect is amplified in general equilibrium. In fact, an increase in the level of enforcement induces price changes that further increase the incentives to operate high productivity technologies relative to low productivity technologies.

2.4 General Equilibrium Implications of CMI

In this section we study how limited enforcement affects equilibrium allocations in the presence of asymmetric information. We show that in general equilibrium the way to provide incentives for low productivity entrepreneurs to reveal their type crucially depends on the level of enforcement (ϕ): In particular, the low productivity technology is operated only if enforcement is sufficiently low. Moreover, when enforcement is sufficiently low, entrepreneurs are able to extract rents from the factors of production that they hire so that all entrepreneurs are better off by joining a coalition. The analysis focuses in steady state equilibria and consists in a comparative statics exercise.

In order to obtain some analytical results we assume that capital fully depreciates in a period $(\delta = 1)$: Moreover, we consider economies with only one industry in the intermediate goods sector $(n = 1)$ and that the fixed cost $f = 0$: In the next section, we consider cross-industry implications of limited enforcement. To this end we consider an economy that has more than one industry in the intermediate goods sector and these industries differ in the magnitude of the fixed cost f:

We define entrepreneurial rents as the ex-ante profits (net of the opportunity costs of entrepreneurs' time)

$$\pi \equiv (1 - \nu)e_h \left[(q_z - y_h)^{\frac{1}{2}} - w \right] + \nu e_l \left[(q_z - y_l)^{\frac{1}{2}} - w \right] :$$

In equilibrium, intermediate goods are produced only if entrepreneurial rents are non-negative ($\pi \geq 0$). In Proposition 3.1 we find conditions so that, in general equilibrium, entrepreneurial rents are equal to zero when enforcement is sufficiently high. In this case, high quality entrepreneurs are indifferent about whether to operate their technology or not and low quality entrepreneurs strictly prefer to work instead of operating their technology (since $y_l > y_h$).

The intuition behind Proposition 3.1 is quite straightforward. When enforcement is sufficiently high (ϕ is close to 1) the aggregate supply of intermediate goods is not limited by enforcement problems since, in this case, high productivity entrepreneurs can commit to repay the resources they need for funding production. To understand this observation the reader should bear in mind that a necessary condition for positive production of intermediate goods is that $q_z > y_h$ (that is, the price should be higher than the marginal cost of production in order to make up for the opportunity cost of entrepreneurial time). This implies $\phi q_z > y_h$ for ϕ close to 1, which means that entrepreneurs can commit to repay the costs of increasing the scale of project operation. If the maximum scale of production $\bar{z}$ were large enough for high quality entrepreneurs to be able to produce more than the equilibrium quantity of intermediate goods, then a necessary condition for the market of intermediate goods to clear would be that only a fraction less than 1 of high quality entrepreneurs operate their technology ($e_h < 1$). In equilibrium this can only happen if high quality entrepreneurs are indifferent about whether to operate or not their technology, that is, if $(q_z - y_h)\bar{z} - w = 0$. In this case, the low productivity technologies are not profitable $(q_z - y_l)\bar{z} - w < 0$ so that $e_l = 0$ and entrepreneurial rents are equal to 0 ($\pi = 0$).

Proposition 3.1: Let $\bar{\lambda} \geq z^{*}\frac{(1+2\mu_e)}{(1-\nu)\mu_e}$, where z^{*} is defined in equation below. Then, the low productivity technology is not used when enforcement is sufficiently high ($\phi = 1$) and entrepreneurial rents are equal to zero.

Proof.

We restrict parameters in our economy so that a fraction strictly less than 1 of high quality entrepreneurs operate their technology when $\phi = 1$. This requires equilibrium prices to satisfy $w = (q_z - y_h)\bar{\lambda}$. Using firms' FOC and the consumers' Euler equation (together with $\delta = 1$), we can express this equation as a single equation in the ratio of intermediate goods to labor in the final goods sector.[42] Denote by z^{*} the solution to this equation.

Then, the quantity of intermediate goods is bounded above by $Z^{*} = z^{*}(1 + 2\mu_e)$ (since aggregate labor in the economy is less than $1 + 2\mu_e$). Setting $\bar{\lambda}$ large enough so that $(1-\nu)\mu_e\bar{\lambda} > Z^{*}$, guarantees that only a fraction less than one of high quality entrepreneurs operate their technology in equilibrium. If $w < (q_z - y_h)\bar{\lambda}$, then the aggregate supply of intermediate goods would be at least $\mu_e(1-\nu)\bar{\lambda}$ (and even higher if low quality entrepreneurs choose to operate their technology). Since this amount is bigger than Z^{*}, the market will not clear. Then, for the market to clear it is necessary that $w = (q_z - y_h)\bar{\lambda}$. In this case, entrepreneurs are indifferent about whether to join a coalition or not. In equilibrium, the number of entrepreneurs joining coalitions is determined so that the market for intermediate goods clear.

42 Using firms' FOC and households Euler equation we can obtain $w = \frac{(1-\alpha)}{\alpha}k$, $q_z = \frac{k^{\mu}}{\beta\alpha(1-\mu)z}$, $r = 1/\beta = \alpha(1-\mu)k^{\alpha(1-\mu)-1}z^{\mu}$, where k and z denote the capital to labor and the intermediate goods to labor ratios in the final goods sector. Then, y_h can be written as $y_h = \frac{1}{\alpha A_h^{\beta\alpha}}k^{1-\alpha}$. Combining the expressions just obtained for w, q_z, and y_h, the equation $w = (q_z - y_h)\bar{\lambda}$ can be expressed as an equation in a single unknown (z).

