FUNDAÇÃO GETULIO VARGAS
ESCOLA DE ECONOMIA DE SÃO PAULO

DIEGO DE SOUSA RODRIGUES

LIQUIDITY CONSTRAINTS AND COLLATERAL CRISES

SÃO PAULO
2018

DIEGO DE SOUSA RODRIGUES

LIQUIDITY CONSTRAINTS AND COLLATERAL CRISES

Dissertação apresentada à Escola de Economia de São Paulo da Fundação Getulio Vargas como requisito para obtenção do título de Mestre em Economia de Empresas

Campo de Conhecimento:
Macroeconomia e Mercados financeiros

Orientador: Prof. Dr. Bernardo Guimarães

SÃO PAULO

2018

Rodrigues, Diego de Sousa.
Liquidity constraints and collateral crises / Diego de Sousa Rodrigues. - 2018.
40 f.

Orientador: Bernardo Guimarães.
Dissertação (CMEE) - Escola de Economia de São Paulo.

1. Macroeconomia. 2. Mercado financeiro. 3. Securitização. 4. Liquidez (Economia). 5. Títulos (Finanças). I. Guimarães, Bernardo. II. Dissertação (CMEE) - Escola de Economia de São Paulo. III. Liquidity constraints and collateral crises.

CDU 336.76

Ficha catalográfica elaborada por: Isabele Oliveira dos Santos Garcia CRB SP-010191/O
Biblioteca Karl A. Boedecker da Fundação Getulio Vargas - SP

DIEGO DE SOUSA RODRIGUES

LIQUIDITY CONSTRAINTS AND COLLATERAL CRISES

Dissertação apresentada à Escola de Economia de São Paulo da Fundação Getulio Vargas como requisito para obtenção do título de Mestre em Economia de Empresas.

Campo de Conhecimento:
Macroeconomia e Mercados Financeiros

Data de Aprovação:
___/___/_____

Banca examinadora:

Prof. Dr. Bernardo Guimarães
FGV-EESP

Prof. Dr. Luis Araujo
FGV-EESP

Prof. Dr. Ricardo Cavalcanti
FGV-EPGE

AGRADECIMENTOS

Aos meu pais e ao meu irmão, sem o apoio deles não conseguiria ter completado mais essa jornada. Obrigado por sempre apoiarem as minhas decisões.

Agradecimentos especiais a todo apoio e suporte recebido do professor Luis Araujo durante a execução desse trabalho, sem a ajuda incomensurável dele não teria conseguido desenvolver esta dissertação. Agradeço por ele ter me recebido em Michigan e por todas as conversas que tivemos durante este período, conversas estas que me ajudaram a confirmar minha decisão de continuar pesquisando em Economia.

Ao meu orientador Bernardo Guimarães pela sabedoria em Economia, pelos questionamentos e por toda ajuda dada em minha decisão de prosseguir meus estudos no exterior. Sua preocupação com os alunos e humildade são fonte de inspiração.

Aos demais professores da EESP pelas aulas de excelente qualidade, em especial ao Tiago Cavalcanti.

Aos colegas de turma do mestrado e doutorado da EESP, em especial aos grandes amigos que fiz durante este período: Nicolas Borsoi, Maurício Barbosa e Victor Wong. Estudar com vocês tornou a trajetória mais fácil e divertida. Admiro imensamente a sabedoria de vocês em Economia e agradeço por tudo que consegui aprender com vocês durante este período, ver o tanto que vocês sabem de Macroeconomia e a preocupação em entender tudo da forma mais minuciosa possível é algo que levarei para a vida acadêmica que pretendo seguir. Obrigado pelas risadas, por compartilhar frustrações, pela ajuda nas inúmeras listas e pelas conversas sempre interessantes e relevantes.

Aos demais amigos e aos amigos que fiz durante meu período nos Estados Unidos, por tornar essa fase de aprendizado ainda mais divertida.

Aos funcionários da EESP pela solicitude e ajuda nas questões burocráticas.

Por fim agradeço à FAPESP por financiar essa dissertação através das bolsas de número 2016/02584-0 e 2017/06724-1. Agradeço também à CAPES for financiar o começo do meu mestrado.

ABSTRACT

Asset-backed securities were widely traded. Arguably, this happened because they were complicated claims, in the sense that it was very costly to assess their fundamental value. Here, we show that if this is the case, then the emergence of alternative ways to address liquidity needs, by undermining the liquidity role of these assets and reinforcing the relevance of their fundamental value, may increase the incentives to acquire information about them, and negatively impact the credit market. Hence, our results suggest that it is easier for these assets to accomplish the role of private money when there are fewer alternative ways to address liquidity needs.

Key-words: Macroeconomics: Production. Financial crises. Financial Markets and the Macroeconomy. Collateral. Asset-backed-securities. Financial constraints. Private money

RESUMO

Os títulos lastreados em ativos eram amplamente negociados. Provavelmente, isso aconteceu porque eram títulos complicadas, no sentido de que era muito custoso avaliar seu valor fundamental. Aqui, mostramos que, se este é o caso, então o surgimento de formas alternativas de atender às necessidades de liquidez, ao enfraquecer o papel de liquidez desses ativos e reforçar a relevância de seu valor fundamental, pode aumentar os incentivos para obter informações sobre eles e impactar negativamente o mercado de crédito. Portanto, nossos resultados sugerem que é mais fácil para esses ativos desempenharem o papel do dinheiro privado quando há menos formas alternativas de atender às necessidades de liquidez.

Palavras-chaves: Macroeconomia: Produção. Crises financeiras. Mercados Financeiros e Macroeconomia. Garantia. Títulos lastreados em ativos. Restrições financeiras. Dinheiro privado

List of Figures

Contents

1 Introduction

Asset-backed securities were extensively traded in the period leading up to the 2008 financial crisis. The demand for such assets was driven not only by their fundamental value but also for their liquidity role. In particular, Gorton & Ordonez (2013) argues asset-backed securities were needed as collateral due to a shortage of safer assets that could play this role [1]. In addition, Gorton & Ordoñez (2014) posits that these securities could perform as collateral because they were information-insensitive, i.e., due to their complexity it was very costly to acquire information about their fundamental value.

In this paper, we argue that, while it is true that information-insensitive assets can play a liquidity role, the fact that they play this role may reinforce their information insensitivity. Intuitively, one may have less incentives to acquire information about the fundamental value of an asset if the main reason for holding the asset comes from its liquidity role as collateral. We build on this argument to show that the emergence of alternative ways to address liquidity needs, by undermining the liquidity role of an asset and reinforcing the relevance of its fundamental value, may increase the incentives to acquire information about the asset, and negatively impact the credit market.

Our environment is based on Gorton & Ordoñez (2014) (henceforth also labelled as GO). It follows an overlapping generation structure, where in each period the economy is populated by a unit continuum of young agents and a unit continuum of old agents. Each member of a new generation is born with an endowment of capital but she is only able to use the capital in a productive way when she becomes old. There is also an initial generation of old agents with no endowment of capital, but with an endowment of one unit of land. Land is meant to capture the role of asset-backed securities, i.e., it has no productive use but it has an unobservable intrinsic utility. Land is used as collateral, i.e., since production is assumed to be risky, in case the old agent (the borrower) is unsuccessful in production, he can offer the land to the young agent (the lender) as a compensation.

Absent any information asymmetries, the environment in Gorton & Ordoñez (2014) is a standard OLG economy in which land is performing the role of money. In fact, like money, land is transferred across generations, and it allows the borrower to credibly pledge his production to the lender. The key feature that makes their environment interesting is the assumption that the intrinsic quality of the land held by the borrower can only be verified by the lender, but in order to do so, the latter needs to incur a cost. It is further assumed that, if the lender chooses to incur the cost, she can do it publicly or privately. A potential benefit of the latter to the lender is that she can incur the cost and only lend the capital if she discovers that the land is of good quality.

We depart from Gorton & Ordoñez (2014) by assuming that the young agent's

[1] Krishnamurthy & Vissing-Jorgensen (2013) empirically document the relative shortage of US treasure bonds.

endowment of capital is storable subject to a positive depreciation rate. In their environment, capital fully depreciates. By assuming that capital is storable, we aim at capturing the idea that a young agent may choose to self-finance her production activity. As it will be shown below, there is ample evidence that firms save for future investments if they anticipate having problems accessing the credit market. We want to make sure that firms have this option in our model, so they have an alternative to fund future projects that does not necessarily involve the acquisition of collateral. More generally, we are interested in a scenario where collateral competes with alternative sources of resources, and self-finance is a simple way to introduce an alternative.

Our main result is that the incentives of the lender to privately verify the underlying quality of the land depends on the relative abundance of her endowment. The reasoning runs as follows. Consider a match between a borrower and a lender with a relatively abundant endowment. In this case, the decision of the lender on whether privately verify the quality of the land has no bearing on her decision on whether to implement a project in the following period. She will always have enough resources to do so in an efficient manner. As a result, she has stronger incentives to deviate in order to enjoy the extra-benefit coming from keeping a land of good quality instead of selling this land at a price below its fundamental value. Consider now a scenario where the endowment of the lender is relatively scarce. In this case, if the lender chooses to privately incur the cost of verifying the quality of the land, she will be unable to fund her future production activity, or she will be forced to do so inefficiently, through self-finance. This reduces her incentives to deviate. The implication of this result is that II contracts are more prevalent in the economy when the lender has a relatively small endowment. This has a positive effect on welfare, as lending always takes place under information-insensitive contracts.

