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Financial constraints and collateral crises ☆

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ABSTRACT

Assessing the fundamental value of a wide range of asset-backed securities is costly. As a result, these assets can become information insensitive, which allows them to be used as collateral in credit transactions. In this paper, we show that while it is true that information-insensitive assets can play a liquidity role, the fact that they play this role reinforces their information insensitivity. This implies that the availability of alternative ways of financing can harm the liquidity role of assets, even if these alternatives are costly and not used in equilibrium. The reason is that such options raise the asset's sensitivity to information by increasing the relative importance of their fundamental value vis-a-vis their role as collateral.

1. Introduction

Asset-backed securities were extensively traded in the period leading up to the 2008 financial crisis. The demand for these assets was driven not only by their fundamental value but also for their liquidity role, i.e., their use as collateral in credit operations. Gorton and Ordoñez (2014) links the liquidity of such assets to their complexity. They argue that if it is very costly to acquire information about the fundamental value of an asset, there exist equilibria in which this information is not acquired and the asset becomes information-insensitive, which allows it to perform money-like functions.

In this paper, we posit that while it is true that information-insensitive assets can play a liquidity role, the fact that they play this role reinforces their information insensitivity. Intuitively, one has fewer 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. The downside of this result is that the emergence of alternative ways to address financing needs, by undermining the liquidity role of an asset and reinforcing its fundamental value, raises the incentives to acquire information about the asset, and reduces its information-insensitivity.

Our environment is based on Gorton and Ordoñez (2014). There is an overlapping generation structure, wherein each period the economy is populated by a unit continuum of young agents and a unit continuum of old agents. Each member

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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. The land captures the role of asset-backed securities. It has no productive use, but it has an unobservable intrinsic value. Old agents borrow from young agents to finance their projects, and land is used as collateral.

Absent any information asymmetries, the environment in Gorton and 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, allowing the borrower to credibly pledge his production to the lender. The key feature of their environment is the assumption that the intrinsic quality of the land held by the borrower can only be verified by the lender at a cost. They also assume that capital fully depreciates. We depart from their environment by assuming that capital is storable, and subject to a positive depreciation rate. With this modification, we aim at capturing the idea that a young agent may choose to self-finance her production activity. Our objective is to have the use of land as collateral competing with alternative sources of resources, and self-finance is a simple way to introduce such an alternative.

Our main result is that the incentives of a lender to privately verify the underlying quality of 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, whether the lender chooses to verify the quality of the land or not has no bearing on her decision about implementing a project in the following period. She will have enough resources to do so either way. As a result, she has stronger incentives to deviate and enjoy the extra-benefit coming from keeping 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 land quality and keep it in case it is good, she will be unable to fund her future production activity. This reduces her incentives to deviate. This result implies that information-insensitive contracts are more prevalent in the economy when the lender has a relatively small endowment and, therefore, no access to alternative ways of financing. This has a positive effect on welfare, as lending always takes place under information-insensitive contracts.

A low endowment captures, in a stylized way, a situation where alternative forms of financing projects are scarce (or expensive). This could happen to lenders for a variety of reasons: a shortage of deposits, little cash (perhaps owing to past investment decisions), or a high demand for credit from borrowers.[1] In these cases, lenders face a high opportunity cost for their resources. A high endowment corresponds to a situation when financial institutions have a low opportunity cost for their deposits, resources are somewhat idle, either because there is little demand for loans or because funding is cheap.[2]

While a formal test of the model is beyond the scope of this paper, we conjecture that the driving forces of our model might have played a role in the collapse of the market for asset-backed securities in 2007. The demand for loans from banks seems to have plummeted after 2005. In the model, this would be captured by a surge in the endowment of lenders. By raising incentives for assessing the value of assets used as collateral, this fall in demand for credit could jeopardize the market of collateralized credit. Hence the adverse shocks hitting the economy would be amplified by a change in the behavior of financial institutions.

A growing literature argues that a shortage of safe assets has led to the use of complex assets as collateral, i.e., assets whose information about their intrinsic value is costly to acquire. Key references are Dang et al. (2012), Xie (2012), Gorton and Ordonez (2013) and Gorton and Ordoñez (2014).[3] The innovation of our model in relation to those papers lies in exploring how the difficulty in finding viable alternatives to the use of collateral may reinforce the latter's information insensitivity.

The remaining of the paper is organized as follows. In the next section, we present the model. Section 3 presents the equilibrium. Section 4 discusses how the model could be connected to the collapse of the market for asset-backed securities. Section 5 concludes.

2. Model

The environment is based on Gorton and Ordoñez (2014), GO henceforth. Consider an overlapping generations economy initially populated by a unit continuum of young agents and a unit continuum of old agents. Agents are risk-neutral, live for two periods, and young agents enter the economy with an endowment E of a good. The good is storable across periods and it depreciates at a rate $\delta \in (0, 1]$. Young agents can store the good 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 with the complementary probability. The outcome of the project is privately observed by the old agent.

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[1] A literature in corporate finance shows that firms' investment decisions are positively affected by shocks to cash flows. Examples include Kim et al. (1998), Opler et al. (1999), Almeida et al. (2004), and Faulkender and Wang (2006). Here, the focus is on lenders and the mechanism is completely different: abundance of cash might undermine the role of assets as collateral and, consequently, have a negative impact on credit markets.

[2] Loose monetary policy may reduce the opportunity cost of resources for banks. This has a negative effect on collateralized credit markets. In this sense, our paper is related to a literature arguing that accommodative monetary policies are linked to credit booms and excessive risk-taking. A few papers suggest that the relatively low interest rates in the US were at the root of the 2008 financial crisis. Dell'Ariccia et al. (2014) argue that in a low-interest-rate regime, banks take on more risk. Maddaloni and Peydró (2011) and Jiménez et al. (2014) find evidence that low overnight rates lead banks to soften their lending standards. In a different direction, Hirata et al. (2013) argues that a low interest rate was an important factor behind the increases in house prices and household leverages.

[3] For empirical evidence related to these models, see Krishnamurthy and Vissing-Jorgensen (2015).

We say that a young agent self-finances a project if she stores an amount $\frac{1}{1-\delta}$ of goods when young in order to implement the project when she becomes old. We assume that $qA > \frac{1}{1-\delta}$ and self-finance is efficient relative to consumption of the endowment.