By continuity, the above argument holds for ϕ close to $1.$

Q.E.D.

In the next proposition, we find a restriction in the parameter space such that when enforcement is low enough (ϕ close to 0); the low productivity technology is used in equilibrium. This condition states a lower bound in the share of intermediate goods in the production function. Intuitively, as the importance of intermediate goods in the production function rises (μ increases), intermediate goods become more valuable. When enforcement is low (ϕ is close to 0) and intermediate goods are scarce (μ sufficiently high), the price of intermediate goods may be high enough to encourage low productivity entrepreneurs to operate their technology. In this case, entrepreneurial rents are positive and all entrepreneurs join coalitions.

Proposition 3.2: *Suppose $\mu > \mu^* = \frac{(1-\alpha)A_h\mu_e}{(1-\alpha)A_h\mu_e + A_l}$. Then, when enforcement is sufficiently low, the low productivity technology is operated in equilibrium and entrepreneurial rents are positive.*

Proof. We proceed by contradiction and assume that low quality entrepreneurs do not operate their technology ($e_l = 0$) when $\phi = 0$. This requires that $w > q_z \frac{A_l}{A_h}\hat{\varepsilon}.$ Using the firms' FOC and the consumers' Euler equation, this condition can be written as $\frac{(1-\mu)}{\mu}(1-\alpha)z > \frac{A_l}{A_h}\hat{\varepsilon}$, where z denotes the ratio of intermediate goods to labor in the final goods sector. Notice that z is bounded above by $\mu_e\hat{\varepsilon}$ (since total production of Z is bounded above by $\mu_e\hat{\varepsilon}$ and the total number of workers is bounded below by 1). As a result, we can write $\frac{(1-\mu)}{\mu}(1-\alpha)\mu_e\bar{z} > \frac{(1-\mu)}{\mu}(1-\alpha)z > \frac{A_l}{A_h}\bar{z}$. These inequalities imply that $\mu < \frac{(1-\alpha)A_h\mu_e}{(1-\alpha)A_h\mu_e+A_l}$, which contradicts our initial assumption that $\mu > \mu^* = \frac{(1-\alpha)A_h\mu_e}{(1-\alpha)A_h\mu_e+A_l}$. As a result, we conclude that $e_l > 0$. Since $y_l > y_h$, it is easy to see that entrepreneurial rents π are positive. By continuity, we can extend this argument to ϕ close to 0.

Q.E.D.

In the next proposition, we show that there exist a threshold enforcement level ϕ^* so that the incentive compatibility constraint for low productivity entrepreneurs binds for economies with $\phi < \phi^*$ and does not bind otherwise. It then follows from Proposition 2 that low productivity technologies are operated in economies with $\phi < \phi^*$. We also show that there is a threshold level of enforcement ϕ^{**} such that the enforcement constraint does not bind for $\phi > \phi^{**}$ and binds for $\phi < \phi^{**}$. Moreover, we find restrictions in the parameters so that $\phi^{**} > \phi^*$. It follows that when $\phi > \phi^{**}$, neither the incentive compatibility nor the enforcement constraint bind. As a result, equilibrium allocations are not affected by ϕ (as long as $\phi > \phi^{**}$) and entrepreneurial rents are equal to 0. When $\phi = \phi^{**}$ the enforcement constraint binds and so a small decrease in ϕ leads to a reduction in the aggregate supply of intermediate goods. The prize of intermediate goods increases so that the market for intermediate goods clears and entrepreneurial rents become positive. As ϕ decreases, prices of intermediate goods increase and the wage rate decrease. This general equilibrium prize effects increase the reward from operating a technology relative to becoming a worker. It should then be intuitive that there exists ϕ^* such that for economies with $\phi < \phi^*$ the incentive compatibility constraint of low productivity entrepreneurs binds.

Proposition 3.3: Suppose $\mu > \mu^* = \frac{(1-\alpha)A_h\mu_e}{(1-\alpha)A_h\mu_e + A_l}$, $\rho \geq z^* \frac{(1-\nu)\mu_e}{(1+2\mu_e)}$, and $\frac{A_h}{A_l} > 1 + \frac{1}{(1-\nu)}$. Then, there exist two threshold levels of enforcement ϕ^{**} and ϕ^*, with $\phi^* < \phi^{**}$ such that : i) when $\phi \geq \phi^{**}$ the low productivity technology is not used in equilibrium and entrepreneurial rents are equal to 0, ii) when $\phi^{**} > \phi \geq \phi^*$ the low productivity technology is not used in equilibrium and entrepreneurial rents are positive, iii) when $\phi < \phi^*$ the low productivity technology is used in equilibrium and entrepreneurial rents are positive. Moreover, $\frac{\partial e_h}{\partial \phi} \geq 0$, $\frac{\partial w}{\partial \phi} \geq 0$, $\frac{\partial q_z}{\partial \phi} \leq 0$, $\frac{\partial k}{\partial \phi} \geq 0$, $\frac{\partial \eta}{\partial \phi} \geq 0$, $\frac{\partial y_h}{\partial \phi} > 0$, $\frac{\partial e_h/e_l}{\partial \phi} \geq 0$ (all the inequalities are strict if $\phi < \phi^*$).

Proof. See appendix.