We broadly interpret the message of our paper as follows. Think of economies in which an inefficient distribution of resources, combined with frictions in the credit market, render collateral relevant from a liquidity perspective. In other words, collateral works like money, circulating across agents and enabling their transactions. However, in order for collateral to efficiently operate as money, it needs to be information-insensitive. Gorton & Ordoñez (2014) emphasize the intrinsic properties of the collateral that render it information-insensitive. Our contribution lies in identifying an extrinsic component that also matters. In particular, we show that the existence of an alternative way in which the liquidity problem can be solved, self-finance, makes the collateral more information-sensitive, and undermines its liquidity role. This has a negative impact on welfare because the collateral is in the hands of the agents with the skills to implement productive projects but without funds to do so.

There is a relatively extensive literature that supports the role of self-finance. For example, Almeida, Campello & Weisbach (2004) and Faulkender & Wang (2006) find that firms not able to participate in the loan market will save for future investment opportunities. Similar results were also found by Kim, Mauer & Sherman (1998) and Opler et al. (1999). We contribute to this literature by arguing that the possibility of self-financing itself, by undermining the role of assets as collateral, can have a negative impact on the credit market. In other words, self-finance is not only an effect, it can also be a cause of credit market frictions. There is also an extensive literature that builds on the assumption that, whenever external financing is available, self-financing is relatively inefficient; in particular, that it is better to fund projects with debt as opposed to equity. Examples are Bernanke & Gertler (1989), MacKie-Mason (1990), Bronars & Deere (1991), Dasgupta & Sengupta (1993), Moore (1993), Carlstrom & Fuerst (1997), Graham (2000), Blouin, Core & Guay (2010), and Matsa (2010).

There is also a growing literature arguing that a shortage of safe assets leads to the use of complex assets as collateral, i.e., assets whose information about their intrinsic value is costly to acquire. Key references in this regard are Doepke & Schneider (2006), Dang, Gorton & Holmström (2012), Xie (2012), Krishnamurthy & Vissing-Jorgensen (2013), Gorton & Ordonez (2013), and Gorton & Ordoñez (2014). The innovation of our paper in relation to these papers lies in exploring how the difficulty in finding viable alternatives to the use of collateral may reinforce the latter's information insensitivity. Lastly, our work also relates to the literature on the interaction between excess of liquidity in the economy and the occurrence of crisis. According to this literature, accommodative monetary policies, especially the ones that take place for extended periods of time, are linked to credit booms and to excessive risk-taking. For example, Stiglitz & Weiss (1981) suggest that agents take on more risk when interest rates decline and liquidity is relatively abundant. More recently, a few papers argue that relatively low interest rates in the US were at the root of the 2008 financial crisis, since this was an important factor behind the increases in house prices and in household leverages. A reference is Hirata et al. (2012). In a different direction, Dell'Ariccia, Marquez & Laeven (2010) argue that, when facing with a lower interest rate regime, a well-capitalized bank decreases its monitoring and takes on more risk.

The rest of the paper is organized as follows. In the next section, we present the model. Section 3 characterizes the contracts and the equilibrium, while section 4 concludes. All proofs are in the Appendix.

2 Model

The environment is based on Gorton & Ordoñez (2014). Consider an overlapping generations economy populated by a unit continuum of young agents and a unit continuum of old agents. Agents are risk-neutral and, with the exception of an initial generation of old agents, they live for two periods, and they not discount across periods. Young agents enter the economy with an endowment E of a good that is storable but depreciates at a rate $\delta \in (0,1]$. Young agents can store the good across periods, but only old agents have the ability to use the good as an input into a productive project. This project requires one unit of the good and delivers A units of goods with probability q, and zero units of goods with the complementary probability. We assume that $qA > 1$, i.e., it is always efficient to implement a project.

The initial generation of old agents have no endowment but they enter the economy with one unit of land. Land has no productive use but it may provide an intrinsic utility. There is a probability p that the land is good and provides utility C, and a complementary probability that it is bad and provides no utility. Land is storable until the moment its intrinsic value is extracted, after which it disappears. Henceforth, we say that an agent consumes the land when she extracts its intrinsic value.

There are two sources of informational frictions. First, if the old agent implements a project, the outcome of the project is his private information. This assumption will require the old agent to put up some collateral in order to borrow capital from the young agent. Second, both the young agent and the old agent cannot observe the quality of the land. However, the young can incur a cost $\gamma > 0$ and privately observe the land's quality. If the young agent does so, we say that she has produced information about the quality of the land. She can then choose between disclosing this information to the old agent and keeping this information to herself. This assumption will impose constraints on the feasibility of contracts that do not involve the disclosure of information by the young agent.[1]

The sequence of events in a period unfolds as follows. At the beginning of the period, young agents and old agents are randomly and bilaterally matched. In each meeting, the old agent has all the bargaining power in determining the terms of the loan. In case the old agent receives the loan, he implements the project. At the end of the period, the old agent can sell his land to the young agent. In this case, the young agent makes a take it or leave it offer to the old agent. The old agent can choose, instead, to sell the land in

[1] GO motivate the unobservability of the quality of the land as follows: "To fix ideas it is useful to think of an example. Assume oil is the intrinsic value of land. Land is good if it has oil underground, which can be exchanged for C units of (good) at the end of the period. Land is bad if it does not have any oil underground. Oil is nonobservable at first sight, but there is a common perception about the probability each unit of land has oil underground. It is possible to confirm this perception by drilling the land at a cost of γ units of (good)." (Gorton & Ordoñez (2014), page 349)

the market. Following GO, we assume that the price of land in the market is equal to its expected intrinsic utility.

Throughout our analysis, we assume that $pC > 1$. This ensures that, if the young agent does not produce information about the quality of the land, the first generation of old agents can use the land as collateral in order to borrow one unit of good from the young agent and implement the project. We make two additional assumptions. First, we assume that $E > C$. This ensures that young agents always enter the economy with enough resources to acquire land, which can then be used as collateral in the next period, when they become old. Second, we assume that $E > 1 + \frac{1}{1-\delta}$. This ensures that young agents have enough resources to self-finance the implementation of a project when they become old. Combining these assumptions, we have

$$A1 : E > \max\left\{C, 1 + \frac{1}{1-\delta}\right\}.$$

Remarks Our environment is essentially the same as GO, with two modifications. First, while in their paper the endowment is not storable, here we assume that the endowment is storable and depreciates at a rate $\delta \in (0, 1]$. This is a natural assumption since the endowment works as capital in the implementation of a project. Besides, it allows to include the option of self-finance, i.e., if a young agent chooses not to lend to the old agent, she can store his endowment and use it in the project in the next period, when she becomes old. Second, since a project requires exactly one unit of goods, we are implicitly assuming that loans have a fixed size. In GO, projects can use different amounts of capital, hence loans may be small or large depending on fundamentals.

3 Contracts

In what follows, we will consider two types of contracts between young agents (henceforth also referred to as lenders) and old agents (henceforth also referred to as borrowers). We first look at contracts in which loans always take place in every match between a lender and a borrower. A key feature of this contract is that there is no production of information about the quality of the land. Following GO, we label such contracts information-insensitive (II). In the following subsection, we will analyze contracts in which the lender verifies the quality of the land and discloses this information to the borrower. In this case there is production of information about the quality of the land and loans only occur if the land is verified to be of good quality. Following GO, we label such contracts information-sensitive (IS).

3.1 II contracts

In an information-insensitive contract the lender lends one unit of endowment to the borrower in exchange for a repayment of R units of goods in case the project succeeds, and a fraction x of the collateral in case the project fails. From now on, we will refer to an information-insensitive contract as the pair (R, x). We will separate our analysis in two parts, depending on whether the lender enters the economy with a small amount of endowment or with a large amount of endowment. As said before, this allows to consider how the access to alternative funding channels, captured here by the possibility of self-finance, impacts the lender's incentive to privately verify the quality of the land.

Low-endowment ($E < 1 + pC$) First, in order make sure that there exists a positive region of parameters consistent with the low endowment scenario, we need $C < 1 + pC$. Together with the fact that $pC > 1$, henceforth we assume

$$A2 : pC > \max\{C - 1, 1\}.$$

Consider a contract (R, x). The expected payoff of the borrower under this contract is

$$V_{b|II} = q(A - R + pC) + (1 - q)(1 - x)pC \tag{1}$$

There is a probability q that the project succeeds, in which case the borrower obtains $A - R$, keeps the land and sells it at the end of the period. With the complementary probability, he keeps a fraction $1 - x$ of the land, which he sells at the end of the period.

We need to make sure that the borrower does not have an incentive to misrepresent the outcome of the project. First, he does not have an incentive to say that the project failed when it was successful if and only if

$$A - R + pC \geq A + (1-x)pC \implies R \leq xpC. \tag{2}$$

In turn, he does not have an incentive to say that the project was successful when it failed if and only if [1]

$$(1-x)pC \geq pC - R \implies R \geq xpC. \tag{3}$$

Combining (2) and (3) with the fact that borrower holds all the bargaining power in the meeting, we obtain $R = xpC = 1$, where the latter equality says that the lender simply gets the value of her loan back. We know that $x < 1$ because we assume that $pC > 1$. We can then rewrite (1) as

$$V_{b|II} = qA - 1 + pC. \tag{4}$$

Let us now consider the expected payoff of the lender. Since the lender has no bargaining power, she obtains no surplus from her interaction with the borrower. As a result her expected payoff under a contract (R, x) is given by

$$V_{l|II} = \max\left\{E, E - \frac{1}{1-\delta} + qA, E - pC + V_{b|II}\right\}. \tag{5}$$

The lender has three options. First, she can consume the endowment and obtain E. Second, she can consume $E - \dfrac{1}{1-\delta}$ of the endowment and keep the rest to implement a project in the next period. Lastly, she can choose to use the endowment to buy land at the end of the period, in which case her expected payoff in the next period is the same as that of a borrower with one unit of land. Note that, for any $\delta \in (0, 1]$, if the agent chooses not to consume the entire endowment, it is never optimal to self-finance. Intuitively, under self-finance the actual cost of the project is given by $\frac{1}{1-\delta}$, since it is paid by the agent himself, when he becomes old. In contrast, the cost of the project if the agent finances through a loan is given by 1, since it is paid by the current young agent. This implies that

$$V_{l|II} = E - 1 + qA, \tag{6}$$

and it is optimal for the lender to use her endowment to buy land at the end of the period, which will then be used as collateral in the following period, when she becomes old.