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, which allows it to be used as collateral by old agents. 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. Following GO, we assume that collateral ownership is indivisible, i.e., the old agent has to hold the whole unit of good land in order to keep its value. The quality of the land is not directly observable. However, it can be observed by the young agent if she incurs a cost $\gamma > 0$ at the beginning of the period. If the young agent incurs the cost, we say that she has produced information about the quality of the land. If the young agent chooses to produce information, she can do it publicly and reveal the information to everyone in the economy; or she can do it privately and keep the information to herself throughout the period.

There exists a competitive market for land that can be accessed throughout the period. Following GO, we assume that the market price of land is equal to its expected intrinsic utility.[4] Throughout, we assume that $E > pC > 1$. This implies that, if there is no production of information about the quality of the land, an old agent has enough collateral to borrow the funds required to implement the project, and a young agent has enough endowment to purchase one unit of land. We also assume that $E > 1 + \frac{1}{1-\delta}$., i.e., a young agent has enough endowment to fund the project of an old agent and, at the same time, self-finance her own project when she becomes old. Two types of contracts may emerge in the economy, information-insensitive (II) contracts, in which there is no production of information; and information-sensitive (IS) contracts, in which there is production of information. In every 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 land in case the project fails. From now on, we will refer to an II contract as the pair (R_{II}, x_{II}), and to an IS contract as the pair (R_{IS}, x_{IS}). As it will become clear, in an IS contract it does not matter whether the young agent chooses to produce information publicly or privately. Intuitively, her action will reveal the information about the quality of the land. We will return to this point later.

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 contract. This implies that the young agent determines the conditions on II and IS contracts that make her indifferent between lending or not, and the old agent chooses the contract that maximizes his expected payoff. At the end of the period, the young agent makes a take it or leave it offers for the land of the old agent in her match. We assume that, if there is private production of information, by the end of the period the information becomes available in the meeting in which the young agent participates, and it becomes publicly available at the beginning of the following period.

Remarks. Our environment is based on GO, but with three key modifications. First, we add to their model the possibility of self-finance, i.e., a young agent can store her endowment and use it when old to implement a project. Self-finance is relatively inefficient because a fraction δ of the stored endowment depreciates.[5] This is a natural assumption since the endowment works as capital in the implementation of a project.

Second, we assume that projects are indivisible and require one unit of goods. In GO, projects are divisible, which allows them to capture how the incentives to produce information about the quality of the land impacts the size of the project. Here, we want to capture how the size of the endowment and the possibility of self-financing impacts the incentives to produce information about the quality of the land.

Third, we make a different assumption regarding the timing of the revelation of information about the quality of land. In GO, if there is private production of information, everyone has access to the information at the end of the period. In our set up, if the young agent privately produces information, only the old agent in her match has access to this information at the end of the period. The agents not participating in the match are only informed about the quality of the land at the beginning of the following period. We will address the implications of this difference later in the paper.

Finally, we also impose some restrictions on parameters. Most of them are natural extensions of the ones considered in GO. First, while they assume that $qA > 1$ and production is efficient, we assume that $qA > \frac{1}{1-\delta}$ and self-finance is viable. Second, since projects are indivisible, $pC > 1$ is necessary to ensure that the old agent has enough collateral to fund the project under an II contract. Third, $E > pC$ is necessary to ensure that the young agent can acquire land at the end of the period under an II contract. Finally, the assumption that $E > 1 + \frac{1}{1-\delta}$ captures the idea that self-finance is an inferior option but the young agent always has enough resources to undertake it and, at the same time, fund the project of the current old agent.[6]

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[4] The indivisibility of collateral ownership implies that, if a young agent wants to use land as collateral in the following period, she must purchase the whole unit of land.

[5] An extensive literature builds on the assumption that whenever external financing is available, self-financing is less profitable, in the sense that it is better to fund projects with debt as opposed to equity. Examples include Bernanke and Gertler (1989), MacKie-Mason (1990), Bronars and Deere (1991), Dasgupta and Sengupta (1993), Moore (1993), Carlstrom and Fuerst (1997), Graham (2000), Blouin et al. (2010), and Matsa (2010).

[6] For completeness, an additional difference between our set up and GO is that is they consider a full distribution of the probability that the collateral is of good quality, while here we treat this probability as a parameter.

3. Equilibrium

Henceforth, we also refer to young agents as lenders and to old agents as borrowers. We start by considering a scenario where only II contracts can be implemented. We will then consider the scenario in which II contracts cannot be implemented, in which case agents either implement an IS contract or self-finance.

3.1. II contracts

Consider a contract (R_{II}, x_{II}). The expected payoff of the borrower under this contract is

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

There is a probability q that the project succeeds, in which case the borrower obtains $A - R_{II}$, and keeps the land. He is indifferent between selling his unit of land to the lender in his match or in the market for land, and we break the tie in favor of the latter. This way, the market for land is always active. With the complementary probability, the borrower keeps a fraction $1 - x_{II}$ of the land and sells it to the lender at the end of the period. In both cases, since borrowers can always keep the land and obtain pC in expectation, the price of the land is given by pC.

We need to make sure that the borrower does not have an incentive to misrepresent the outcome of the project. If the project succeeds, he obtains $A - R_{II}$ and keeps all the land. If he misrepresents the outcome and says that the project failed, he keeps all the returns from the project but only keeps a fraction $1 - x_{II}$ of the land. The borrower does not misrepresent the outcome of the project if and only if

$$A - R_{II} + pC \geq A + (1 - x_{II})pC \implies R_{II} \leq x_{II}pC. \tag{2}$$

If, instead, the project fails, the borrower keeps a fraction $1 - x_{II}$ of the land. If he chooses to misrepresent the outcome, he needs to sell the land in the market for a price pC and transfer R_{II} to the lender. He has no incentive to misrepresent the outcome of the project if and only if

$$(1 - x_{II})pC \geq pC - R_{II} \implies R_{II} \geq x_{II}pC. \tag{3}$$

Combining (2) and (3) we obtain

$$R_{II} = x_{II}pC = 1,$$

where the latter equality is an implication of the fact that the borrower holds all the bargaining power in determining the terms of the contract. We can then rewrite (1) as

