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Caspar Siegert:

Optimal Opacity on Financial Markets

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Department of Economics
University of Munich

Volkswirtschaftliche Fakultät
Ludwig-Maximilians-Universität München

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Caspar Siegert

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Abstract

We analyze the incentives for information disclosure in financial markets. We show that borrowers may have incentives to voluntarily withhold information and that doing so is most attractive for claims that are inherently hard to value, such as portfolios of subprime mortgages. Interestingly, opacity may be optimal even though it increases informational asymmetries between contracting parties. Finally, in our setting a government can intervene in ways that ensure the liquidity of financial markets and that resemble the initial plans for TARP. Even if such interventions are ex-post optimal, they affect incentives for information disclosure and have ambiguous ex-ante effects.

JEL: D82, G21, G32

Keywords: Information Acquisition, Adverse Selection, Allocative Efficiency, Opacity

*caspar.siegert@lrz.uni-muenchen.de. I would like to thank Klaus Schmidt for very useful comments and discussions as well as Patrick Bolton, Regis Bréton, Jacques Crèmer, Tri Vi Dang, Florian Englmaier, Michael Fishman, Christian Hellwig, Fabian Herweg, Niko Matouschek, Artur Raviv, Dominik Ruderer, Florian Scheuer, Anno Stolper, Roland Strausz, Piers Trepper and the participants of the AMES 2011 and ESEM 2012 conferences and seminars at the University of Munich, Bank of England, Banque de France and the SFB TR 15 meeting for helpful suggestions. Financial support from the German Science Foundation (DFG) through GRK 801 and SFB TR 15 is gratefully acknowledged.

1 Introduction

The recent financial crisis has often been attributed to wide-spread opacity of financial claims. From a theoretical point of view the amount of intransparency was staggering. A more transparent financial system should not only allow for funds to be directed to the most efficient projects, but it should also reduce the informational asymmetry between informed issuers and potentially uninformed buyers of financial claims. Starting with Akerlof (1970) a large body of literature has argued that from an ex-ante perspective, a seller would be best off by disclosing as much information as possible in order to guarantee symmetric information.

We show that this need not be the case if an issuer of financial claims is concerned about his access to alternative sources of funding. Instead, an issuer of claims may want to restrict information disclosure, even if doing so increases informational asymmetries between the contracting parties. While this insight may be surprising from a theoretical point of view, it is in line with a large number of stylized facts that suggest that agents on financial markets choose to obfuscate information on a regular basis. Most importantly, our model may explain why certain claims such as Collateralized Debt Obligations (CDOs) on subprime mortgages were structured in a highly opaque fashion, while issuers of other claims disclose much more information.

In the US alone, the value of outstanding CDOs reached more than US$1.3 trillion in 2007.[1] There seems to be a wide-spread believe that these claims were structured in ways that made them considerably more opaque than their underlying assets. More specifically, it is often suggested that the process of bundling and tranching a large number of different claims made CDOs more intransparent than necessary. In its 2010 proposal to revise the disclosure regulations for Asset Backed Securities, including CDOs, the US Securities and Exchange Commission (SEC) argued that "*...in many cases, investors did not have the information necessary to understand and properly analyze structured products...*" and suggests that these financial products could indeed have been made more transparent. Hence, the SEC seems to believe that opacity was not only an important problem, but was also a choice rather than a technological necessity.

Our model predicts that the incentives to *voluntarily* withhold information should be largest in sectors where there are significant limits to how much information a borrower *can* disclose. If

[1] Securities Industry and Financial Markets Association (2012)

a borrower is highly constrained in the maximal level of information that he can disclose, then he may react by reducing transparency even below the technologically feasible level. This could explain why opaque financial instruments were particularly popular in market segments that are inevitably subject to considerable informational frictions, such as the market for subprime mortgages.[2]

However, selling CDOs that are backed by a portfolio of mortgages is only one particular way in which banks may generate opaque claims. Alternatively, banks may raise funding by issuing bonds that are backed by the bank itself. To the extent that a bank does not disclose all information necessary to understand the riskiness of its balance sheet, these bonds may also be opaque. The facts that the balance sheet of banks are inherently intransparent and that banks do not disclose all of the information that could be communicated to investors is widely acknowledged in the literature.