The information-insensitive contract requires that lenders have no incentive to produce information by verifying the quality of the land. Proposition 1 provides the conditions on parameters under which there is no production of information. The proof is in the Appendix.

[1] Note that, as in GO, we are implicitly assuming that the market for land is always open. This way, a borrower can always access this market and sell his land after observing the outcome of the project.

Proposition 1. *Let $E < 1 + pC$ and and assume that the lender and the borrower can only implement the II contract $(R_{II}, x_{II}) \equiv (1, \frac{1}{pC})$.*

(1) Let $qA - \frac{1}{1-\delta} < 0$. The lender does not have an incentive to deviate and verify the quality of the land if and only if

$$\gamma \geq \gamma^1_{II_{low}} \equiv \max \left\{ (1-q)(1-pqA), 0 \right\}.$$

(2) Let $qA - \frac{1}{1-\delta} \geq 0$. The lender does not have an incentive to deviate and verify the quality of the land if and only if

$$\gamma \geq \gamma^2_{II_{low}} \equiv \max \left\{ (1-q)\left(1 - \frac{p}{1-\delta}\right), 0 \right\}.$$

In Proposition 1, the parameter $\gamma^i_{II_{low}}$, $i \in \{1, 2\}$ captures the incentives of the lender to deviate and privately verify the underlying quality of the land. Two scenarios emerge, depending on the value of $qA - \frac{1}{1-\delta}$, which captures the surplus generated by a project that is funded through self-finance.

Consider, first, the scenario where $qA - \frac{1}{1-\delta}$ is negative. In this case, self-finance is never an option, and the lender is faced with two alternatives, which only differ from one another if the lender receives some fraction of land due to the failure of the project [2]. First, she may choose to consume the land if it turns out of good quality and sell the land otherwise. Alternatively, she may also sell the good land in the market at price pC, which is below the actual value of the land, in order to gather enough resources and buy one unit of land to use as collateral in the following period [3]. This last alternative strictly dominates consuming the land in case $qA \geq \frac{1}{p}$. The problem is that, in this case, the lender is taking exactly the same actions she takes one the equilibrium path, which renders the deviation always dominated for any $\gamma > 0$. If, instead, $qA < \frac{1}{p}$, it is strictly optimal for the lender to consume the good land, and the lender may have an incentive to deviate if γ is small, i.e., if $\gamma < (1-q)(1-pqA)$. Consider, now, the scenario where $qA - \frac{1}{1-\delta}$ is positive. Now, self-finance becomes the strictly dominant action in case the lender chooses to deviate. If δ is not too small, although self-finance is the best alternative, the lender has no incentive to deviate irrespective of the value of γ. If, instead δ is small enough, a deviation does not happen only if $\gamma \geq (1-q)\left(1 - \frac{p}{1-\delta}\right)$.

Summarizing, when the endowment is low, the instances in which it may be profitable to deviate always involve consuming the land if it turns out be of good quality. The problem is that, in this case, the lender is either unable to implement a project in the following period, or she has to self-finance the project. It is the existence of this trade-off

[2] If the project succeeds, $qA > 1$ implies that is it always optimal to use the repayment together with the endoment to buy one unit of land.

[3] Note that we are implicitly assuming here that a firm has to hold a whole unit of land in order to use it as collateral, which renders collateral ownership effectively indivisible. We borrow this assumption from GO.

that makes it unappealing to deviate in the first place, even if the cost γ associated with the deviation is relatively small.

Figure 1 describes how $\gamma_{II_{low}}$ varies as a function of the value of the land for an old agent $(V_{b|II})$ [4]. Since the old agent will use the land as collateral and since he has all the bargaining power, this value is given by the surplus $qA - 1$ of the project, plus the value pC of the land. Naturally, the higher the value of the land, the weaker the incentive to deviate and produce private information. The figure on the right describes how $\gamma_{II_{low}}$ varies as a function of the return of the project (qA). It is trival to note that the higher is the return in the project, i.e., the higher is the liquidity value of the the land, the weaker is the incentive to deviate and produce information.

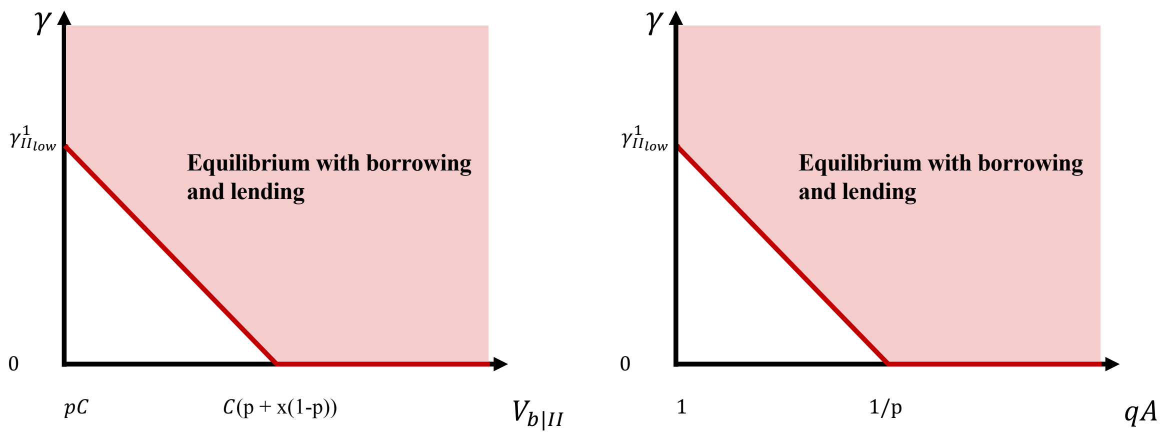

Figure 1 – Regions with II contracts and low-endowment

High-endowment $(E \geq 1 + pC)$ Consider an II contract (R, x). Following the same steps as in the case of the low-endowment, it is straightforward to show that the contract will be exactly the same, given by $R = 1$ and $x = \frac{1}{pC}$. Moreover, the expected payoff of the borrower and that of the lender will also be the same as before, given respectively by

$$V_{b|II} = qA - 1 + pC, \tag{7}$$

and

$$V_{l|II} = E - 1 + qA. \tag{8}$$

[4] In figure 1, we assumed that $qA < \frac{1}{1-\delta}$, i.e., the storage technology is sufficiently inefficient such that it is never optimal to self-finance.

The key difference between the low endowment and the high endowment case comes when we consider the incentives of the lender to deviate and privately verify the underlying quality of the land. We have the following result. The proof is in the Appendix.

Proposition 2. *Let $E - 1 \geq pC$ and assume that the lender and the borrower can only implement the II contract $(R_{II}, x_{II}) \equiv (1, \frac{1}{pC})$. The lender does not have an incentive to deviate and verify the quality of the land if and only if*

$$\gamma \geq \gamma_{II_{high}} \equiv (1-q)(1-p) \, .$$

In contrast to Proposition 1, the expected return of the project or the relative efficiency of the storage technology does not affect the incentives of the lender to produce private information. The reason is that, in the high-endowment scenario, the lender can always purchase land and participate in the credit market in the following period, irrespective of whether she chooses to deviate or not. In other words, if she deviates and the project fails, she is free to consume the land if it turns out to be of good quality, with no repercussion on her activities in the following period. This increase her incentives to deviate and the corresponding lower bound that prevents deviations must also increase. Formally, the net benefit from a deviation (excluding the cost γ) is given by

$$p\left[qR + (1-q)xC\right] - p\left[qR + (1-q)xpC\right],$$

where the first term captures the instance where the lender knows that the land is of good quality, in which case she consumes it; and the second term captures the instance where the lender does not have such information, in which case she lender the good land at a market price below its actual value. Using $R = xpC = 1$ delivers the lower bound $(1-q)(1-p)$.

Figure 2 describes how $\gamma_{II_{high}}$ varies as a function of the value of the land for an old agent ($V_{b|II}$). Different from Figure 1, in this instance there is no relation between the lower bound in the value of γ and the return of the project, since there is no trade-off between consume a land known to be good and invest in the project in the following period. This result is in accordance with the one presented by Gorton & Ordoñez (2014). Hence, in order to ensure an equilibrium with II contracts the cost to acquire information must be relatively large. Actually, this cost is larger than the cost in the low-endowment case. The results we have obtained so far mean that the existence of a trade-off reduces the incentives for the lender to deviate of the equilibrium path. In other words, when the agent needs land for liquidity reasons, her incentives to deviate decreases in comparison to the case where land begin to acquire importance due to its fundamental value.

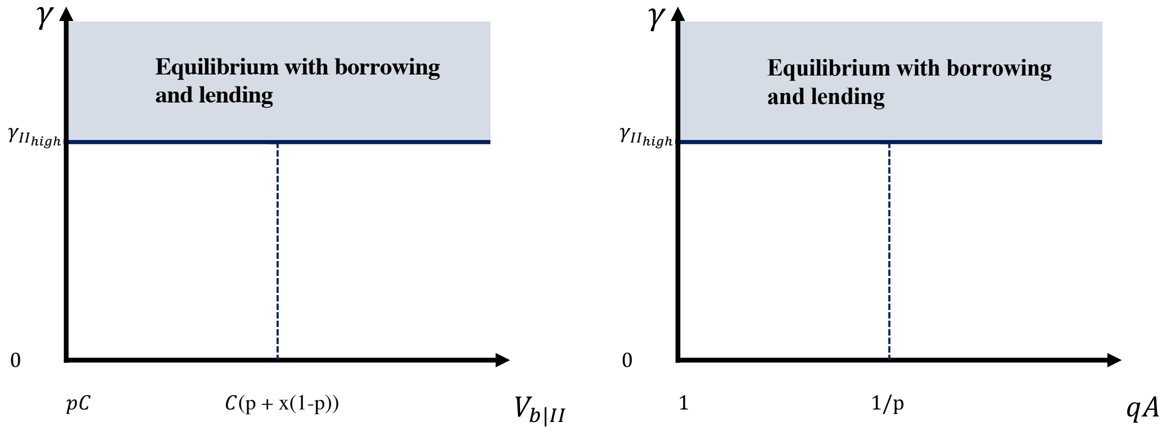

Figure 2 – Regions with II contracts and high-endowment

In the high-endowment scenario there is no relationship between the value of γ and qA, since in this case even when the return of the project goes to 1 the lender can always take benefit of this project by buying land and participating in the credit market.