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

Let us now consider the expected payoff of the lender, under the assumption that she does not produce information about the quality of the land. She is indifferent between lending and not lending, and we break the tie in favor of lending. There is a probability q that the project succeeds. In this case, the lender receives a repayment of one unit of goods and leaves the contracting stage with E units. There is a complementary probability that the project fails, in which case the lender receives a fraction x_{II} of the land. Since $x_{II}pC = 1$, this fraction is worth one unit of goods, so the lender ends up with E units of goods.[7] Thus, we only need to contemplate the possible uses that the lender can make of her endowment E. First, she can consume the entire endowment, obtaining E. Second, she can self-finance, obtaining $E - \dfrac{1}{1-\delta} + qA$. Since $qA > \dfrac{1}{1-\delta}$ self-finance strictly dominates consuming the entire endowment. Finally, she can purchase one unit of land to use as collateral in the following period. Her payoff in this case is $E - pC + V_{b|II}$, which using (4) can be rewritten as $E - 1 + qA$. Since $\dfrac{1}{1-\delta} > 1$, this option strictly dominates self-finance. Intuitively, under self-finance the actual cost of the project is $\frac{1}{1-\delta}$, since it is paid by the agent herself. 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. The lender's expected payoff is then

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

Summarizing, on the path of play implied by the II contract, the lender does not incur the cost γ, lends to the borrower, and uses her endowment to enter the following period with one unit of land, to be used as collateral. In order to check whether the II contract can be implemented, we need to make sure that the lender has no incentive to produce information

[7] In more detail, upon receiving her fraction x_{II} of the land, she uses her endowment of goods $E - 1$ to purchase the land kept by the borrower. She can then sell the whole unit of land in the market in exchange for pC units of goods, ending up with E units of goods.

about the quality of the land. If she deviates and incurs the cost γ, two scenarios arise, depending on whether the land turns out to be of bad or good quality. We will examine each possibility in turn.

There is a probability $1-p$ that the land is of bad quality. In this case, the young agent still wants to lend because the information about the quality of the land will not be disclosed outside her meeting at the end of the period. In particular, the lender knows that she can purchase the land from the borrower in her match and sell it for the price pC since all other agents believe that every unit of land in the market is good with probability p. This implies that the expected payoff of the lender after a deviation in which the land turns out to be of bad quality, is equal to $E+qA-1$, i.e., it coincides with the payoff obtained on the path of play implied by the II contract. As a result, if there is any benefit associated with producing information about the quality of the land, it must come from the possibility that the land turns out to be of good quality.[8]

Let us then consider the case where the land is of good quality, an event with probability p. There are two possibilities, depending on the outcome of the project. If the project turns out successful, an event with probability q, the lender will receive her loan back and will have E units of goods. She can then use her endowment to buy land in the market, which she will use as collateral in the following period. Since the cost of land is pC, her expected payoff is $E-pC+V_{b|II}$, and it can be rewritten as $E+qA-1$.[9] As argued above, this option strictly dominates consumption of the endowment and self-finance.

What if the project fails, an event with probability $1-q$? In this case, the lender has $E-1$ goods and receives a fraction x_{II} of good land. There are two optimal choices. The lender can purchase the remaining land from the borrower in her match and use the whole land as collateral in the following period. The expected payoff in this case is $E-1-(1-x_{II})C+qA-1+C$, and it can be rewritten as $\frac{1-p}{p}+E+qA-1$. This option is feasible if and only if $E-1\geq(1-x_{II})C$, i.e., $E\geq C-\frac{1-p}{p}$. Alternatively, she can consume her fraction of the land and purchase another land in the market to use as collateral in the following period. The resulting expected payoff is $E-1+x_{II}C-pC+qA-1+pC$, and it can be rewritten as $\frac{1-p}{p}+E+qA-1$. This option is feasible if and only if $E-1\geq pC$, i.e., $E\geq 1+pC$. The superiority of these choices comes from the fact they allow the lender to enjoy the benefit of her superior information about the quality of the land, while keeping her ability to fund the implementation of her project in the least costly way.

In summary, as long as

$$E\geq\min\left\{1+\frac{pC-1}{p},1+pC\right\}$$

and liquidity is abundant, if the lender chooses to produce information about the quality of the land, her expected payoff is

$$V_{l|II}^{\text{ab}}=-\gamma+(1-p)(E+qA-1)+p\left[q(E+qA-1)+(1-q)\left(\frac{1-p}{p}+E+qA-1\right)\right],$$

and it can be rewritten as

$$V_{l|II}^{\text{ab}}=-\gamma+E+qA-1+(1-q)(1-p).$$

The lender has no incentives to deviate if and only if $V_{l|II}\geq V_{l|II}^{\text{ab}}$, which can be rewritten as

$$\gamma\geq\gamma^{\text{ab}}\equiv(1-q)(1-p).$$

The lower bound γ^{ab} is exactly the same as in GO, keeping in mind that, in our case, the project is indivisible and it requires one unit of goods. This is somewhat expected since GO restricts attention to a scenario where liquidity is abundant.[10] It is also important to highlight that the reasoning above makes an extensive use of the fact that to fund a project with collateral is cheaper than self-finance. Thus, if the endowment is relatively abundant and the agent can always fund with collateral, the possibility of self-finance is immaterial.

Let us now consider the scenario where

$$E<\min\left\{1+\frac{pC-1}{p},1+pC\right\},$$

and liquidity scarce. The assumption that $pC>1$ ensures that there exists a non-empty region of parameters where this inequality is satisfied. In this case, if the land turns out of good quality but the project fails, the lender can no longer

[8] As mentioned in the previous section, this is a key difference between our set up in GO. In their paper, if the lender produces but not discloses information about the quality of the land, this information becomes publicly available at the end of the period. Anticipating this outcome, the lender chooses not to accept land of bad quality as collateral, as it will become worthless before she has the opportunity to sell it in the market. Thus, in GO, the benefit of producing information is linked to the possibility that land turns out to be of bad quality.

[9] In principle, if $E>C$, the lender can also use her endowment to buy the land from the borrower in her match, at a price C. In this case, the best option would be to use the land as collateral in the following period, at which point the quality of the land would be known by everyone, delivering an expected payoff equal to $E-C+qA-1+C$. This payoff coincides with the expected payoff of purchasing the land in the market.

[10] It is important to reiterate that this equivalence is not trivial because, unlike in GO, lending takes place even if the lender knows that the land is of bad quality.