We consider a model in which a bank is endowed with a profitable investment opportunity that can be set up at arbitrary scale and may be more or less profitable. The bank finds it optimal to invest its own capital into the project regardless of the project's type. On top of that, it may want to to borrow funds from financial institutions that have excess liquidity (e.g. other banks or shadow banks) to increase the scale of the investment. The borrowing bank will do so by selling claims on the project's future cash-flow. There are two kinds of lenders that the borrower can sell claims to. Some lenders are able to obtain information on the quality of the investment project (e.g. by performing due diligence), while others do not possess any payoff-relevant information.

An informed lender who has evaluated the investment opportunity receives a non-verifiable, imperfect signal on the quality of the claim. In order to make it incentive compatible for the informed lender to reveal this signal truthfully, it is optimal to agree that the lender will buy claims at a pre-specified price if and only if he has received favorable information on the project. Otherwise the borrower has to turn to a spot market comprised of uninformed lenders. However, at this point in time the borrower has obtained information on the quality of his project and the market is subject to asymmetric information. Hence, the fact that the borrower may have

[2]Portfolios of subprime mortgages tend to be hard to value for outside investors since it is generally hard to asses the precise underwriting standards that a bank has used when approving such mortgages.

to resort to a spot market may give rise to an inefficiency.

Let us now consider the effect of transparency. On the spot market claims will always trade at a discount since uninformed lenders know that they face an adverse selection of projects. Moreover, if uninformed lenders expect claims to be of very low quality this may give rise to a "market for lemons". The price for claims that is offered on the spot market is so low that a borrower with a good project who ends up in need of spot market financing (i.e., who has received a negative evaluation) no longer finds it worthwhile to sell any claims. This is inefficient since it sharply reduces the scale at which some of the most efficient projects are implemented. This kind of market breakdown becomes more likely the more information an informed lender obtains. Highly transparent financial claims reduce the probability that an informed lender misjudges the quality of a project and reduces the likelihood that good claims end up being offered on the spot market. Hence, the stigma of offering claims on the spot market increases and uninformed lenders offer lower prices, which may trigger a market freeze. Designing intransparent claims convinces uninformed lenders that they are not at a large informational disadvantage vis-à-vis an informed lender. This can ensure market liquidity and may hence be desirable.

However, intransparency comes at a cost. It increases the price that a borrower with a negative evaluation can obtain for his claims on the spot market, but it reduces the price that borrowers with a positive evaluation obtain from an informed lender. This reduces the scale at which projects of a high expected quality can be set up and increases the scale at which the less profitable projects are financed. This cost in terms of a reduction in the allocative efficiency of the financial sector can be substantial. However, it is smaller for projects where the borrower is highly constrained in the amount of information that he *can* disclose to begin with. Moreover, for such projects a market breakdown is particularly costly. Even if the borrower discloses as much information as he possibly can, there is still a large probability that high quality projects will end up in need of spot market funding and will be affected by the spot market breakdown. This implies that we should expect to find voluntary opacity in those market segments where information disclosure will necessarily be highly imperfect.

In a second part of the paper, we consider government interventions that are aimed at ensuring the liquidity of spot markets. Our model of optimal opacity gives us a good framework to consider the implication that such interventions may have on the incentives for information disclosure. The intervention we consider resembles the initial plans for the Troubled Asset Relief Program (TARP) in that the government offers to buy claims on the spot market at an expected loss. By doing so the government effectively subsidizes trade on the spot market and ensures that the market remains liquid even for high levels of transparency.[3] We refer to this as 'market support'. From an ex-ante perspective offering market support may be desirable since it encourages borrowers to adopt more transparent financial structures. This increases the allocative efficiency of the financial sector and can increase welfare as long as the government guarantees the liquidity of the spot market. However, there are also situations in which borrowers can choose levels of transparency that are excessive from the point of view of a social planner in order to force the government into offering support ex-post. The government may want to avoid such hold-up problems by committing ex-ante not to intervene. This is consistent with concerns about about ex-ante moral hazard that market support may create.