It is interesting that low productivity entrepreneurs may operate their technology even when their operation is not profitable. This happens when the revenue from operating the project net of operating costs is not sufficient to cover the opportunity cost of entrepreneurs' time $\rho(q_z - y_l) < w$. In this case, low productivity entrepreneurs decide to operate their technology because they are being subsidized by high productivity entrepreneurs. Subsidies minimize the amount of resources transferred to inefficient entrepreneurs by providing them incentives to reveal their type truthfully. As enforcement decreases, entrepreneurial profits increase since the price of intermediate goods increases and the wage rate decreases. Under the conditions stated in Proposition 3.2, low productivity entrepreneurs make positive profits when the enforcement level is sufficiently close to zero.

In Proposition 3.3 we consider the parameter restriction $\frac{A_h}{A_l} > 1 + \frac{1}{(1-\nu)}$ that implies $\phi^{**} > \phi^*$. On the contrary, when $\frac{A_h}{A_l} < 1 + \frac{1}{(1-\nu)}$, we have that $\phi^{**} < \phi^*$. In this case, the threshold level of enforcement for which the incentive compatibility constraint starts binding is higher than the one for which the enforcement constraint binds. Then, when $Á > Á^{¤}$ high productivity entrepreneurs make zero pro ts and entrepreneurs are indifferent between joining a coalition or not (otherwise, the supply of intermediate goods would increase since it is not constrain by enforcement problems). As long as $Á > Á^{¤}$; equilibrium prices do not depend on the value of $Á$ and low productivity entrepreneurs become workers. When $Á < Á^{¤}$, the incentive compatibility for low productivity entrepreneur binds. Proposition 2 implies that a fraction of low productivity entrepreneurs operate their technology. Since at $Á = Á^{¤}$ high productivity entrepreneurs make zero pro ts, it follows that low productivity entrepreneurs make negative pro ts for $Á$ close to $Á^{¤}$: In this case, low productivity entrepreneurs need to be subsidized in order to operate their technologies. If high productivity entrepreneurs make zero pro ts, they would not be able to subsidize low productivity entrepreneurs. Thus, when $Á$ decreases below $Á^{¤}$ prices of intermediate goods increase so that high productivity entrepreneurs can make pro ts in order to nance subsidies to the low productivity entrepreneurs. The coalition as a whole does not extract economic rents since the pro ts from high productivity entrepreneurs are transferred to low productivity entrepreneurs. Notice that economic rents can not be positive when the enforcement constraint does not bind. Otherwise, entrepreneurs would not be indifferent about whether to join the Coalition or not and the market for intermediate goods would not clear. When $Á < Á^{¤¤}$, the enforcement constraint binds and entrepreneurial rents are strictly positive.

2.4.1 Cross-industry Productivity Differences

In this section we show that our framework with capital market imperfections can rationalize some important observations discussed in the economic development literature. Since the work of Kuznets (1966), it is well known that developing countries are characterized by substantial differences in labor productivity (output per worker) across sectors. Poor countries, paradoxically, tend to employ a large fraction of their labor force in sectors with low productivity. In a study of sub-Saharan African countries, Van Biesebroeck (2003) reports that the share of GDP generated by the manufacturing industry is invariably higher than the share of the labor force it employs. In fact, the share of manufacturing in aggregate employment is typically below 10% despite the fact that labor productivity in this industry is often ve times higher than in services and agriculture. Restuccia et al. (2003) document that labor productivity differences in agriculture across countries are several orders of magnitude larger than those for non-agriculture. They report that while the GDP per worker of the richest countries in roughly 30 times the GDP per worker of the poorest countries, non-agricultural labor productivity differences are only a factor of 8 and agricultural labor productivity differences are of a factor of more than 100. Poor countries allocate 90% of their labor force to agriculture, compared to 5% in the richest countries. Similarly, Golin et al. (2002) argue that understanding the low productivity and high labor share in agriculture (relative to non-agriculture) in poor countries is central for understanding economic development. In a recent paper, Hsieh and Klenow (2002) argue that poor countries are also characterized by low ef ciency in the production of investment goods, which lead to a high relative price of capital and a low real investment rate.

In our economy, capital market imperfections can lead to large productivity differences across sectors and to the allocation of a large fraction of productive resources to industries with low productivity. When enforcement is sufficiently high, labor productivity does not differ across sectors. As the level of enforcement decreases, productivity decreases in all sectors in the economy in a non-uniform way. Capital market imperfections negatively affect the efficiency with which capital and labor are combined in the intermediate goods industries due to bad entrepreneurial selection. As intermediate goods become scarce, their price in terms of consumption goods increase. Changes in relative prices increase the value added per worker in the intermediate goods industries relative to other sectors in the economy. The low quantity and high price of intermediate goods reduce labor productivity in the final goods sector. In fact, the final goods sector is the least productive sector in poor countries, despite our assumption that it is not directly affected by capital market imperfections. Though productivity in the intermediate goods industries is relatively high, these industries employ a low fraction of productive resources due to enforcement problems.

Rajan and Zingales (1998) provide evidence that capital market imperfections affect industries differently. Their starting point is that industries differ in their needs of external funds. These needs are determined by the cash flows of the industry, which are likely to be determined by technological reasons. For instance, because the pharmaceutical industry requires large initial investments, it is much more dependent on external financing than the average industry in the economy. Rajan and Zingales then argue that if financial development is important for economic development, it should then be the case that low levels of financial development affect more negatively those industries that depend heavily on external financing than the average industry in the economy. Rajan and Zingales test this hypothesis in the data and found that it could not be rejected.

Motivated by the findings of Rajan and Zingales, we assume that intermediate goods industries differ in the fixed operating cost and, thus, in their needs of external financing. Because we can not obtain analytical results, we use some numerical examples to illustrate the cross industry implications of capital market imperfections for the allocation of resources, relative prices, value added per worker, and total factor productivity. A quantitative analysis (together with the development of a suitable model for calibration) is left for future research.