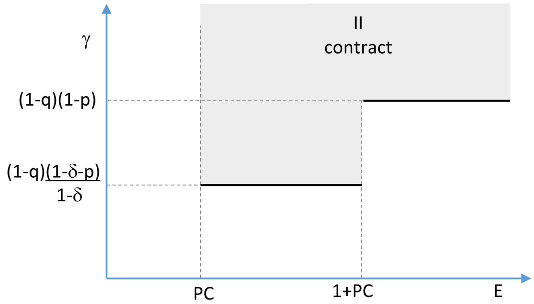

Fig. 1. Region with information-incentive contracts as a function of the endowment E.

enjoy the benefit of the good land and, at the same time, obtain collateral for the next period. Her best option is to consume her fraction of the good land and self-finance her project in the following period. The assumption that $E-1>\frac{1}{1-\delta}$ ensures that this option is feasible, and the resulting payoff is $E-1+x_{II}C+qA-\frac{1}{1-\delta}$, which can be rewritten as $\frac{1-p}{p}+E+qA-\frac{1}{1-\delta}$. The assumption that $qA>\frac{1}{1-\delta}$ implies that this option strictly dominates consumption of the land and of the entire endowment.[11]

Summing over all contingencies, if the lender chooses to produce information about the quality of the land, her expected payoff is

$$V^{sc}_{I|II}=-\gamma+E+qA-1+\max\left\{(1-q)\left(1-\frac{p}{1-\delta}\right),0\right\}.$$

The lender has no incentives to deviate if and only if $V_{I|II}\geq V^{sc}_{I|II}$, which can be rewritten as

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

Proposition 1 summarizes our results.

Proposition 1. *Let* $qA>\frac{1}{1-\delta}$, $pC>1$, $E>\max\left\{pC,1+\frac{1}{1-\delta}\right\}$, *and assume that the lender and the borrower can only implement the II contract.*

(1) If $E\geq\min\left\{1+\frac{pC-1}{p},1+pC\right\}$ *and liquidity is abundant, the lender does not have an incentive to produce information about the quality of the collateral and the II contract is implemented if and only if*

$$\gamma\geq\gamma^{ab}\equiv(1-q)(1-p).$$

(2) If $E<\min\left\{1+\frac{pC-1}{p},1+pC\right\}$ *and liquidity is scarce, the lender does not have an incentive to produce information about the quality of the collateral and the II contract is implemented if and only if*

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

The key message of our paper is that $\gamma^{ab}>\gamma^{sc}$. In words, the incentives to deviate are always stronger when liquidity is abundant. Besides, the possibility of self-finance has no impact on the incentives to deviate under abundant liquidity, but they matter when liquidity is scarce. In particular, the incentives to deviate increase when self-finance is relatively efficient, and they coincide with those under abundant liquidity if the endowment does not depreciate.

Fig. 1 looks at the relation between γ and E.[12] Fig. 2 looks at the relation between γ^{sc} and how inefficient self-finance is (δ).

A last comment is in order. As argued in footnote 8, a key difference between our set up and GO is that, while in their paper the lender wants to deviate and acquire information because she does not want to lend if the land offered as

[11] In principle, the lender could sell the fraction of her land in the market at the price pC per unit of land and use the proceeds to purchase one unit of land to use as collateral. Given our assumption that collateral ownership is indivisible, this scheme would only work if the borrower participating in the match with the lender and holding the complementary fraction of the land is willing to sell her fraction to the same lender for the price pC. However, since the borrower knows that the land is of good quality, he is not willing to participate in this scheme.

[12] We consider the region of parameters where $\gamma^{sc}>0$ and $C>\max\left\{\frac{2-\delta}{p(1-\delta)},\frac{1}{p(1-p)}\right\}$. In this case, $pC=\max\left\{pC,1+\frac{1}{1-\delta}\right\}$ and $1+pC=\min\left\{1+\frac{pC-1}{p},1+pC\right\}$.

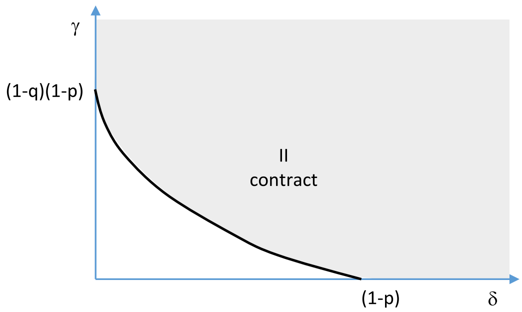

Fig. 2. Region with information-incentive contracts as a function of δ.

collateral is of bad quality, here the lender wants to deviate and acquire information because she wants to keep the good land in case the project fails.

To better understand the implications of this difference, consider a hypothetical scenario where liquidity is abundant and, with the exception of one lender, all lenders have a cost $\gamma \geq \gamma^{ab}$. In GO, the lender with $\gamma < \gamma^{ab}$ would choose not to lend if the land were of bad quality, while in our setup, he would still lend. However, if $\gamma < \gamma^{ab}$ for all agents, lending no longer takes place in our environment. In fact, all agents know that, when $\gamma < \gamma^{ab}$ and the price of the land in the market is pC, every lender has an incentive to know the quality of the land in her match. Besides, in every match, both the lender and the borrower will have information on the quality of the land at the end of the period. As a result, if the land turns out to be of bad quality, both agents would want to sell it in the market. If, instead, the land turns out of good quality, both agents would want to keep it in order to benefit from their superior information. As a result, if land is offered in the market, it must be because it is of low quality, and the only equilibrium price is zero. In anticipation of this fact, lenders will only accept as collateral land of good quality.

3.2. IS contracts and self-finance

In what follows, we determine the outcome when the conditions for the implementation of the II contract are not satisfied. The natural candidates are IS contracts in which there is production of information about the quality of the land, and self-finance. In GO, IS contracts may be optimally chosen because the need to prevent production of information can lead to projects that are too small. Owing to our assumption that projects are indivisible, the model here does not capture those intensive margin effects. As a result, production of information may only be optimal on the path of play implied by the IS contract if the II contract cannot be implemented.