Relation to the Literature

The paper closely relates to the literature on market liquidity: Dang, Gorton and Holmström (2009) present a model in which information acquisition is harmful since it generates asymmetric information. In their model nobody knows anything about the quality of a claim unless he acquires information. Hence, by preventing information acquisition the designer of a claim can preserve symmetric ignorance. Our model differs from Dang, Gorton and Holmström (2009) in three important aspects: First, we assume that the issuer of a claim will always learn the quality of his claim perfectly. Hence, withholding information *increases* informational asymmetries between the borrower and (partially informed) lenders. Second, we explicitly consider the effects of opacity on allocative efficiency. Third, we model transparency as a continuos variable, which allows us to obtain a rich set of policy implications. In particular, our model predicts how

[3] In its initial plans for the Troubled Asset Relief Program the US Treasury planned to buy certain so-called "troubled" assets at an expected loss rather than to inject equity into failing banks. Similar programs (the "Commercial Paper Funding Facility" and the "Term Asset-Backed Securities Loan Facility") were later implemented by the Federal Reserve Bank. While these programs were arguably not intended to make any losses, they did provide liquidity to purchase Commercial Papers and Asset Backed Securities and may have had a positive effect on their price.

the choice to withhold information is related to the amount of information that borrower *could* disclose. Pagano and Volpin (2012) show that opacity can be desirable since it makes it more difficult for sophisticated investors to learn the quality of a claim, which reduces informational asymmetries between different classes of investors. However, they assume that the issuer of a claim can not condition the decision to sell claims on any information he has on the quality of the claim. Hence, informational asymmetries between the borrower and investors are unproblematic by assumption.[4] Malherbe (2014) shows that expectations of a market breakdown can be self-fulfilling. Hence, market liquidity may depend not only on fundamentals but also on beliefs. Finally, Alvarez and Barlevy (2013) show that if information disclosure is costly and there is scope for contagion, banks may invest too little into information disclosure since they do not internalize the positive spillovers that their disclosure decision has on other banks.

The fact that losing funding from a well-informed lender carries a stigma is well established in the literature. The relationship banking literature (see, e.g., Rajan, 1992; Sharpe, 1990; von Thadden, 1995) shows that this may create hold-up problems since lenders can use their information monopoly to extract rents from entrepreneurs. Ways to address this problem include entertaining multiple banking relationships (Ongena and Smith, 2000) or using more sophisticated contractual arrangements (von Thadden, 1995).[5] The effect we consider in this model is considerably different and exists even if the potential hold-up problem has been solved by appropriate contracts.

In the second part of the paper we consider possible government interventions. Our model of government interventions in markets with asymmetric information builds on a recent body of literature initiated by Philippon and Skreta (2012) and Tirole (2012), who analyze optimal mechanisms by which a government can ensure the liquidity of a market hampered by asymmetric information. We contribute to this literature by analyzing the effects that such interventions can have on the ex-ante incentives to disclose information.

The rest of the paper is organised as follows. Section 2 formulates the baseline model and

[4] A similar situation is considered by Bignon and Breton (2004) who discuss how imprecise accounting rules can reduce informational asymmetries between investors and, hence, lower the cost of raising capital. Burkhardt and Strausz (2009) show that opaque accounting rules may be desirable even if they reduce the liquidity of secondary markets since this can solve commitment problems.

[5] A related rationale for multiple banking relationships is put forward by Detragiache, Garella and Guiso (2000). In their model single banks are fragile and may fail to supply credit.

Section 3 derives the optimal financial contracts. Section 4 analyses the benefits of opacity in this framework. In a second part of the paper, we build on our previous results to consider the effects of government interventions in the spot market on the incentives for information disclosure. The final section summarizes the results and concludes.

2 The Model

We consider a setting with two classes of risk-neutral financial institutions. (Shadow) banks that have excess funds, which we refer to as lenders, and banks that are in need of funding and which we refer to as borrowers.[6]

A representative borrower B, is endowed with some limited amount of capital A and an investment project that can be set up at an arbitrary scale $S \in \mathbb{R}^+$. We can think of this investment opportunity as a large-scale project for which the bank may want to raise additional funds on a wholesale market. Each unit of investment has a cost of \$1 and will generate future, non-pledgable income of ρ_{np}. This income can not be promised to outside investors and may include information rents that have to be left to the borrower and its management to provide appropriate incentives. With probability θ_i the investment will generate financial returns ρ_p that can be pledged to outside investors. The probability that a project is commercially successful depends on the type of the project: $i \in \{H, L\}$ where $\theta_H > \theta_L$. We denote the probability of a project being of high type (i.e. $i = H$) by α.