Numerical Example. We consider a model economy with two intermediate goods sectors $(n = 2)$. We assume that the second sector requires a higher amount of fixed expenditures than the first sector. As a result, the second sector is more reliant on external funding than the first sector. The model period is set to 25 years. The depreciation rate δ is set at 1; the discount factor is such that $\beta = .95^{25}$; the capital share is equal to $1/3$, and the measure of entrepreneurs $\mu^e = .10$. The fixed cost parameters f_1 and f_2 are set at 0 and 20, respectively. The maximum scale of operation $\bar{2} = 100$. The productivity parameters are set to satisfy $A_y = A_l = 1 < A_h = 3$ and the fraction of high productivity entrepreneurs $\pi = .10$. Finally, the parameters a_1 and a_2, representing input weights in the aggregator for intermediate goods, are set so that: $a_1 = a_2 = 1/2$. We compute steady state equilibrium for economies with $\phi = 1, .8, .4, .0$. In Table 1 we present statistics for economies with a unitary elasticity of substitution between intermediate goods in the final goods sector ($\rho = 0$). Tables 2 and 3 present statistics for economies in which intermediate goods are "good" ($\rho = .5$) and "poor" ($\rho = -.5$) substitutes in production, respectively.

[Insert Table 1]

In all examples considered, Sector 2 is characterized by high xed costs. Consequently, in the absence of nancial market frictions ($\phi = 1$); Sector 2 relies more heavily on external nancing than Sector 1. In our rst example, the ratio of external funds to internal funds is equal to 12.1 and 5.2 for Sectors 2 and 1, respectively. Since the reader may consider these values as high, we emphasize that in our view both equity and bank loans should be considered as a source of external nance. We think that internal funds represent the stake of the owners who control the business. It is also important to recognize that the amount of external funds that rms raise represents both supply and demand conditions. In our theory, the "technological demand" for external funds can be obtained as the external funds in the frictionless economy ($\phi = 1$). As enforcement decreases, however, the amount of external nancing is determined by the supply of funds rather than by the demand side. Table 1 shows that when external nancing is constrained by enforcement problems, the ratio of external to internal funds is about the same across sectors (see statistics for economies with $\phi = .8; .4; .0$): Since entrepreneurs in the two sectors have the same networth, the supply of funds is basically determined by the value of the output they produce (since a fraction ϕ of output can be used as collateral for loans). Since Table 1 considers an example with a Cobb-Douglas technology (where intermediate goods have the same share in the production function), we obtain that both sectors are able to raise the same amount of external funds. Thus, in the presence of financial market frictions, Sector 2 does not rely more on external funds than Sector 1.

Table 1 presents statistics on productivity across sectors and economies. We consider two measures of productivity: labor productivity and total factor productivity. Labor productivity is measured as value added per worker. Total factor productivity is computed as the ratio between value added and an index of a composite factor given by $K^{\alpha}N^{1-\alpha}$. We find that a decrease in enforcement decreases productivity in all industries, though not uniformly. When capital markets function perfectly $(\phi = 1)$, there are no productivity differences across sectors. When enforcement is imperfect, however, productivity differs substantially across sectors. In this case, productivity is at the lowest in the final goods sector. Productivity is low in this sector due to the low production of intermediate goods, which negatively affect the efficiency with which capital and labor factors are combined to produce output. The intermediate goods sector exhibits low productivity in the presence of imperfect enforcement, in turn, because of bad entrepreneurial selection. Indeed, high productivity projects represent 100% of the projects operated under perfect enforcement but they are only 25% of the projects operated under low levels of enforcement. Bad entrepreneurial selection translates into low measured productivity despite the fact that output prices increase for both intermediate goods industries.

Changes in enforcement leads to important variations in relative prices which have consequences for cross-industry productivity differences. Limited enforcement affects the amount of resources used in the production of intermediate goods and the efficiency with which these resources are combined (poor entrepreneurial selection). These two effects translate into a low production of intermediate goods. As a result, intermediate goods become relatively scarce and their market clearing prices become high. High intermediate goods prices, ceteris paribus, increase value added and measured productivity in the intermediate goods industries. On the other hand, higher input prices decrease the value added and productivity in the final goods industry.

It is interesting that, if we interpret the agricultural sector as being part of the final goods sector, our findings provide a rationale for the observations made in Restuccia et. at. (2003). These authors find that the low agricultural productivity in poor countries is explained by low use of intermediate goods (such as pesticides, chemical fertilizers, fuel, among others). They also document that prices of intermediate goods are relatively high in poor countries. They calibrate a two sector growth model with an explicit agricultural sector and find that cross-country differences in relative price play an important role in understanding cross-country differences in the use of intermediate goods and, thus, in agricultural productivity. Interestingly, they find that "barriers to labor mobility" are needed in order to explain the high employment share of agriculture in poor countries. Our findings points that capital market imperfections may well be at the origin of these barriers. We find that the share of the final goods industry in employment is relatively high in the presence of low levels of enforcement, despite that this industry has the lowest labor productivity across sectors in the economy (see Table 1). Capital market imperfections do not allow resources to be shifted to the intermediate goods sector.