Consider then the scenario where the lender has chosen to publicly incur the cost γ and observe the underlying quality of the land.[13] She will only finance the project if the land turns out of good quality. Moreover, since the information produced by the lender becomes publicly available, the need to incur the cost γ only applies to the first generation of lenders.[14] Henceforth, we proceed by characterizing the IS contract of the first generation, labeled (R^0_{IS}, x^0_{IS}), and then we consider the contract of future generations.

Fix a contract (R^0_{IS}, x^0_{IS}). If the land turns out of bad quality, the expected payoff of the borrower is zero, since he will not be able to fund his project. If, instead, the land is of good quality, his expected payoff is

$$V^G_{b|IS} = q(A - R^0_{IS} + C) + (1-q)(1 - x^0_{IS})C$$

There is a probability q that the project succeeds, in which case the borrower obtains $A - R^0_{IS}$ and keeps the land. With the complementary probability, he keeps a fraction $1 - x^0_{IS}$ of the land. We need to make sure that the borrower does not have an incentive to misrepresent the outcome of the project. The same reasoning used for II contracts implies that he does not have an incentive to claim that the project failed when it was successful if and only if

$$A - R^0_{IS} + C \geq A + (1 - x^0_{IS})C \implies R^0_{IS} \leq x^0_{IS} C. \tag{5}$$

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

$$(1 - x^0_{IS})C \geq C - R^0_{IS} \implies R^0_{IS} \geq x^0_{IS} C. \tag{6}$$

[13] In the Appendix, in the proof of Proposition 2, we show that in an IS contract, it does not matter whether the young agent chooses to reveal or not the information. Intuitively, her action will reveal the information about the quality of the land.

[14] GO are interested in cases in which the need to produce information is always present. As a result, they assume that land may suffer a shock that changes its quality over time in an unobservable way. Here, the gist of our message can be conveyed by examining II contracts under distinct liquidity needs, so there is no clear benefit and a cost in tractability in adding the possibility of shocks.

Combining (5) and (6), we obtain $R^0_{IS} = x^0_{IS}C$. The surplus of the lender from participating in the contract is

$$-\gamma + p\left[qR^0_{IS} + (1-q)x^0_{IS}C - 1\right].$$

Using $R^0_{IS} = x^0_{IS}C$ and the fact that the borrower has all the bargaining power, we obtain

$$x^0_{IS} = \frac{p+\gamma}{pC}.$$

Note that feasibility requires $\gamma \leq p(C-1)$. The expected payoff of the borrower with good land under the IS contract can then be rewritten as $-\frac{\gamma}{p} + qA - 1 + C$. Since the borrower can always choose not to participate in the contract, the IS contract requires $-\frac{\gamma}{p} + qA - 1 \geq 0$, i.e.,

$$\gamma \leq \gamma^{\inf} \equiv p\,(qA-1)\,.$$

Henceforth, we follow GO and assume that

$$qA < C.$$

This ensures that, whenever it is optimal to borrow, it is feasible to do so. As a result, the expected payoff of the initial generation of borrowers is

$$V^0_{b|IS} = \begin{cases} p(qA-1) - \gamma + pC \text{ if } \gamma \leq \gamma^{\inf} \\ pC \text{ if } \gamma > \gamma^{\inf} \end{cases}, \tag{7}$$

where we take into account that the IS contract may only be implemented if the land is of good quality, an event with probability p.

Summarizing, if $\gamma \leq \gamma^{\inf}$, there is production of information about the quality of the land, and lending takes place if the land is of good quality. Otherwise, there is no production of information and no lending. The key observation is that the expected payoff of the borrower is strictly lower under the IS contract, which implies that this contract is only chosen if the II contract cannot be implemented. II contracts are superior for two reasons. First, lending takes place irrespective of the quality of the land. Second, there is no need to incur the cost γ.

We now consider the choices of the first generation of lenders if there is production of information about the quality of the land, i.e., if $\gamma \leq \gamma^{\inf}$. In this case, a measure p of lenders participate in matches with borrowers carrying good land. By the end of the period, each such lender will have $E + \frac{\gamma}{p}$ units of goods, since they were compensated for incurring the cost γ. If $E + \frac{\gamma}{p} < C$, which can be rewritten as $\gamma < p(C-E)$, these lenders will not have enough endowment to purchase good land and self-financing will be their best option. In this case, all land will be consumed by the initial generation of borrowers and all generations of lenders will self-finance. If, instead, $E + \frac{\gamma}{p} \geq C$, the lender will have enough resources to purchase the good land, and it is optimal for them to do so, since the continuation payoff is $qA-1$, which strictly dominates self-finance. There is also a complementary measure $1-p$ of lenders that participate in matches with borrowers carrying bad land. The best option for these lenders is to self-finance, obtaining $qA - \frac{1}{1-\delta}$. It remains to determine the choice of future generations of lenders. There are two possibilities. If $E \geq C$, these lenders will have enough resources to purchase good land, and good land can then be carried over across generations and used as collateral in all future periods. If, instead, $E < C$, good land will be consumed by the end of the second period, and all future generations of lenders must self-finance.

Turning to the choice of future generations of lenders, there are two possibilities. If $E \geq C$, these lenders will have enough resources to purchase good land, and good land can then be carried over across generations and used as collateral in all future periods. If, instead, $E < C$, good land will be consumed by the end of the second period, and all future generations of lenders must self-finance.

What about the region of parameters where $\gamma > \gamma^{\inf}$? In this case, there is no production of information and the initial generation of borrowers simply hold one unit of land of unknown quality at the end the period. If the first generation of lenders chooses to purchase one unit of land, they will end up in the same situation as the initial generation of borrowers, holding one unit of land of unknown quality at the end of the period. Assuming that the II contract is not feasible, the best option for the lenders is to self-finance. Proposition 2 summarizes our results.

Proposition 2. *Let $\frac{1}{1-\delta} < qA < C$, $pC > 1$, $E > \max\left\{pC, 1 + \frac{1}{1-\delta}\right\}$, and assume that the II contract is not feasible.*

(1) If $\gamma \leq \gamma^{inf} \equiv p\,(qA-1)$, there is production of information by the first generation of lenders. If $E \geq C$, all generations of lenders use good land as collateral. If $E < C$ and $\gamma \geq p(C-E)$, the first generation of lenders uses good land as collateral, but all future generations self-finance. If $E < C$ and $\gamma < p(C-E)$, all generations of lenders self-finance.