There are two kinds of lenders: Informed lenders who are able to obtain some information on the borrower's type and uninformed lenders who do not have access to any payoff-relevant information. We assume that there is a large supply of both kinds of lenders and that lenders are perfectly competitive. Moreover, lenders do not face any capital constraints. An informed lender can evaluate the quality of the investment opportunity and receives a non-verifiable, imperfect signal $s \in \{H, L\}$ on the project's type. This allows him to offer B different terms of financing depending on the outcome of the evaluation process. Uninformed lenders on the other hand

[6]While we typically think of banks as lenders, at any given point in time a bank may have more investment opportunities than it has liquidity available and may approach other (shadow) banks in order to obtain additional funds, e.g. by securitizing parts of its loan portfolio.

do not obtain any information. For simplicity, we assume that the borrower can only sign a contract with one informed lender.[7]

The timing of the game can be described by three periods: In $t = 0$ B does not yet posses any information on the type of his project and can secure funding for the upcoming investment opportunity by signing an ex-ante contracts with an informed lender. In $t = 1$, after learning the quality of his investment opportunity, the borrower can obtain additional funds from uninformed lenders on a spot market and has to make his investments.[8] At $t = 2$ uncertainty is resolved, projects are terminated and creditors are repaid.

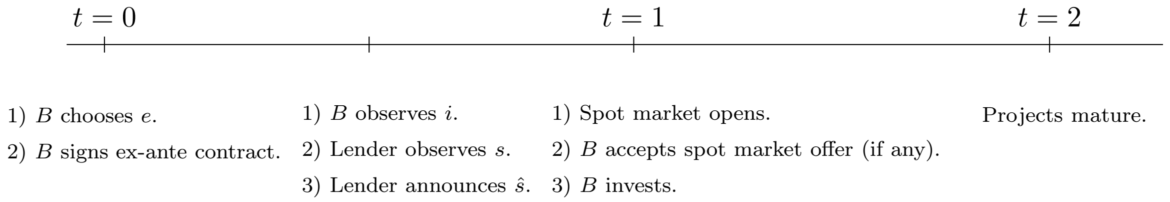

Figure 1: Timing of the Game.

Let us consider period 0 in more detail: At this point B knows that he will need funds for an upcoming investment opportunity in $t = 1$, but he is not yet able to assess the type of the project. He can costlessly choose the level of financial transparency e from some interval $(0, \overline{E}]$ where $\overline{E} < 1$. His choice of e is publicly observable. We will describe the consequences of the borrower's choice of transparency below. Once he has chosen his level of transparency, the borrower can sign a contract with an informed lender. A contract with an informed lender can be characterized by a tuple (q^H, d^H, q^L, d^L) where $q^{\hat{s}}$ describes the amount of funding that a borrower receives in period 1 and $d^{\hat{s}}$ describes the repayment that the lender in entitled to in period 2. Both of these quantities depend on a report $\hat{s} \in \{H, L\}$ that the lender makes about his non-verifiable information.[9] At the time of signing the contract the borrower only knows

[7] This assumption is without loss of generality if the private signals of different lenders are perfectly correlated. If lenders use similar technologies to evaluate the quality of a claim it is indeed reasonable to assume that their signals will be very closely correlated.

[8] In Section 3.2 we will see that the assumption that trade with uninformed lenders takes place in period 1 is without loss of generality.

[9] We assume that for any given $\hat{s}$ the lender offers a *unique* set of payments. Under weak assumptions on the borrower's behaviour this assumption is without loss of generality. In principal, a contract could specify a choice

that the terms of funding will be either (q^H, d^H) or (q^L, d^L). After the contract has been signed (but before the spot market opens) the informed lender receives his signal of the quality of the project s and announces $\hat{s}$. It is only at this point that the borrower learns the exact conditions at which he obtains funding. Throughout the paper, we assume that contracts are unobservable to other lenders.

If the borrower chooses a more transparent structure, this enables the lender to evaluate the quality of the claim with higher precision. For simplicity we assume that for any e we have $Prob(s = H \cap i = L) = Prob(s = L \cap i = H)$, i.e. the lender is equally likely to err in either direction when assessing the type of a project. The probability of either type of misjudgment is given by $\alpha(1-\alpha)(1-e)$.[10] For $e = 0$ the borrower does not disclose any information and the signal is completely uninformative, while for $e = 1$ the probability of misjudgment would become zero. However, the assumption that $\overline{E} < 1$ implies that the lender never obtains such a fully revealing signal.