In our economy, imperfect enforcement also affects relative productivity across intermediate goods industries in non trivial ways. The sign of these effects depend on how intermediate goods enter into the production function and, in particular, their elasticity of substitution. In Table 1 a unitary elasticity of substitution is assumed. In this case, the presence of high fixed production costs in Sector 2 make external financing problems particularly severe in this industry. As a result, goods produced in Sector 2 become relatively more scarce than goods produced in Sector 1 and the ratio of output prices moves accordingly. In Table 2, we consider an example in which intermediate goods are better substitutes than in the benchmark economy (we set $\rho = .5$ instead of $\rho = 0$): Relative to the results in Table 1, a decrease in enforcement is associated with an increase in the rate of substitution of intermediate good 1 for intermediate good 2. Since the value of output in industry 1 rises relative to industry 2 as enforcement decreases, industry 1 is able to rely more on external funding than industry 2 when capital markets are imperfect. Despite the fact that the "technological needs" for external funds is higher in industry 2, industry 1 is able to borrow more because it faces a higher demand for its output. In Table 3, we consider an example where intermediate goods are "poor" substitutes in production (relative to the benchmark case $\rho = 0$ in Table 1). As a result, a decrease in enforcement leads to large increases in the relative price of the second intermediate good. When enforcement is imperfect, labor productivity is substantially higher in Sector 2 than in the other industries in the economy due to the high relative price of intermediate good 2.

It is interesting that our theory can provide some insights about the low real investment rates in poor countries. In a recent paper, Hsieh and Klenow (2002) argue that poor countries have low real investment rates because they are plagued with low efficiency in the production of investment goods, which lead to a high relative price of capital and a low real investment rate. If we extend our model to include an investment sector that relies heavily on external financing and is subject to capital market imperfections, then the relative price of investment would be high in poor countries. Interestingly, Rajan and Zingales (1998) find that Machinery ranks among the most highly dependent industries on external financing.

[Insert Tables 2 and 3]

2.4.2 Taxation and CMI

In a well known paper, Easterly and Rebelo (1993) find that the cross country evidence does not support the contention that taxation has significant negative effects on economic activity, in stark contrast with the implications of standard growth theory. In this section, we stress that our theory offers a potential rationale for reconciling the tax implications of economic theory with the empirical evidence. We show the effects of taxes vary greatly across economies that differ in the development of the capital markets. In our framework, in particular, the negative effect of labor income taxation on economic activity is much higher when the level of enforcement is relatively low. We conclude that abstracting from capital market imperfections may thus prove misleading in studying fiscal policy issues. It also suggests that empirical studies based on cross country regression analysis may face an omitted variable problem when neglecting capital market institutions.

Numerical Example: We compare the effects of taxation across two economies that differ in the level of enforcement. In the first economy, enforcement is perfect (Á = 1) while in the second economy there is no enforcement (Á = 0): We compare the effects of a labor tax of 30% (the revenue is rebated to households) and a subsidy to the hiring of capital and labor services of 30% financed with consumption taxes (the tax rate on consumption that equates the government budget is equal to 33%). We find that while the labor income tax has no effects on aggregate output in an economy with perfect enforcement (Á = 1); it decreases output by 40% in the economy with no enforcement. The intuition for this result is quite simple. A labor income tax decreases the net worth that entrepreneurs accumulate. If capital markets are perfect, this has no negative effect on output because internal funds can be substituted with external funds. When capital markets are imperfect and entrepreneurs are self-financed, the decrease in net worth has a large negative impact in the production of intermediate goods and, thus, on output.

It is interesting that in our framework consumption and labor taxes work quite differently. It has been stressed in the public finance literature that tax systems based on consumption or labor income taxation are essentially equivalent since these taxes affect the same consumption-leisure choice margin (Erosa and Gervais (2002)). This equivalency, however, does not hold in the presence of capital market imperfections. Since income taxes negatively affect wealth accumulation, and since entrepreneurial net worth is an important determinant of economic activity when capital markets are imperfect, it follows that income taxation can be quite distortionary when capital markets do not function well.

Table 4 also shows that if a consumption tax is used to finance subsidies to capital and labor services, then output increases by 22% in the economy with perfect capital markets and by 360% when there is no enforcement. Due to the increase in the wage rate associated with the increase demand for labor, this policy leads to a higher accumulation of entrepreneurial net worth. Interestingly, by combining a consumption tax with a subsidy to inputs, the policy considered is effectively a tax on entrepreneurial rents which decrease from 26% to 20% of GDP.

[Insert Table 4]

Discussion: We would like to stress that there are many plausible explanations for why the strong connection between tax and growth implied by economic theory is not born out in the data. Easterly and Rebelo (1993) discuss some of the econometric issues that arise in trying to isolate this relationship empirically. We think that the endogeneity of tax policy should be a leading explanation. It is plausible that countries with bad enforcement have also dif culty in collecting taxes. Moreover, developed countries have more desire for public goods. We nevertheless think that our paper points to a classic omitted variable problem that may well be relevant. Poor countries may not only face a dif cult time collecting income taxes but it may also be the case that these taxes are quite distortionary when capital markets are imperfect.

2.5 Conclusion

This paper has developed a framework where capital market imperfections lead to use of inef cient technologies and allow entrepreneurs to extract economic rents from the factors of production hired. We have shown that countries where capital markets do not work well are characterized by cross-industry productivity differentials and by a large share of their productive resources allocated in industries with low productivity. Moreover, income taxation can be quite detrimental for economic activity in the presence of capital market imperfections.

We view our theory as related to Parente and Prescott's (1999, 2000) theory of monopoly unions of specialized input suppliers. Since the existence of economic rents provide incentives to workers to organize themselves as a union, capital market imperfections may be an important element in understanding in which industries the forces emphasized by Parente and Prescott will be more important.