(2) If $\gamma > \gamma^{inf} \equiv p\,(qA-1)$, there is no production of information and all generations of lenders self-finance.

Summarizing our analysis so far, we have first determined the region of parameters in which the II contract can be implemented. Since this contract delivers the highest expected payoff to the borrower, he will always choose the II contract whenever it is feasible to do so. We then determined behavior in the region of parameters where the II contract is not feasible. Two outcomes arise, depending on the relative size of the cost γ. If γ is not too large, there is production of information by the first generation of lenders and the initial generation of borrowers choose the IS contract. If, instead, γ is large, there is no production of information by the first generation of lenders and no contract is chosen by the initial generation of borrowers.

In what follows, we provide our definition of equilibrium (analogous to the one in GO) and then combine Propositions 1 and 2 to fully characterize the behavior of borrowers and lenders in all regions of parameters consistent with our assumptions.

Definition 1. In each period, for each match of a borrower and a lender, an equilibrium is:

- A pair of debt face values (R_{II} and R_{IS}) and a pair of fractions of land to be collected in case of default (x_{II} and x_{IS}) such that lenders are indifferent; borrowers choose between information-sensitive debt or information-insensitive debt to maximize their payoffs; and lenders decide on whether to self-finance to maximize their payoffs.
- A land price determined by a take-it-or-leave-it offer made by the lender.
- Beliefs updated using Bayes' rule.

Proposition 3. *Let* $\frac{1}{1-\delta} < qA < C$, $pC > 1$, $E > \max\left\{pC, 1 + \frac{1}{1-\delta}\right\}$. *In equilibrium:*

(1) The II contract is implemented if and only if liquidity is abundant and $\gamma \geq \gamma^{ab}$, *or liquidity is scarce and* $\gamma \geq \gamma^{sc}$.

(2) If the II contract cannot be implemented and $\gamma \leq \gamma^{inf}$, *there is production of information. If* $E \geq C$, *all generations of lenders use good land as collateral. If* $E < C$ *and* $\gamma \geq p(C - E)$, *the first generation of lenders uses good land as collateral, but all future generations self-finance. If* $E < C$ *and* $\gamma < p(C - E)$, *all generations of lenders self-finance.*

(3) If the II contract cannot be implemented and $\gamma > \gamma^{inf}$, *there is no production of information and all generations of lenders self-finance.*

3.3. Dynamics

In what follows, we consider an application of our model to a context where exogenous changes in the endowment makes the economy cycle between a scenario where all projects are funded under an information insensitive contract and a scenario where there is no funding and all agents have to self-finance their project.[15,16]

Let $\gamma \in \left(\gamma^{\text{inf}}, \gamma^{\text{ab}}\right)$ and assume that the endowment $E \in \{E_L, E_H\}$ follows a Markov process with $\Pr(E_H | E_H) = \Pr(E_L | E_L) = \rho$. Moreover, E_L and E_H are such that

$$pC < E_L < 1 + pC < \frac{1}{1-\delta} + pC < E_H.$$

Under these assumptions, if the endowment is always equal to E_L, there is no production of information and the II contract is implemented. In turn, if the endowment is always equal to E_H, there is no production of information but the agent self-finances. Note that, in the latter case, the agent has enough resources to self-finance and still purchase land at the price pC at the end of the period.

Assume that the economy is currently with endowment E_L. The current generation of old agents offers an II contract, and the current generation of young agents accepts. In turn, the latter chooses not to self-finance if and only if

$$-pC + \rho(qA - 1 + pC) + (1-\rho)pC \geq - - \frac{1}{1-\delta} + qA.$$

In words, the young agent incurs a cost pC purchasing one unit of land. There is a probability ρ that the endowment in the next period is equal to E_L, in which case the agent will use the unit of land as collateral; and a complementary probability that the endowment in the next period is equal to E_H, in which case the agent sells the land at the end of the period. If the young agent chooses to deviate and self-finance, the project is always implemented but at a higher cost.

Assume now that the economy is currently with endowment E_H. The current generation of old agents implements the project only if she has chosen to self-finance in the previous period, while the current generation of young agents chooses to self-finance if and only if

[15] The choice of a region where agents self-finance instead of choosing the IS contract is driven by tractability considerations, as it implies that there is never any production of information about the quality of the land.

[16] Precisely, under the same restriction on parameters established in Proposition 3, we further restrict our attention to the region where $\gamma^{\text{sc}} > 0$, $C > \max\left\{\frac{2-\delta}{p(1-\delta)}, \frac{1}{p(1-p)}\right\}$ and $1 + \frac{(1-\frac{p}{1-\delta})(1-q)}{p} < qA < 1 + \frac{(1-p)(1-q)}{p}$. These restrictions imply that $\gamma^{\text{sc}} < \gamma^{\text{inf}} < \gamma^{\text{ab}}$.

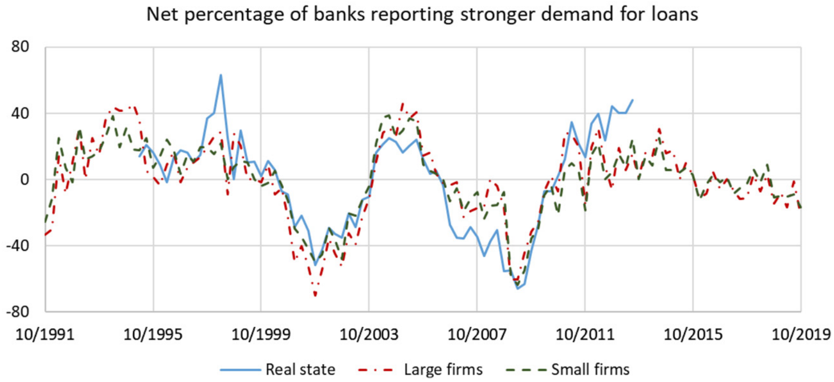

Fig. 3. Demand for corporate loans.

$$-\frac{1}{1-\delta}+qA \geq -pC+\rho pC+(1-\rho)(qA-1+pC).$$

The left-hand side gives the expected payoff of self-financing, while the right-hand side delivers the expected payoff in case the agent chooses not to self-finance. In the latter case, the young agent incurs a cost pC. With probability ρ the endowment in the following period is equal to E_H and the agent simply sells the land at a price pC, since land cannot be used as collateral. With the complementary probability, the endowment in the following period is equal to E_L, and the agent can use the land as collateral.