By using the results stated in Proposition 1 the following figure describes how the lower bound in γ varies as function of the return of the project, qA. In this scenario the restriction in the parameters implies that when the endowment is low the lender has incentives to self-finance her project.

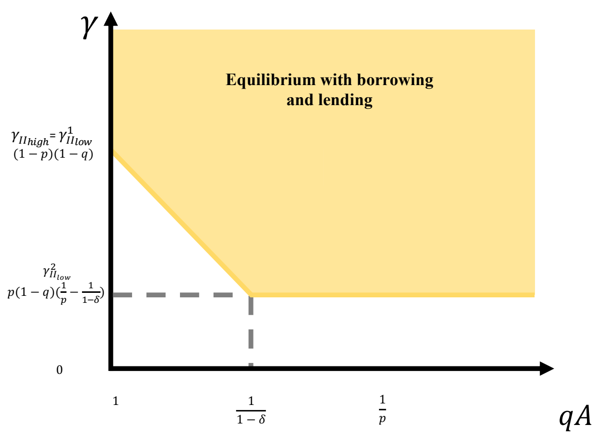

Figure 3 – Regions with II contracts, γ versus qA, $\delta + p < 1$ and $E < pC + 1$

The figure below shows the same relationship, but now the restriction in the parameters implies that the value of δ is relatively large, which implies that even in the instance in which the self-finance is the best alternative, the lender has no incentives to deviate irrespective of the value of γ (i.e., the storage technology is relatively inefficient).

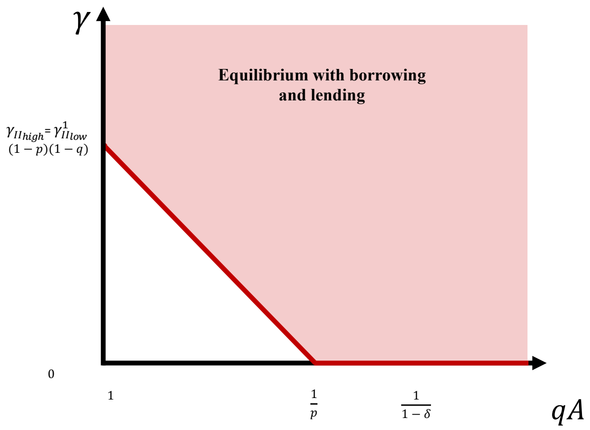

Figure 4 – Regions with II contracts, γ versus qA, $\delta + p \geq 1$ and $E < pC + 1$

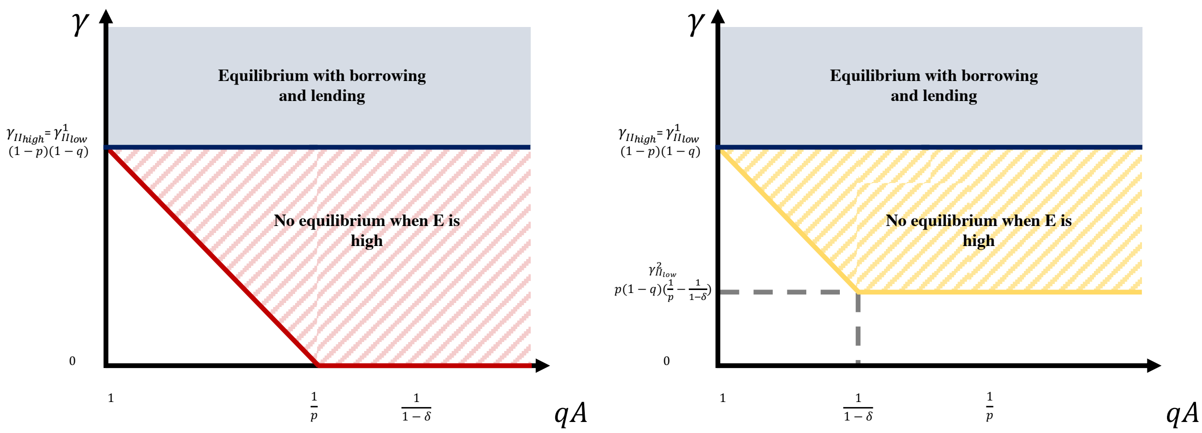

Figure 5 – Comparison between the two regimes of endowment - γ versus qA for the restriction $\delta + p \geq 1$ and $\delta + p < 1$

Comparing the figures we can see that even when the endowment is low, but the restriction in the parameters implies that the agent has the option to self-finance, the region where the lender has no incentives to privately verify the quality of the land is lower than in the case the option to self-finance is not available [5]. Moreover, when the endowment is sufficiently high, such that the agent can self-finance and also purchase land to participate in the credit market in the following period, the region where the lender has no incentives to privately check the quality of the the land is the lowest. This means that it must be the case that the emergence of alternative ways to address liquidity increases the incentives to deviate, undermining the liquidity role of an asset and reinforcing the relevance of its fundamental value.

We can summarize Propositions 1 and 2 as follows. If the endowment is low, the lender has no incentive to privately verify the quality of the land if and only if $\gamma \geq \max\left\{\gamma^1_{II_{low}}, \gamma^2_{II_{low}}\right\}$, while if the endowment is high, the lower bound on γ is given by $\gamma_{II_{high}}$. Since $\gamma_{II_{high}} > \max\left\{\gamma^1_{II_{low}}, \gamma^2_{II_{low}}\right\}$, it must be the case the stronger incentives to deviate happen when the endowment is high. The following figures show this relationship considering a restriction in the parameters such that $1 + \dfrac{1}{1-\delta} < C$. Lemma 3 contained in the Appendix supports the results showed in the figures.

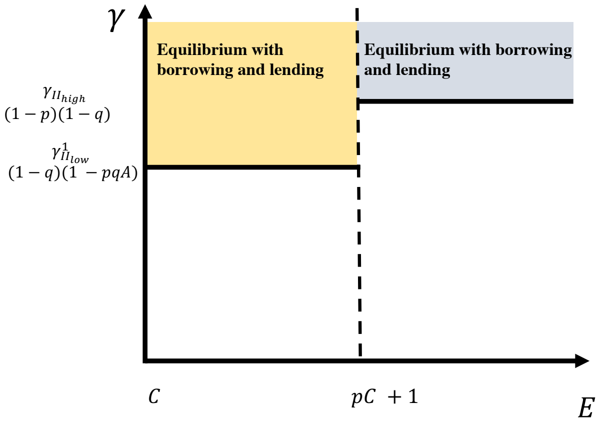

Figure 6 – Regions with II contracts, γ versus E, $1 + \dfrac{1}{1-\delta} < C < pC + 1$ and $qA < \min\left\{\dfrac{1}{p}, \dfrac{1}{1-\delta}\right\}$

[5] Lemmas 1 and 2 in the Appendix contribute to better understanding of the figures.

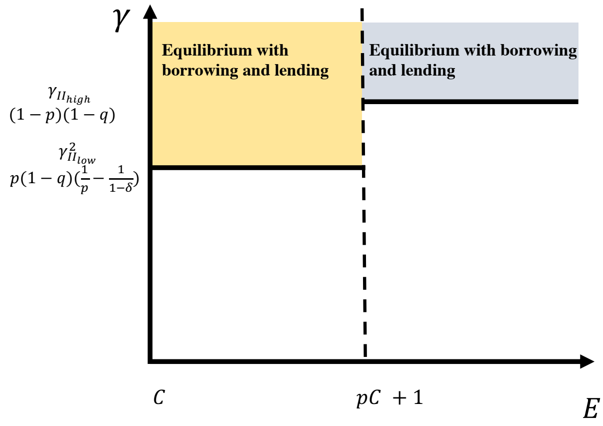

Figure 7 – Regions with II contracts, γ versus E, $1+\dfrac{1}{1-\delta} < C < pC+1$, $\delta + p < 1$ and $qA \geq \dfrac{1}{1-\delta}$

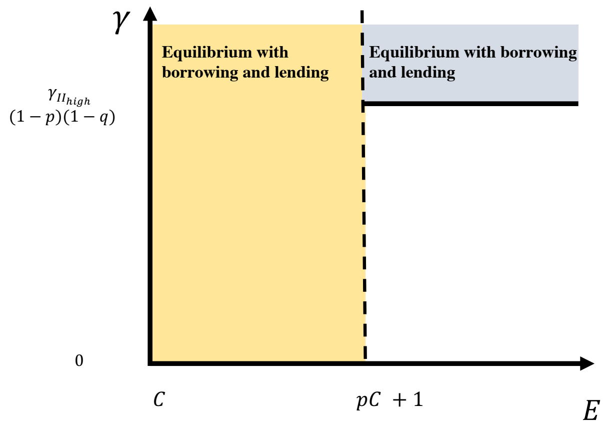

Figure 8 – Regions with II contracts, γ versus E, $1+\dfrac{1}{1-\delta} < C < pC+1$, $\delta + p \geq 1$ and $qA \geq \dfrac{1}{p}$

The following figure describes the relation between the lowest γ consistent with no deviation by the lender and the probability p that the land is of high quality. Since the market price of the land is given by pC, p indirectly measures the relative value of the endowment, for any given E. If p is small, land is relatively cheap, which means that the endowment of the lender is relatively high. In the graph on the left, we assumed that $\frac{1}{qA} > \frac{E-1}{C}$. In this case, there is a smaller jump when the economy transits from the high endowment to the low endowment scenario. In the graph on the right, we assumed instead that $\frac{1}{qA} < \frac{E-1}{C}$. In this case, as soon as the economy transits from the high endowment to the low endowment scenario, the lender never deviates [6]. Lemma 4 in the Appendix provides the restriction on the parameters to construct the figures below.