2.6 Appendix

Proof of Proposition 2

As we previously showed, when the incentive compatibility constraint of low quality entrepreneurs binds, $e_l(\chi)$ is given by equation 2.38 and $e_h(\chi)$ is obtained from combining equations 2.37 and 2.38, where χ is the fraction of output that low types contract to repay at the end of the period. By Lemma 3 we know that χ is either equal to 0 or ϕ in an optimal contract. Denote by $c^e(\chi)$ the coalitions' consumption as a function of χ:

$$c^e(\chi) \equiv \nu[e_l(\chi)q_z^{\theta}(1-\chi) + (1-e_l(\chi))w] + (1-\nu)[e_h(\chi)q_z(1-\phi)^{\theta} + (1-e_h(\chi))w].$$

Then $\chi = \phi$ is optimal if and only if $c^e(\phi) \geq c^e(0)$. Using the expressions derived for $e_l(\chi)$ and $e_h(\chi)$ we obtain

$$c^e(\chi) = \frac{\eta v[q_z^{\theta}(1-\chi) - w] + \eta(1-\nu)[q_z^{\theta}(1-\phi) - w]\left(\frac{(1-\chi)q_z^{\theta} - w}{(1-\phi)\,q_z\frac{A_l}{A_h}^{\theta} - w}\right)}{\nu\{(y_l - \chi q_z)^{\theta} + f\} + (1-\nu)\{(y_h - \phi q_z)^{\theta} + f\}\left(\frac{(1-\chi)q_z^{\theta} - w}{(1-\phi)\,q_z\frac{A_l}{A_h}^{\theta} - w}\right)} + w \tag{2.39}$$

Defining $M \equiv \nu\{(y_l - \phi q_z)\lambda + f\} + (1-\nu)\{(y_h - \phi q_z)\lambda + f\}\left(\frac{(1-\phi)q_z\lambda - w}{(1-\phi)\, q_z \frac{A_l}{A_h}\lambda - w}\right)$ and $N \equiv \nu\{y_l\lambda + f\} + (1-\nu)\{(y_h - \phi q_z)\lambda + f\}\left(\frac{q_z\lambda - w}{(1-\phi)\, q_z \frac{A_l}{A_h}\lambda - w}\right)$; we obtain that $c^e(0) \leq c^e(\phi))$ if and only if

$$\left\{v(q_z\lambda - w) + (1-v)(q_z\lambda(1-\phi) - w)\left(\frac{q_z\lambda - w}{(1-\phi)\, q_z \frac{A_l}{A_h}\lambda - w}\right)\right\} M$$
$$- \left\{[q_z\lambda(1-\phi) - w]\left[\nu + (1-\nu)\left(\frac{(1-\phi)q_z\lambda - w}{(1-\phi)\, q_z \frac{A_l}{A_h}\lambda - w}\right)\right]\right\} N \leq 0;$$

which is equivalent to

$$\Big[(q_z\lambda - w)M - (q_z\lambda(1-\phi) - w)N\Big]\left[\nu + (1-\nu)\frac{(q_z\lambda(1-\phi) - w)}{((1-\phi)\, q_z \frac{A_l}{A_h}\lambda - w)}\right] \leq 0$$

Since $(q_z\lambda - w)M - (q_z\lambda(1-\phi) - w)N\} = \nu q_z \phi[\lambda(-q_z + y_l) + f + w]$; the previous inequality can be written as

$$\nu q_z \phi \Big[\lambda(-q_z + y_l) + f + w\Big]\left\{\nu + (1-\nu)\frac{(q_z\lambda(1-\phi) - w)}{((1-\phi)\, q_z \frac{A_l}{A_h}\lambda - w)}\right\} \leq 0 \qquad (2.40)$$

The sign of expression on the LHS of the above inequality is determined by the sign of the two terms in brackets. The second term in brackets is positive since $w < (1-\phi)\, q_z \frac{A_l}{A_h}\lambda < (1-\phi)q_z\lambda$ (the first inequality follows from the assumption that the incentive compatibility of low quality entrepreneurs bind). It then follows that $c^e(0) \leq c^e(\phi)$ if an only if

$$\lambda(q_z - y_l) - w - f \geq 0. \qquad (2.41)$$

This condition says that the revenue from operating low quality projects (net of operating costs) should be higher than the opportunity cost of entrepreneurs' time. We thus conclude that it is optimal to set $\hat{\chi} = \phi$ if it is profitable for the coalition to operate low quality projects. On the other hand, if $w > \lambda(q_z - y_l) - f$ it is optimal to set $\hat{\chi} = 0$. Thus, when the parameter region is such that $\lambda(q_z - y_l) - f < w < (1 - \phi)\, q_z \frac{A_l}{A_h}\lambda$ is optimal to set $e_l = e_l(0) > 0$ and $\chi = 0$.

Q.E.D.

Proof of Proposition 3.2.

Step 1. Using the arguments developed in Propositions 3.1 and 3.2 and exploiting continuity of our equilibrium conditions, we can apply the Intermediate Value Theorem (I.V.T.) to argue that there exist a level of enforcement ϕ^{*} such that in the steady state equilibrium of the economy with $\phi = \phi^{**}$ low productivity entrepreneurs are indifferent between lying or telling the truth. We can also apply the I.V.T. to argue that there exists a level of enforcement ϕ^{**} so that in equilibrium the enforcement constraint of high quality entrepreneurs does not bind.