Summarizing, as long as

$$\rho > \max\left\{\frac{qA-\frac{1}{1-\delta}}{qA-1}, \frac{\frac{\delta}{1-\delta}}{qA-1}\right\},$$

exogenous changes in the availability of liquidity make the economy transit from a scenario where there is no production of information about the quality of the land, which can then be used as collateral; and a scenario where the abundance of liquidity increases the incentives of lenders to produce information about the quality of the land, and self-finance is the only viable option.

4. The collapse of ABS markets

The market of asset-backed commercial papers collapsed in 2007. From July to December, ABCP outstandings were reduced by around 30% and kept going down (Covitz et al., 2013). We conjecture that the forces highlighted in the model might have played a role. While a formal test of the mechanism is beyond the scope of this paper, this Section spells out the possible connection between the model and the market for asset-backed securities.

The crucial implication of the model is that asset-backed securities are more likely to play a money-like role when the endowment E is low. In this case, financial intermediaries cannot rely on internal finance, and asset-backed securities can be valuable because they can be used as collateral. In contrast, when the endowment E is high, banks have a low opportunity cost for their deposits and are thus more likely to try to understand whether assets often used as collateral are of good quality. Hence the model predicts that when banks have less profitable opportunities and more "idle" resources, collateralized debt markets are more likely to collapse.

Was the collapse of ABS markets preceded by a fall in the amount of profitable opportunities available for banks? Retrieving this information from the data is challenging owing to the usual endogeneity problems: factors that determine the supply of loans often affect the demand for credit as well. Nevertheless, there is evidence that the demand for loans was falling after 2005. Fig. 3 shows data from bank-level responses to the Federal Reserve's Loan Officer Opinion Survey. This survey collects the perceptions of banks regarding the demand for loans. The picture shows that the demand for credit reaches a peak around 2005 and then plummets.[17]

Gorton and Ordoñez (2014) propose that asset-backed securities played a money-like role because it was sufficiently costly to assess their fundamental value. This paper points out that if this is true, then the abundance of internal finance might turn this securities information sensitive and could put a halt on the market of collateralized debt. To the extent that abundance of internal finance is linked to the scarcity of investment opportunities, this channel would amplify any shock to the economy, driving down the return to firms' investment.

[17] This data has been used as a measure of demand for credit by Bassett et al. (2014) and Ciccarelli et al. (2015), for example.

5. Conclusion

In economies with frictions in the credit market, collateral is relevant from a liquidity perspective. In these economies, collateral circulates like money, enabling transactions. Collateral can only efficiently operate as money if it is information insensitive. This property is usually attributed to assets with well-known and easy-to-check values. However, as emphasized by Gorton and Ordoñez (2014), information insensitivity might also be a feature of assets with an intrinsic value that is very costly to assess.

In this environment, economic shocks might affect incentives for financial institutions to invest in understanding the value of assets commonly used as collateral. In a related contribution, Gorton and Ordonez (2020) have shown that in times of high productivity and low default probabilities, lenders have less incentives to learn the quality of assets used as collateral. This induces a credit boom, but might leave the economy subject to a crisis when productivity declines. The main result of our paper is that the availability of alternative ways of financing, albeit less productive, can reduce the information-insensitivity of an asset and undermine its liquidity role. Extensions of this framework might shed further light on the conditions for opaque assets to work as collateral. Future empirical research might be able to estimate the importance of this channel in the 2007-8 financial crisis.

Appendix A

Proof of Proposition 1. As derived in the main text, under the II contract, the borrower holds a land of unknown quality, which is valued at pC. He also has all the bargaining power and appropriates the full surplus $qA-1$. Thus, his expected payoff is

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

In the main text, we also derived the expected payoff of the lender if she chooses to not produce information about the quality of the land. We show that her payoff is given by the sum of her endowment when young and the full surplus of her investment when old, i.e.,

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

We need to make sure that the lender has no incentive to produce information about the quality of the land. If she does so, two scenarios arise. There is a probability $1-p$ that the land is of bad quality. In this case, the lender can sell her land for the unit price pC since, under the path of play implied by the II contract, all other agents believe that every unit of land in the market is good with probability p. The expected payoff of the lender is then equal to $E+qA-1$. There is a complementary probability $1-p$ that the land is of good quality. In this case, with probability q the project will be a success and the lender will receive her loan back and accumulate E units of goods at the end of the period. She can then use her endowment to buy land in the market, which she will use as collateral in the following period. Her expected payoff is $E-pC+V_{b|II}$, and it can be rewritten as $E+qA-1$. If, instead, the project fails, the lender has $E-1$ goods and receives a fraction x_{II} of good land. In this case, as derived in the main text, the lender has two options. First, she can purchase the remaining land from the borrower in her match and use the whole land as collateral in the following period. This option is feasible if and only if the remaining endowment after the loan, given by $E-1$, is larger than or equal to the cost of a fraction $1-x_{II}$ of land of good quality, given by $(1-x_{II})C$. This condition is given by $E\geq C-\frac{1-p}{p}$. Second, the lender can consume her fraction of the land and purchase another land in the market to use as collateral in the following period. This option is feasible if and only if $E-1\geq pC$, i.e., the remaining endowment after the loan is larger than or equal to the cost of one unit of land of unknown quality in the market. As derived in the main text, irrespective of her choice, the expected payoff of the lender is $\frac{1-p}{p}+E+qA-1$. Besides, it is sufficient to only check these two choices because they are the only ones that allow the lender to enjoy the benefit of her superior information about the quality of the land, while keeping her ability to fund the implementation of her project in the least costly way, i.e., with no need to self-finance. Summarizing, if

$$E\geq\min\left\{1+\frac{pC-1}{p},1+pC\right\},$$

and the lender chooses to produce information about the quality of the land, her expected payoff is

$$V^{\mathrm{ab}}_{l|II}=-\gamma+E+qA-1+(1-q)(1-p).$$

The lender does not deviate if and only if $V_{l|II}\geq V^{\mathrm{ab}}_{l|II}$, i.e.,