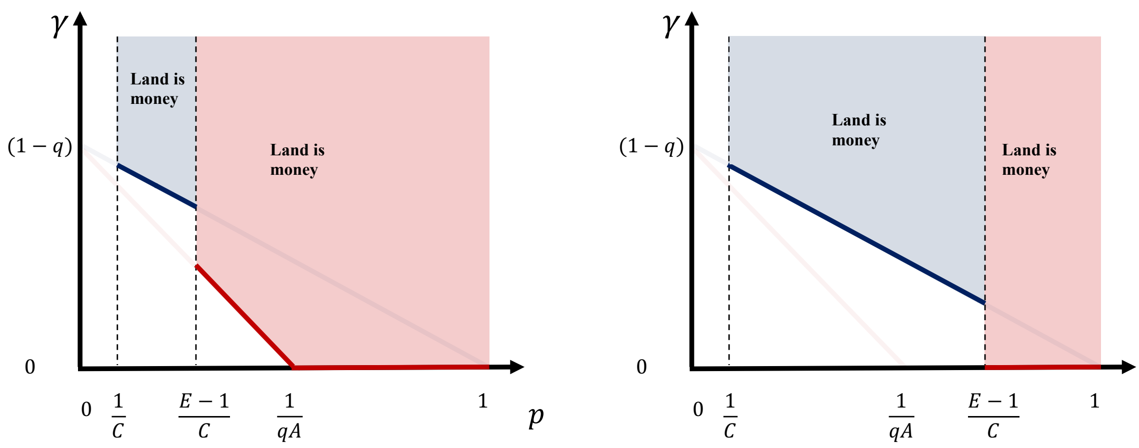

Figure 9 – Regions where land is money, γ versus p

3.2 IS contracts

We will now consider contracts where the lender publicly verifies the quality of the land. Before we proceed, two observations are in order. First, the lender will only have an incentive to finance a project if the land turns out to be of good quality. In fact, if the land is bad, the borrower will always have an incentive to default on the debt and give the collateral to the lender. In this case, the lender is better off waiting until the end of the period and directly purchasing the land from the borrower [7]. Second, since there is production of information, the lender and the borrower may have different priors about the quality of the land. In fact, in every period, since the lender has just entered the economy,

[6] We also assumed that $qA < \frac{1}{1-\delta}$ in both graphs.

[7] The borrower will face a price of zero if he chooses to sell in the market, which implies that the lender in his match can also buy at this price. This is so because the market price is equal to the intrinsic value of the land, and a land of bad quality has zero intrinsic value. Note that, as in GO, we are implicitly assuming that the lender discloses the information on the quality of the land not only to the borrower in her match, but also to all other lenders participating in the economy.

she holds the prior p that the land in any given match is of good quality. In contrast, the borrower, been a lender in the previous period, knows the quality of the land she bought from the borrower in her match [8].

Consider then a contract (R, x). First, if the borrower knows that the land is bad, his expected payoff is

$$V^B_{b|IS} = 0. \tag{9}$$

In this case he knows that he will not receive a loan from the lender, and he will sell the land for a price of zero at the end of the period. If, instead, the borrower knows that the land is good, his expected payoff under the contract is

$$V^G_{b|IS} = q(A - R + C) + (1 - q)(1 - x)C \tag{10}$$

There is a probability q that the project succeeds, in which case the borrower obtains $A - R$, keeps the land and sells it to the lender at the end of the period at the price C. With the complementary probability, he keeps a fraction $1 - x$ of the land, which he sells to the lender at the end of the period at the price C.

We need to make sure that the borrower does not have an incentive to misrepresent the outcome of the project. First, he does not have an incentive to claim that the project failed when it was successful if and only if

$$A - R + C \geq A + (1 - x)C \implies R \leq xC. \tag{11}$$

In turn, he does not have an incentive to claim that the project was successful when it failed if and only if

$$(1 - x)C \geq C - R \implies R \geq xC. \tag{12}$$

Combining (11) and (12), we obtain $R = xC$. Moreover, since the borrower has all the bargaining power in the contracting stage, it must be that

$$\gamma = p(xC - 1).$$

In words, the expected surplus of the lender in the contract compensates her for incurring the verification cost γ. Note that we used the prior of the lender when considering the buyer's take it or leave it offer. Note also that feasibility requires $x \leq 1$, i.e., $p \geq \frac{\gamma}{C-1}$. This implies that the expected payoff of the borrower under the IS contract can then be rewritten as

$$V^G_{b|IS} = (qA - 1) - \frac{\gamma}{p} + C. \tag{13}$$

We also need to make sure that the borrower wants to participate in the contract. Since he can choose to simply sell the land at the end of the period at the expected market price C, this requires $V^G_{b|IS} \geq C$, i.e., $p \geq \frac{\gamma}{qA-1}$. Henceforth, we follow GO and assume that

$$A3 : qA < C.$$

[8] Note, however, that the first generation of old agents holds the same prior as the young agents about the underlying quality of the land. We will consider their problem later in the subsection.

This ensures that, whenever it is optimal to borrow, it is feasible to do so. As a result,

$$V^G_{b|IS} = \begin{cases} qA - 1 - \frac{\gamma}{p} + C \text{ if } p \geq \frac{\gamma}{qA-1} \\ C \text{ if } p < \frac{\gamma}{qA-1} \end{cases}. \tag{14}$$

It remains to consider the expected payoff of the first generation of borrowers. Since they hold a prior p that the land is good quality, their payoff is given by

$$V^0_{b|IS} = \begin{cases} p(qA - 1) - \gamma + pC \text{ if } p \geq \frac{\gamma}{qA-1} \\ pC \text{ if } p < \frac{\gamma}{qA-1} \end{cases}. \tag{15}$$

Consider now the expected payoff of the lender. Since she has no bargaining power at the contracting stage, her payoff only depends on her decision on whether to buy land at the end of the period. If she does so, her expected payoff is

$$V^{finance}_{l|IS} = E + p\left(-C + V^G_{b|IS}\right) + (1-p)V^B_{b|IS},$$

which can be rewritten as

$$V^{finance}_{l|IS} = \begin{cases} E + p(qA - 1) - \gamma \text{ if } p \geq \frac{\gamma}{qA-1} \\ E \text{ if } p < \frac{\gamma}{qA-1} \end{cases}. \tag{16}$$

We also need to make sure that the lender will have enough endowment to buy the good land. Under the IS contract, with probability p the lender transfers one unit of the endowment and receives back one unit of goods plus an amount $\frac{\gamma}{p}$, to compensate for the cost of verifying the land's quality. Thus, she has enough resources to buy good land if and only if

$$E \geq \frac{pC - \gamma}{p},$$

which is always satisfied since $E > C$. Alternatively, the lender may choose not buy land to use as collateral and instead self-finance the project in the following period [9]. In this case, she obtains

$$V^{self-finance}_{l|IS} = E - \frac{1}{1-\delta} + qA. \tag{17}$$

Proposition 3 summarizes our results.

Proposition 3. *Assume that the lender and the borrower can only implement the IS contract* $(R_{IS}, x_{IS}) \equiv \left(1 + \frac{\gamma}{p}, \frac{1}{C} + \frac{\gamma}{pC}\right)$.

(1) If $\gamma \leq \gamma_{IS} \equiv p(qA-1)$, *the contract is implemented if and only if the land is of good quality, and the lender buys land to use as collateral in the following period.*

(2) If $\gamma > \gamma_{IS} \equiv p(qA-1)$ *and* $qA < \frac{1}{1-\delta}$ *the contract is not implemented and the lender buys land to use as collateral in the following period.*

(3) If $\gamma > \gamma_{IS} \equiv p(qA-1)$ *and* $qA \geq \frac{1}{1-\delta}$ *the contract is not implemented and the lender self-finance the project in the following period.*

[9] In principle, the lender can always choose to simply consume the endowment, but this option is always strictly dominated by purchasing land.

We are now ready to compare across contracts, and determine which contract, if any, will be chosen in a match.

3.3 Strategies and equilibrium

We first describe the strategies of the agents. The strategy of the young agent can be summarized as follows. At the beginning of the period, upon meeting an old agent, the young agent accepts or rejects the contract offered by the old agent. Irrespective of her choice, at the end of the period she makes a take it or leave it offer for the remaining land of the old agent. She also chooses between consuming the endowment and the land, consuming the endowment and keeping the land to use as collateral, and consuming the land and keeping part of the endowment to self-finance the project. In turn, the strategy of the old agent is summarized as follows. At the beginning of the period, upon meeting a young agent, he makes a take it or leave it offer to the young agent between the II contract (determined in subsection 3.1) and the IS contract (determined in subsection 3.2). Irrespective of the choice of the young agent, at the end of the period he accepts or rejects the offer made by the young agent for his land. If he rejects the offer, he can sell the land in the market at a price that is assumed to be equal to the expected intrinsic value of the land. Finally, he consumes whatever endowment he has left.