Step 2. We show that if $\frac{A_h}{A_l} > 1 + \frac{1}{\beta(1-\gamma)}$, then $\phi^{*} < \phi^{**}$. Consider the economy with $\phi = 1$. Proposition 3.1 implies that in this economy, prices are such that $(q_z - y_h)\lambda = w$. Since in the economy with $\phi = 1$ neither the enforcement constraint nor the IC constraint bind, a small reduction in ϕ does not change equilibrium prices. At these prices, the values of ϕ at which the enforcement and incentive compatibility constraint bind are given by $\phi^{**} = \frac{y_h}{q_z} - \frac{\eta}{(1-\gamma)\lambda q_z}$ and $\phi^{*} = 1 - \frac{wA_h}{q_z A_l \lambda}$, respectively. Using $w = \eta/\beta$ and $(q_z - y_h)\lambda = w$, we can obtain $\phi^{*} - \phi^{**} = \frac{(q_z - y_h)}{q_z}\left(1 + \frac{1}{\beta(1-\gamma)} - \frac{A_h}{A_l}\right)$ from which the desired result follows. Notice, that equilibrium prices do not change with ϕ for $\phi \geq \phi^{**}$. For $\phi < \phi^{**}$, a small change in ϕ affects prices.

Step 3. We show that an increase in ϕ leads to an increase in the aggregate production of intermediate goods.

Suppose that, as a way of finding a contradiction, a marginal increase in ϕ leads to a decrease in aggregate production of intermediate goods. A decrease in Z is associated with an increase in the aggregate labor supply (because there is a rise in the number of entrepreneurs working) so that the intermediate good to labor ratio $z = Z/L$ declines. Steady state equilibrium conditions imply that the decline in z is associated with a decline in k.[43] We now study how relative prices change with the decline in z. From consumers' and firms' FOC we obtain the following equilibrium conditions $w = \frac{(1-\alpha)k}{\alpha\beta}$, $q_z = \frac{k^{\mu}}{\beta\alpha(1-\mu)z}$, $y_h = \frac{k^{1-\alpha}}{\alpha A_h \beta}$, $\eta = w/\beta$. Taking logs and differentiating w.r.t ϕ and denoting by g the rate of change of wages we obtain

$$g = \frac{\dot{\eta}}{\eta} = \frac{\dot{w}}{w} = \frac{\dot{k}}{k} < \frac{\dot{y}_h}{y_h} = (1-\alpha)g < 0 < \frac{\dot{q}_z}{q_z}.$$

We now show that the changes in relative prices just described imply that the optimal fraction of high quality entrepreneurs operating projects (e_h) should increase, contradicting our initial assumption that aggregate production of Z has decrease. Consider that the economy was initially in a situation with $e_l = 0$ (so that $e_h = \frac{\eta/y_h}{(1-\gamma)\frac{1}{2}[1-\phi q_z/y_h]}$) and that there is a marginal increase in ϕ. In order to sign its effects on e_h we take logs and differentiating w.r.t. ϕ our formula for e_h and obtain

$$\begin{aligned}\frac{\dot{e}}{e} &= \frac{\dot{\eta}}{\eta} - \frac{\dot{y}_h}{y_h} + \frac{1}{1-\phi q/y_h}\left(\frac{q}{y_h} + \phi\frac{dq/y_h}{d\phi}\right) \\ &= \alpha g + \frac{1}{1-\phi q/y_h}\left(\frac{q}{y_h} + \phi\frac{dq/y_h}{d\phi}\right) > 0,\end{aligned}$$

since the second term is the product of two terms bigger than 1 and the first term is greater than -1 (notice that $g > -1$ since wages can not decrease by more than a 100% across

[43] This can be seen by differentiating the steady state equilibrium condition $r = 1/\beta = \alpha(1-\mu)k^{\alpha(1-\mu)-1}z^{\mu}$ with respect to ϕ.

steady states as ϕ increases). Thus, changes in relative prices are such that the optimal fraction of high quality entrepreneurs that operate projects increases. But this contradicts our initial assumption that the aggregate production of Z has decreased.

Step 4. Since an increase in ϕ implies an increase in e_h it is easy to see that the aggregate labor supply decreases and that the production of intermediate goods increases. As a result, z increases. Using consumers' and firms' FOC, we can obtain

$$
\begin{aligned}
0 &< g = \frac{\dot{\eta}}{\eta} = \frac{\dot{w}}{w} = \frac{\dot{k}}{k}; \\
\frac{\dot{q}_z}{q_z} &= \frac{(1-\mu)(\alpha-1)}{\mu} g < 0; \\
\frac{\dot{y}_h}{y_h} &= (1-\alpha) g; \\
\frac{\dot{z}}{z} &= \frac{1-(1-\mu)\alpha}{\mu} g.
\end{aligned}
$$

Step 5. Because at $\phi = \phi^*$ low type entrepreneurs are indifferent about reporting the truth, we know that in this economy $\frac{w}{q_z} = \frac{A_l}{A_h}(1-\phi^*)\mathbf{b}.$ It follows from $\frac{\partial w}{\partial \phi} > 0$ and $\frac{\partial q_z}{\partial \phi} < 0$ that $\frac{\partial w / q_z}{\partial \phi} > 0$ so that $\frac{w}{q_z} > \frac{A_l}{A_h}(1-\phi)\mathbf{b}$ for economies with $\phi > \phi^*$. As a result, the incentive compatibility constraint of low productivity entrepreneurs does not bind and $e_l = 0$ when $\phi > \phi^*$.