$$\gamma\geq\gamma^{\mathrm{ab}}\equiv(1-q)(1-p).$$

Finally, we also need to consider the complementary scenario in which

$$E < \min\left\{1 + \frac{pC - 1}{p}, 1 + pC\right\},$$

and the land turns out of good quality but the project fails. In this case, the lender does not have enough resources to enjoy the benefit of the good land and, at the same time, obtain collateral for the next period. Her best alternative is to simply consume her fraction of the good land and self-finance her project in the following period. This option is feasible due to the assumption that $E - 1 > \frac{1}{1-\delta}$, and the resulting payoff is $E - 1 + x_{II}C + qA - \frac{1}{1-\delta}$, which can be rewritten as $\frac{1-p}{p} + E + qA - \frac{1}{1-\delta}$. Note that, since $qA > \frac{1}{1-\delta}$, it is indeed the case that this option strictly dominates consumption of the land and of the entire endowment. Summing over all contingencies, if the lender deviates, her expected payoff is

$$V^{\mathrm{sc}}_{l|II} = -\gamma + E + qA - 1 + \max\left\{(1-q)\left(1 - \frac{p}{1-\delta}\right), 0\right\}.$$

She has no incentives to do so if and only if $V_{l|II} \geq V^{\mathrm{sc}}_{l|II}$, i.e.,

$$\gamma \geq \gamma^{\mathrm{sc}} \equiv \max\left\{(1-q)\left(1 - \frac{p}{1-\delta}\right), 0\right\}. \quad \square$$

Proof of Proposition 2. We first show that, if the lender chooses to incur the cost γ and observe the quality of the land in her match, it does not matter whether she does it publicly or privately. Assume that there is lending under private production of information in the match. In this case, by the end of the period the information about the quality of the land will become available in the meeting in which the young agent participates, but it will only become publicly available at the beginning of the following period. It is thus optimal to keep the land of good quality within the match and only sell the land of bad quality. As a result, the market price of the land in equilibrium must be equal to zero. In anticipation of this fact, after privately observing the quality of the land, lenders will only accept as collateral land of good quality, since they know that the collateral will be worth zero if the land is of bad quality. In other words, the act of lending reveals the private information of the lender, thus making it immaterial whether the lender chooses to publicly reveal the information about the quality of the land or not.

Now fix a contract (R^0_{IS}, x^0_{IS}), i.e., the IS contract of the first generation of lenders. In the main text, we derived the expected payoff of the initial generation of borrowers, given by

$$V^0_{b|IS} = \begin{cases} p(qA-1) - \gamma + pC \text{ if } \gamma \leq \gamma^{\inf} \\ pC \text{ if } \gamma > \gamma^{\inf} \end{cases},$$

where $\gamma^{\inf} \equiv p(qA - 1)$. In turn, the assumption that

$$qA < C,$$

which follows GO and ensures that, whenever it is optimal to borrow, it is feasible to do so.

Let us first consider the region of parameters where $\gamma > \gamma^{\inf}$. In this case, the first generation of lenders does not lend, there is no production of information about the quality of the land and the initial generation of borrowers simply hold one unit of land of unknown quality at the end the period. If the first generation of lenders chooses to purchase one unit of land, they will end up in the same situation as the initial generation of borrowers, holding one unit of land of unknown quality at the end of the period. Since the II contract is not feasible, the best option for lenders is to use their endowment to self-finance, as self-finance strictly dominates the consumption of the endowment.

Let us now consider the region of parameters where $\gamma \leq \gamma^{\inf}$. In this case, lending takes place in all matches with borrowers carrying good land. By the end of the period, each lender participating in one of these matches will have $E + \frac{\gamma}{p}$ units of goods. Two possibilities arise in this case, depending on the relative size of the endowment E. If $E + \frac{\gamma}{p} < C$, which can be rewritten as $\gamma < p(C - E)$, lenders will not have enough endowment to purchase good land and their best option is to self-finance, since self-finance strictly dominates consumption of the endowment. As a result, all land will be consumed by the initial generation of borrowers and all generations of lenders will self-finance. If, instead, $E + \frac{\gamma}{p} \geq C$, lenders will have enough resources to purchase good land, and it is optimal for them to do so, since borrowing strictly dominates self-finance. They will obtain $qA - 1$ as continuation payoff. Now, in matches in which borrowers carry land of bad quality, there is no lending, and the best option for the lenders at the end of the period is to self-finance. In fact, these lenders will end up with E units of goods at the end of the period, and if $E \geq C$, they would be able purchase good land. However, they would be competing with the measure p of lenders carrying $E + \frac{\gamma}{p}$ units of goods, and it is natural to break the tie in the market in favor of the latter, since they are carrying more resources.

Lastly, we need to determine the choices of future generations in the region where $\gamma \leq \gamma^{\inf}$. There are two possibilities, depending on the relative size of the endowment. If $E \geq C$, lenders will have enough resources to purchase good land, and good land can then be carried over across generations and used as collateral in all future periods. If, instead, $E < C$, good land will be consumed by the end of the second period, and all future generations of lenders must self-finance. $\square$

Proof of Proposition 3. The proof is immediate, and it simply collects the results of Propositions 1 and 2. We start in the region of parameters where either $E \geq \min\left\{1+\frac{pC-1}{p}, 1+pC\right\}$ and $\gamma \geq \gamma^{\text{ab}}$, or $E < \min\left\{1+\frac{pC-1}{p}, 1+pC\right\}$ and $\gamma \geq \gamma^{\text{sc}}$. In this case, following Proposition 1, in every period and in every match, the borrower chooses the II contract, which is accepted by the lender. There is no production of information about the quality of the land and, at the end of the period, the lender holds one unit of land, that she will use as collateral in the following period. There is no self-finance.

Now, consider the complementary region of parameters where the II contract is not feasible and $\gamma \leq \gamma^{\text{inf}}$. In this case, following Proposition 2, in every match in the first period, the initial generation of borrowers chooses the IS contract, which is accepted by the lenders. As a result, there is production of information about the quality of the land by the first generation of lenders. If $E \geq C$, in all periods, lenders participating in a match with a good land acquire the land and use it as collateral in the following period. If $E < C$ and $\gamma \geq p(C-E)$, the first generation of lenders uses good land as collateral, but all future generations self-finance. If $E < C$ and $\gamma < p(C-E)$, all generations of lenders self-finance. Finally, if $\gamma > \gamma^{\text{inf}}$, borrowers do not offer any contract, there is no production of information and all generations of lenders self-finance. □

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