Our equilibrium concept is Perfect Bayesian Equilibrium (PBE), and we only consider symmetric equilibria. We are interested in a steady-state in which land is continually used as collateral, i.e., its intrinsic value is never extracted on the equilibrium path. As a result, we restrict attention to the region of parameters under which self-finance is strictly dominated under the IS contract, which requires $qA < \frac{1}{1-\delta}$. All the restrictions imposed on the parameters can be summarized as follows

$$A0 : \max\left\{\frac{1}{C}, 1-\frac{1}{C}\right\} < p < 1 < qA < \min\left\{C, \frac{1}{1-\delta}\right\} < \max\left\{C, 1+\frac{1}{1-\delta}\right\} < E.$$

We are now in conditions to compare the expected payoff in instances where both the II contract and the IS contract are feasible. In the II contract, since there is no production of information, the borrower and the lender always share the same prior about the underlying quality of the land. Instead, in the IS contract, with the exception of the first period of the economy, there is production of information and the borrower knows the quality of the land, while the lender holds a prior p that the land is of good quality. However, since production of information only emerges in equilibrium if the first generation of old agents has the incentive to choose the IS contract, in order to determine which contract will emerge in equilibrium, we need to compare $V_{b|II}$ with $V^0_{b|IS}$. Simple inspection shows that $V_{b|II}$ is always strictly larger than $V^0_{b|IS}$, so it is never the case the initial old generation of borrower ever has an incentive to choose the IS contract. Intuitively, the borrower extracts all the surplus from the contract and there is less surplus to be shared under the IS contract. Proposition 4 characterizes the equilibrium.

Proposition 4. *There exists a unique symmetric PBE. In this PBE, the II contract is implemented if and only if either* $p > \frac{E-1}{C}$ *and* $\gamma \geq \gamma^1_{II_{low}}$ *or* $p \leq \frac{E-1}{C}$ *and* $\gamma \geq \gamma_{II_{high}}$*. If the II contract is not implemented, then the IS contract is implemented when the land is of good quality if* $\gamma \leq \gamma_{IS}$*, while no contract is implemented if* $\gamma > \gamma_{IS}$*.*

The figure below provides a complete characterization of the equilibrium in a graph where γ is measured in the vertical axis and p is measured in the horizontal axis. Note that

$$p_0 = \frac{1}{C}$$

is the lowest p consistent with A0. In turn,

$$p_1 = \frac{E-1}{C}$$

is the threshold that separates the case of high endowment from the case of low endowment, while

$$\underline{p} = \frac{1-q}{q(A-1)}$$

is such that $\gamma_{II_{high}} = \gamma_{IS} \equiv \gamma(\underline{p})$. In words, if we are in the region of high endowment, the II contract is feasible if and only if $\gamma \geq \gamma(\underline{p})$ and the IS contract is feasible if and only if $\gamma \leq \gamma(\underline{p})$. Finally,

$$\overline{p} = \frac{1}{qA}$$

is such that, if we are in the region of low endowment, the II contract is always feasible if $p \geq \overline{p}$, while for $p < \overline{p}$, it is only feasible if $\gamma \geq (1-q)(1-pqA)$ [10].

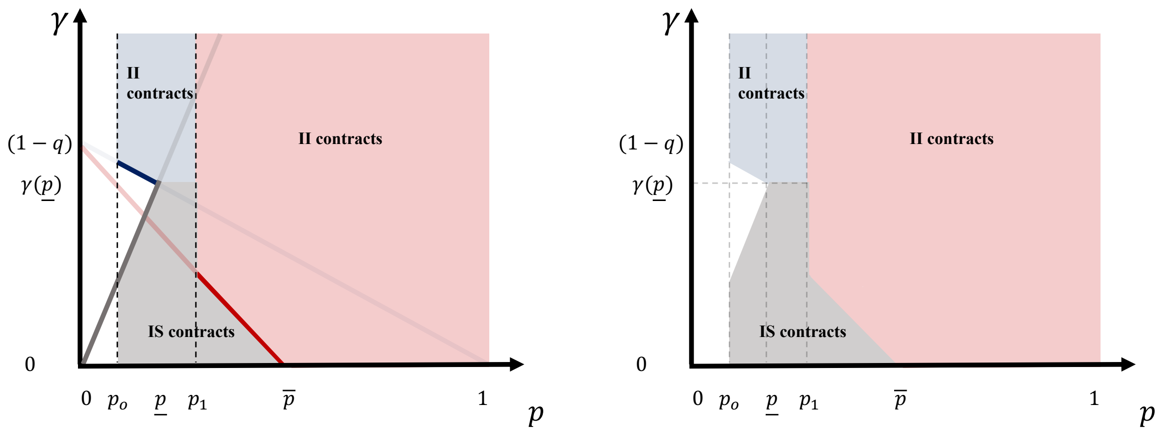

Figure 10 – γ versus p, II contracts and IS contracts

[10] In the figure, we assume that $C \in (1, 2)$ and $E \in \left(2, \frac{5}{2}\right)$, which implies $0 < p_0 < \underline{p} < p_1 < \overline{p} < 1$.

Note that the higher the p, since land becomes expensive under the II contract, the lower is the relative endowment. We obtain that the region where we have II contracts increases with p. To put it differently, if γ is not too high and the economy is at $p = p_1$ under the II contract, an arbitrarily small increase in the endowment E moves the economy to the IS contract. Now, since under the IS contract lending only occurs if the land is of good quality, as a result of the increase in E, lending stops occurring in a measure $1 - p$ of matches between lenders and borrowers.

4 Conclusion

In Gorton & Ordoñez (2014), the II contract is implemented whenever $\gamma \geq (1-p)(1-q)$, which coincides with our results if we assume that the endowment is relatively abundant. Intuitively, in their paper, if the lender deviates and privately verifies the quality of the land, she faces no trade-off between implementing the project in the following period and consuming the land, if it turns out of good quality. In other words, the lender always has enough resources to purchase an additional unit of land to use as collateral in the following period. The existence of this trade-off, and how it impacts the information-sensitivity of the collateral, is the main contribution of our paper.

Bibliography

ALMEIDA, H.; CAMPELLO, M.; WEISBACH, M. S. The cash flow sensitivity of cash. *The Journal of Finance*, Wiley Online Library, v. 59, n. 4, p. 1777–1804, 2004.

BERNANKE, B.; GERTLER, M. Agency costs, net worth, and business fluctuation. *American Economic Review*, v. 79, n. 1, p. 14–31, 1989.

BLOUIN, J.; CORE, J. E.; GUAY, W. Have the tax benefits of debt been overestimated? *Journal of Financial Economics*, Elsevier, v. 98, n. 2, p. 195–213, 2010.

BRONARS, S. G.; DEERE, D. R. The threat of unionization, the use of debt, and the preservation of shareholder wealth. *The Quarterly Journal of Economics*, MIT Press, v. 106, n. 1, p. 231–254, 1991.

CARLSTROM, C. T.; FUERST, T. S. Agency costs, net worth, and business fluctuations: A computable general equilibrium analysis. *The American Economic Review*, JSTOR, p. 893–910, 1997.

DANG, T. V.; GORTON, G.; HOLMSTRÖM, B. Ignorance, debt and financial crises. *Yale University and Massachusetts Institute of Technology, working paper*, v. 17, 2012.

DASGUPTA, S.; SENGUPTA, K. Sunk investment, bargaining and choice of capital structure. *International Economic Review*, JSTOR, p. 203–220, 1993.

DELL'ARICCIA, M. G.; MARQUEZ, M. R.; LAEVEN, M. L. *Monetary policy, leverage, and bank risk-taking*. [S.l.]: International Monetary Fund, 2010.

DOEPKE, M.; SCHNEIDER, M. Inflation and the redistribution of nominal wealth. *Journal of Political Economy*, JSTOR, v. 114, n. 6, p. 1069–1097, 2006.

FAULKENDER, M.; WANG, R. Corporate financial policy and the value of cash. *The Journal of Finance*, Wiley Online Library, v. 61, n. 4, p. 1957–1990, 2006.

GORTON, G.; ORDOÑEZ, G. Collateral crises. *The American Economic Review*, American Economic Association, v. 104, n. 2, p. 343–378, 2014.

GORTON, G. B.; ORDONEZ, G. *The supply and demand for safe assets*. [S.l.], 2013.

GRAHAM, J. R. How big are the tax benefits of debt? *The Journal of Finance*, Wiley Online Library, v. 55, n. 5, p. 1901–1941, 2000.

HIRATA, H. et al. *Global house price fluctuations: Synchronization and determinants*. [S.l.], 2012.

KIM, C.-S.; MAUER, D. C.; SHERMAN, A. E. The determinants of corporate liquidity: Theory and evidence. *Journal of financial and quantitative analysis*, Cambridge University Press, v. 33, n. 3, p. 335–359, 1998.

KRISHNAMURTHY, A.; VISSING-JORGENSEN, A. Short-term debt and financial crises: What we can learn from us treasury supply. *unpublished, Northwestern University, May*, Citeseer, 2013.

MACKIE-MASON, J. K. Do taxes affect corporate financing decisions? *The journal of finance*, Wiley Online Library, v. 45, n. 5, p. 1471–1493, 1990.

MATSA, D. A. Capital structure as a strategic variable: Evidence from collective bargaining. *The Journal of Finance*, Wiley Online Library, v. 65, n. 3, p. 1197–1232, 2010.

MOORE, R. R. Asymmetric information, repeated lending, and capital structure. *Journal of Money, Credit and Banking*, JSTOR, v. 25, n. 3, p. 393–409, 1993.

OPLER, T. et al. The determinants and implications of corporate cash holdings. *Journal of financial economics*, Elsevier, v. 52, n. 1, p. 3–46, 1999.

STIGLITZ, J. E.; WEISS, A. Credit rationing in markets with imperfect information. *The American economic review*, JSTOR, v. 71, n. 3, p. 393–410, 1981.