Step 6. Consider now economies where $\phi < \phi^*$. The ratio $\frac{e_h}{e_l}$ can be expressed as $\frac{e_h}{e_l} = \frac{(1-\phi)\mathbf{b} - R}{(1-\phi)\frac{A_l}{A_h}\mathbf{b} - R}$, where $R = \frac{w}{q_z}$.

Differentiating the ratio e_h/e_l w.r.t. ϕ we obtain that

$$\frac{\partial(e_h/e_l)}{\partial\phi} = \frac{(-\hat{\rho} - \frac{\partial R}{\partial\phi})[(1-\phi)\frac{A_l}{A_h}\hat{\rho} - R] - [(1-\phi)\hat{\rho} - R](-\frac{A_l}{A_h}\hat{\rho} - \frac{\partial R}{\partial\phi})}{((1-\phi)\frac{A_l}{A_h}\hat{\rho} - R)^2},$$

$$\frac{\partial(e_h/e_l)}{\partial\phi} = \frac{\left(\hat{\rho} R + \frac{\partial R}{\partial\phi}(1-\phi)\right)(1 - \frac{A_l}{A_h})}{((1-\phi)\frac{A_l}{A_h}\hat{\rho} - R)^2} > 0, \tag{2.42}$$

if $\frac{\partial R}{\partial\phi} > 0$. To see that $\frac{\partial R}{\partial\phi} > 0$, then consider a small increase in ϕ. Then, for fixed prices, equations (2.37) and (2.38) imply that the number of businesses being operated decreases. As a result, for fixed prices, the supply of intermediate goods decreases and the demand of labor decreases. In order for the markets to clear, q_z should increase and w should decrease, that is, R should increase.

Q.E.D.

Table 1 : Sectorial Statistics (Case ½ = 0)				
Enforcement Á	1	.8	.4	.0
Relative Prices				
q_1	.18	.23	.27	.34
q_2	.38	.45	.53	1.25
Output				
Z_1	.38	.17	.092	.026
Z_2	.18	.086	.047	.007
Ext: ¯nancing=Net worth				
Sector 1	5.2	1.2	1.1	.0
Sector 2	12.1	1.2	1.1	.0
Fraction of High Product: Entr:				
Sector 1	1	.631	.251	.250
Sector 2	1	.628	.250	.250
Value added per worker				
Final goods sector	.12	.066	.039	.008
Sector 1	.12	.072	.050	.036
Sector 2	.12	.078	.061	.114
TFP				
Final goods sector	.54	.36	.25	.08
Sector 1	.54	.39	.33	.40
Sector 2	.54	.43	.40	1.25
Aggregate Labor				
Final goods sector	.40	.42	.46	.78
Sector 1	.40	.38	.36	.17
Sector 2	.19	.20	.18	.05

Table 2 : Sectorial Statistics (Case ½ = :5)				
Enforcement Á	1	.8	.4	.0
Relative Prices				
q_1	.19	.25	.31	.48
q_2	.39	.42	.47	.89
Output				
Z_1	.48	.191	.102	.027
Z_2	.11	.072	.043	.008
Ext: ¯nancing=Net worth				
Sector 1	5.1	1.5	1.3	.0
Sector 2	11.5	1.0	0.8	.0
Fraction of High Product. Entr:				
Sector 1	1	.6317	.2506	.25
Sector 2	1	.6280	.2503	.25
Value added per worker				
Final goods sector	.13	.069	.042	.009
Sector 1	.13	.081	.058	.054
Sector 2	.13	.069	.052	.078
TFP				
Final goods sector	.57	.37	.27	.10
Sector 1	.57	.44	.37	.57
Sector 2	.57	.37	.33	.83
Aggregate Labor				
Final goods sector	0.37	0.41	0.45	.78
Sector 1	0.51	0.43	0.39	.17
Sector 2	0.12	0.16	0.16	.05

Table3 : Sectorial Statistics (Case ½ = ¡ :5)				
Enforcement Á	1	.8	.4	.0
Relative Prices				
q_1	.18	.21	.25	.20
q_2	.38	.47	.56	1.63
Output				
Z_1	.336	.157	.085	.025
Z_2	.203	.091	.050	0.006
Ext: ¯nancing=Net worth				
Sector 1	5.3	1.1	0.95	.0
Sector 2	12.4	1.4	1.2	.0
Fraction of High Product: Entr:				
Sector 1	1	.631	.25	.25
Sector 2	1	.629	.25	.25
Value added per worker				
Final goods sector	.117	.063	.038	.007
Sector 1	.117	.066	.046	.021
Sector 2	.117	.085	.066	.146
TFP				
Final goods sector	.53	.35	.25	.08
Sector 1	.53	.36	.30	.24
Sector 2	.53	.21	.44	1.7
Aggregate Labor				
Final goods sector	.42	.43	.47	.79
Sector 1	.36	.36	.33	.17
Sector 2	.22	.21	.20	.04

Table 4 : Taxation and CMI (case ½ = 0)						
Enforcement Á	Á = 1			Á = 0		
Tax System	No tax	¿ʷ = :3	Sub	No tax	¿ʷ = :3	Sub
GDP	.204	0.204	0.249	.0263	.0158	.0569
Relative Prices						
q_1	.18	0.18	0.18	.34	.35	.31
q_2	.38	0.38	0.38	1.25	1.78	.81
Output						
Z_1	.38	0.377	0.459	.26	.015	.061
Z_2	.18	0.179	0.218	.007	.003	.023
Aggregate Labor						
Final goods	.40	.40	.40	.78	.86	.65
Sector 1	.40	.40	.40	.17	.12	.26
Sector 2	.19	.19	.19	.05	.02	.10

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