XIE, L. The seasons of money: Abs/mbs issuance and the convenience yield. *Unpublished working paper. Yale University*, 2012.

APPENDIX A – Proofs

A. Proof of Proposition 1

Proof. First of all, observe that if the land is of bad quality, the lender is always willing to accept it as collateral since in the case the project fails the lender can sell the fraction of bad land received by the price pC and with this gather resources to buy a land and take advantage of having one in the following period [1]. It is trivial to note that since asymmetric information can exist during the period, this strategy is better than does not lend to borrowers who have bad land and self-finance her own project ($E - pC + V_{b|II} > E - \dfrac{1}{1-\delta} + qA$). Moreover, this strategy is also better than the strategy in which the lender decides to keep his endowment and consume all of it in the first period of her life ($E - pC + V_{b|II} > E$). In case the land is of bad quality and the project is successful, the lender receives the repayment $R = 1$ and can use the remaining endowment together with this repayment to buy land in the market by the price pC and take advantage of having a land in the following period ($E - pC + V_{b|II}$). Note that this strategy is also better than self-finance her project and is better than the strategy to keep the endowment and consume all of it in the first period of her life. At the end the best payoff the lender can obtain when the land is discovered to be bad is given by $E - pC + V_{b|II}$ and is independent whether $qA - \frac{1}{1-\delta}$ is positive or negative.

In the case the land is of good quality and the project is successful the lender is also willing to accept it as collateral, since she can use the amount of $R = 1$ received and the remaining endowment to buy land in the market by the price pC in order to take advantage of having land in the following period. As before it is easy to note that $E - pC + V_{b|II} > E - \dfrac{1}{1-\delta} + qA$ and $E - pC + V_{b|II} > E$.

The restriction in the parameter E by using the assumption A1 and considering the low endowment is such that $\max\left\{C, 1 + \frac{1}{1-\delta}\right\} < E < pC + 1$. In this case when the land is of good quality and the project fails, the lender has available the following strategies:

i Consume the intrinsic value of the collateral known to be good. The payoff in this case is $E - 1 + xC$;

ii Sell the good land in the market by the price pC to obtain the value of land $V_{b|II}$ in the following period. The payoff in this case is $E - pC + V_{b|II} = E - 1 + qA$;

iii Consume the intrinsic value of the collateral and save part of the endowment to self-finance the project in the following period. The payoff in this case is $E - 1 - \dfrac{1}{1-\delta} + xC + qA$.

[1] Here is essential the hypothesis that asymmetric information can exist during the period.

Now we argument for the both cases in the proposition

1 Let $qA < \dfrac{1}{1-\delta}$. In this scenario we have strategy (i) is optimal compared with strategy (iii) and self-finace is never optimal. The lender is faced with strategies (i) and (ii).

When the strategy (i) is the best one, the best payoff the lender can obtain when she incurs the cost γ to verify the quality of land is

$$V'_{l|II} = -\gamma + p[q(E - pC + V_{b|II}) + (1-q)(E - 1 + xC)] + (1-p)(E - pC + V_{b|II})$$

It is trivial to note that the lender does not deviate if and only if $V_{l|II} \geq V'_{l|II}$, where $V'_{l|II} = -\gamma + p[q(E - pC + V_{b|II}) + (1-q)(E - 1 + xC)] + (1-p)(E - pC + V_{b|II})$. This implies that the lender does not deviate if and only if $\gamma \geq (1-q)(1-pqA)$.

Now, when the strategy (ii) is the best one, the best payoff the lender can obtain when she incurs the cost γ to verify the quality of land is

$$V'_{l|II} = -\gamma + p[q(E - pC + V_{b|II}) + (1-q)(E - pC + V_{b|II})] + (1-p)(E - pC + V_{b|II})$$

The lender does not deviate if and only if $V_{l|II} \geq V'_{l|II}$, where $V'_{l|II} = -\gamma + p[q(E - pC + V_{b|II}) + (1-q)(E - pC + V_{b|II})] + (1-p)(E - pC + V_{b|II})$. This implies that the lender does not deviate if and only if $\gamma \geq 0$.

Therefore, in this case the lower bound in the value of γ such that we have an equilibrium in the II case is $\gamma^1_{II_{low}}$ and the lender does not deviate if an only if

$$\gamma \geq \gamma^1_{II_{low}} \equiv \max\left\{(1-q)\left(1-pqA\right), 0\right\}.$$

Strategy (i) is optimal whenever we have $qA < \dfrac{1}{p}$ and the lender is optimal consuming the good land, instead of selling it at a lower price than its fundamental value to gather funds to participate in the market of collateral. On the other hand, when $qA \geq \dfrac{1}{p}$ the lender is better by selling the good land at a lower price than the fundamental value. In such an instance, the gain the lender expects to receive in the future with the land is so high that she prefers to stay in the equilibrium path rather than to deviate and consume the intrinsic value of her portion of land known to be good (in case she discovers the collateral is good and the project fails). This is so because if she deviates and consumes the intrinsic value of her portion of land known to be good, the lender will not have resources to buy land in the market and in the following period she will not be able to invest in the more productive project. In this last case, the lender is taking exactly the same action she takes on the equilibrium path, which renders the deviation no intrinsic utility.

2 Let $qA \geq \dfrac{1}{1-\delta}$. In this scenario we have strategy (iii) is optimal compared with strategy (i).

When strategy (iii) is the best one, the best payoff the lender can obtain when she incurs in the cost γ to verify the quality of land is

$$V'_{l|II} = -\gamma + p\Big[q(E - pC + V_{b|II}) + (1-q)\Big(E - 1 - \frac{1}{1-\delta} + xC + qA\Big)\Big] + (1-p)(E - pC + V_{b|II})$$

The lender does not deviate if and only if $V_{l|II} \geq V'_{l|II}$, where $V'_{l|II} = -\gamma + p\Big[q(E - pC + V_{b|II}) + (1-q)\Big(E - 1 - \dfrac{1}{1-\delta} + xC + qA\Big)\Big] + (1-p)(E - pC + V_{b|II})$. This implies that the lender does not deviate if and only if $\gamma \geq (1-q)\Big(1 - \dfrac{p}{1-\delta}\Big)$.

Now, when the strategy (ii) is the best one, the best payoff the lender can obtain when she incurs the cost γ to verify the quality of land is

$$V'_{l|II} = -\gamma + p[q(E - pC + V_{b|II}) + (1-q)(E - pC + V_{b|II})] + (1-p)(E - pC + V_{b|II})$$

The lender does not deviate if and only if $V_{l|II} \geq V'_{l|II}$, where $V'_{l|II} = -\gamma + p[q(E - pC + V_{b|II}) + (1-q)(E - pC + V_{b|II})] + (1-p)(E - pC + V_{b|II})$. This implies that the lender does not deviate if and only if $\gamma \geq 0$.

Thus, the lower bound in the value of γ such that we have an equilibrium in the II case is $\gamma^2_{II_{low}}$ and the lender does not deviate if an only if

$$\gamma \geq \gamma^2_{II_{low}} \equiv \max\left\{(1-q)\left(1 - \frac{p}{1-\delta}\right), 0\right\}.$$

Observe that when δ is sufficiently small, i.e., $\delta < 1-p$, the lender is better by adopting strategy (iii). On the other hand, if δ is not to small, i.e., $\delta \geq 1-p$, although self-finance is the best alternative, the lender has no incentive to deviate irrespective of the value of γ. This is so, because when δ is not too small the lender has to save a great amount of resources to take advantage of the project. ■

A. Proof of Proposition 2

Proof. All the discussion we have made in Proposition 1 about the strategy of the lender in the case she discovers the land is of bad quality and in the case the lender discovers the land is of good quality and the project is successful is still valid and the best payoff the lender can obtain in all these instances is $E - pC + V_{b|II}$. By using A1 and considering the high endowment scenario the parameter E obeys the following restriction $E \geq pC + 1$. The strategies available to the lender when she discovers the land is of good quality and the project fails are:

i Consume the intrinsic value of the collateral known to be good. The payoff in this case is $E - 1 + xC$;

ii Consume the intrinsic value of the collateral and buy land in the market by the price pC to obtain the value of land $V_{b|II}$ in the following period. The payoff in this case is $E - 1 + xC - pC + V_{b|II}$;

iii Consume the intrinsic value of the collateral and save part of the endowment to self-finance the project in the following period. The payoff in this case is $E - 1 - \dfrac{1}{1-\delta} + xC + qA$.

It is trivial to note that strategy (ii) is better than strategy (i) for any value $qA > 1$. Additionally note that $E - 1 + xC - pC + V_{b|II} > E - 1 + xpC - pC + V_{b|II}$, which means that it does not make sense for the lender sells his fraction of good land in the market by the price pC and uses her resources to buy a piece of land by the price pC expecting obtain $V_{b|II}$. Even if the lender can buy as many land as possible he is indifferent between doing this or adopt the strategy (ii) since there is only one opportunity of investment in the following period.

Since $\delta \in (0, 1]$, it is also trivial to realize strategy (ii) is better than strategy (iii). In contrast to the previous proposition, the return of the project or the relative efficiency of the storage technology does not affect the incentives of the lender to produce private information. In this case, the lender can always buy land an participate in the credit market in the following period. This implies that the best payoff the lender can obtain in this case is given by

$$V'_{l|II} = -\gamma + p[q(E - pC + V_{b|II}) + (1-q)(E - 1 + xC - pC + V_{b|II})] + (1-p)(E - pC + V_{b|II})$$

It is trivial to note that the lender does not deviate if and only if $V_{l|II} \geq V'_{l|II}$, where $V'_{l|II} = -\gamma + p[q(E - pC + V_{b|II}) + (1-q)(E - 1 + xC - pC + V_{b|II})] + (1-p)(E - pC + V_{b|II})$. This implies that the lender does not deviate if and only if $\gamma \geq (1-p)(1-q)$.

Thus, the lower bound in the value of γ such that we have an equilibrium in the II case is $\gamma_{II_{high}}$ and the lender does not deviate if an only if

$$\gamma \geq \gamma_{II_{high}} \equiv (1-q)(1-p).$$

■

A. Proof of Lemma 1

Lemma 1. *Suppose $\delta + p < 1$ and $E < pC + 1$. Then,*

(i) If $qA \in \left(1, \frac{1}{1-\delta}\right)$ *the lender does not deviate if and only if* $\gamma \geq \gamma^1_{II_{low}} \equiv (1-q)(1-pqA)$.

(ii) If $qA \in \left[\frac{1}{1-\delta}, \frac{1}{p}\right)$ *the lender does not deviate if and only if* $\gamma \geq \gamma^2_{II_{low}} \equiv (1-q)\left(1 - \frac{p}{1-\delta}\right)$.

(iii) If $qA \in \left[\frac{1}{p}, +\infty\right)$ *the lender does to deviate if and only if* $\gamma \geq \gamma^2_{II_{low}} \equiv (1-q)\left(1 - \frac{p}{1-\delta}\right)$.

Proof. This result is a direct implication from Proposition 1 and, therefore, there is no need to provide a proof. ■

A. Proof of Lemma 2

Lemma 2. *Suppose $\delta + p \geq 1$ and $E < pC + 1$. Then,*

(i) If $qA \in \left(1, \frac{1}{p}\right)$ *the lender does not deviate if and only if* $\gamma \geq \gamma^1_{II_{low}} \equiv (1-q)(1-pqA)$.

(ii) If $qA \in \left[\frac{1}{p}, \frac{1}{1-\delta}\right)$ *the lender does not deviate if and only if* $\gamma \geq \gamma^1_{II_{low}} \equiv 0$.

(iii) If $qA \in \left[\frac{1}{1-\delta}, +\infty\right)$ *the lender does to deviate if and only if* $\gamma \geq \gamma^2_{II_{low}} \equiv 0$.

Proof. This result is a direct implication from Proposition 1 and, therefore, there is no need to provide a proof. ■

A. Proof of Lemma 3

Lemma 3. *Consider the assumption A1:* $E > \max\left\{C, 1 + \dfrac{1}{1-\delta}\right\}$. *Then,*

(i) When $qA < \min\left\{\dfrac{1}{p}, \dfrac{1}{1-\delta}\right\}$

- *If* $E \in \left[\max\left\{C, 1 + \dfrac{1}{1-\delta}\right\}, pC + 1\right)$ *the lender does not deviate if and only if* $\gamma \geq \gamma^1_{II_{low}} \equiv (1-q)(1-pqA)$.
- *If* $E \in \left[pC + 1, +\infty\right)$ *the lender does not deviate if and only if* $\gamma \geq \gamma_{II_{high}} \equiv (1-p)(1-q)$.

(ii) When $\delta + p < 1$ *and* $qA \geq \dfrac{1}{1-\delta}$

- *If* $E \in \left[\max\left\{C, 1 + \dfrac{1}{1-\delta}\right\}, pC + 1\right)$ *the lender does not deviate if and only if* $\gamma \geq \gamma^2_{II_{low}} \equiv (1-q)\left(1 - \dfrac{p}{1-\delta}\right)$.
- *If* $E \in \left[pC + 1, +\infty\right)$ *the lender does not deviate if and only if* $\gamma \geq \gamma_{II_{high}} \equiv (1-p)(1-q)$.

(iii) When $\delta + p \geq 1$ *and* $qA \geq \dfrac{1}{p}$

- *If* $E \in \left[\max\left\{C, 1 + \dfrac{1}{1-\delta}\right\}, pC + 1\right)$ *the lender does not deviate if and only if* $\gamma \geq \gamma^1_{II_{low}} \equiv 0$.
- *If* $E \in \left[pC + 1, +\infty\right)$ *the lender does not deviate if and only if* $\gamma \geq \gamma_{II_{high}} \equiv (1-p)(1-q)$.

Proof. It is a direct implication from Proposition 1 and Proposition 2. ∎

A. Proof of Lemma 4

Lemma 4. *Suppose the following restriction on parameters,* $1 < qA < \max\left\{\dfrac{1}{1-\delta}, 2, C\right\} < E < C + 1$. *Then,*

(i) In all region $\max\left\{\dfrac{1}{1-\delta}, 2, C\right\} < E < \dfrac{C}{qA} + 1$ *we have*

- *If* $p \in \left[\dfrac{1}{C}, \dfrac{E-1}{C}\right]$ *the lender does not deviate if and only if* $\gamma \geq (1-p)(1-q)$
- *If* $p \in \left(\dfrac{E-1}{C}, \dfrac{1}{qA}\right)$ *the lender does not deviate if and only if* $\gamma \geq (1-q)(1-pqA)$

- *If* $p \in \left[\frac{1}{qA}, 1\right]$ *the lender does not deviate if and only if* $\gamma \geq 0$

(ii) In all region $\frac{C}{qA} + 1 \leq E < C + 1$ *we have*

- *If* $p \in \left[\frac{1}{C}, \frac{E-1}{C}\right]$ *the lender does not deviate if and only if* $\gamma \geq (1-p)(1-q)$
- *If* $p \in \left(\frac{E-1}{C}, 1\right]$ *the lender does not deviate if and only if* $\gamma \geq 0$

When $E \geq C + 1$*. Then*

(i) If $p \in \left[\frac{1}{C}, 1\right]$ *the lender does not deviate if and only if* $\gamma \geq (1-p)(1-q)$

Proof. Since our objective is to study the relation of γ with p we now observe the restrictions we need to pose on the parameter p.

By assumption $pC > 1$. Using this assumption, the region in which is feasible the projects to be implemented in the information-insensitive regime is given by $\frac{1}{C} \leq p \leq 1$.

The lowest p consistent with assumption A2 is $p_1 = \frac{E-1}{C}$ and this is the threshold that separates the case of high endowment from the low endowment (i.e., for $p \leq p_1$ we are in the high endowment regime and for $p > p_1$ we are in the low endowment regime).

Observe that if $p_1 \geq 1$, i.e., $E - 1 \geq C$, we are only in the high-endowment case (it does not matter how we move the parameter p in the region $p \in \left[\frac{1}{C}, 1\right]$, the lenders will not deviate if and only if $\gamma \geq (1-p)(1-q)$. On the other hand, when $E - 1 < C$, we can have the two regions - high endowment and low endowment. At the end the restriction about the endowment in this economy such that we have the two regimes of endowment is $E - 1 < C < E$. Given the other assumptions of parameters we already imposed, let us assume the following holds

$$1 < qA < \max\left\{\frac{1}{1-\delta}, 2, C\right\} < E < C + 1$$

Another important restriction in the parameter p is one that define the relation between $\frac{E-1}{C}$ and $\frac{1}{qA}$. The first restriction defines whether we are in a high endowment or low endowment regime, while the second defines (once it is valid the low endowment regime) whether agents have incentives to deviate or not. Depending on the relation between $\frac{E-1}{C}$ and $\frac{1}{qA}$ we have two cases :

(i) $\frac{1}{qA} > \frac{E-1}{C} \Rightarrow E < \frac{C}{qA} + 1 < C + 1$, which implies a restriction on E such that $\max\left\{\frac{1}{1-\delta}, 2, C\right\} < E < \frac{C}{qA} + 1$.

Note that the restriction of parameters imposed above implies that $\frac{E-1}{C} > \frac{1}{C}$. Therefore, in all region $p \in \left[\frac{1}{C}, \frac{E-1}{C}\right]$ the lender does not deviate if and only if $\gamma \geq (1-p)(1-q)$. In the region where $p \in \left(\frac{E-1}{C}, \frac{1}{qA}\right)$ the lender does not deviate if and only if $\gamma \geq (1-q)(1-pqA)$. Lastly, observe that in all region $p \in \left[\frac{1}{qA}, 1\right]$ the lender does not deviate if and only if $\gamma \geq 0$.

(ii) $\frac{1}{qA} \leq \frac{E-1}{C} \Rightarrow E \geq \frac{C}{qA} + 1$, which implies a restriction on E such that $\frac{C}{qA} + 1 \leq E < C + 1$.

Given the restriction of parameters implied above it is still valid the fact that $\frac{E-1}{C} > \frac{1}{C}$. Hence, in all region $p \in \left[\frac{1}{C}, \frac{1}{qA}\right]$ the lender does not deviate if and only if $\gamma \geq (1-p)(1-q)$. In the region $p \in \left(\frac{1}{qA}, \frac{E-1}{C}\right]$ the lender also does not deviate if and only of $\gamma \geq (1-p)(1-q)$. In the region of parameters $p \in \left(\frac{E-1}{C}, 1\right]$ the lender does not deviate if and only if $\gamma \geq 0$.

■

A. Proof of Proposition 3

Proof. In this case it is trivial to note that given $\gamma \leq \gamma_{IS} \equiv p(qA-1)$ it is feasible and profitable to implement the IS contract using the considerations stated in the correspondent section.

On the other hand, when $\gamma > \gamma_{IS} \equiv p(qA-1)$ is is not possible to implement the IS contract and the lender has to face two decisions, which is whether to consume all the endowment in the first period of her life or to use part of her endowment to self-finance her project. Therefore, the lender has to compare the following payoffs E and $E - \frac{1}{1-\delta} + qA$. It is easy to perceive that given $\gamma > \gamma_{IS} \equiv p(qA-1)$, the lender self-finance the project whenever $E - \frac{1}{1-\delta} + qA \geq E$ or, in other words, when $qA \geq \frac{1}{1-\delta}$. If the opposite is true, the IS contract is not implementend and the lender buys land to use as collateral in the following period. ■

A. Proof of Proposition 4

Proof. It is a direct implication from previous results. ■