In period 1 the borrower can obtain additional funds by trading on a spot market. An important property of spot market trade is that the market is subject to asymmetric information. Once the informed lender has evaluated the claim, the borrower has had time to learn the quality of his project, while spot market lenders are perfectly uninformed. We assume that these uninformed lenders compete in the interest rate r_M where a lender is entitled to a repayment of r_M in period 2 for each dollar he lends in period 1.[11] Since a borrower can not pledge any income to more than one lender, he can raise at most q_M units of capital on this market where $\left(A + q^{\hat{s}} + q_M\right)\rho_p = d^{\hat{s}} + q_M r_M$.[12] Asymmetric information may be socially costly since

of two different financing terms for each report $\hat{s}$ and have borrowers with different types select into different options in period 1, once they have learned their own type. However, it may be reasonable to assume that whenever both types of borrowers are indifferent between two options, they accept the same terms of financing. In Appendix B we show that under this tie-breaking rule offering a unique set of payments is indeed optimal. Moreover, in the interest of generality we allow informed lenders to offer $\{q^{\hat{s}}, d^{\hat{s}}\}$ tuples. However, our results remain unaffected if informed lenders can only specify a linear interest rate at which borrowers can obtain funds.

[10]The assumption of a linear relationship between $Prob(s = j \cap i = k)$ for $j \neq k$ and e is without loss of generality. More generally, assume that $g(e) = Prob(s = j \cap i = k)$. We only require that $g'(e) < 0$, $g(0) = \alpha(1-\alpha)$ and $g(1) = 0$.

[11]Note that Attar, Mariotti and Salanié (2011) show competition in linear prices to be indeed an equilibrium under asymmetric information if borrowers can not commit to deal with only one lender. While there are other equilibria, the equilibrium allocation is always unique.

[12]Since contracts are unobservable, the assumption that a borrower can be kept from pledging future income to more than one borrower may not seem very natural. However, we can interpret this assumption as follows: When dealing with any given lender, the borrower sets up a new special purpose vehicle and transfers some of his

a borrower with a good project may decide not to sell claims on the spot market if he considers the interest rate to be unduly high relative to the profits he can make if he does not take out any loan and sets up the project using only his own capital A. At the end of period 1 the borrower makes his investments and sets up the project at the desired scale S.

In the last period, uncertainty is resolved and the claims of creditors are fully honored whenever the project is successful. If the project does not generate any financial return, the borrower defaults on his obligations but is still able to enjoy the non-pledgable income ρ_{np}.

For simplicity, we normalize the discount factor in the economy to one. Moreover, for the rest of the paper, we impose the following parameter restrictions:

$$\rho_{np} + \theta_L \rho_p > 1 \tag{1}$$

$$\theta_H \rho_p < 1 \tag{2}$$

These restrictions imply that while investing is always socially efficient (1), it is never possible to set up a project using only debt (2). Hence, the size of any project is restricted by the amount of capital A that a borrower can invest into it.

The key source of inefficiency in the model is the fact that an informed lender only receive soft information on the quality of a project. If the lender could commit to reveal his signal truthfully, a borrower would make available as much information as possible. He would sign a contract that supplies him with a large, subsidized loan in case his project is likely to be of high quality and that expropriates him in case his investment opportunity is likely to be bad. Moreover, he would never need to turn to the spot market that is subject to asymmetric information. The fact that the informed lender has to find it individually optimal to reveal his signal truthfully introduces two restrictions: First, a lender can not offer a contract that subsidizes borrowers with a favorable signal at the expense of borrowers that are likely to be of low quality. Otherwise, he would always have an incentive to misreport his signal as being $s = L$. Even worse, in order to give a lender incentives to report his signal truthfully, an optimal ex-ante contract does not offer any credit to borrowers in case of a negative signal and these borrowers have to turn to

own funds to this entity. The lender in turn grants credit to this entity and obtains claims on all future cash-flow.

the spot market instead.[13] Hence, whenever the lender is to reveal his signal, it is impossible to circumvent the spot market that is subject to asymmetric information. While it is possible to design ex-ante contracts that supply the borrower with funding irrespective of $\hat{s}$, such contracts can not make use of any of the informed lender's information and turn out never to be optimal.

3 Equilibrium Contracts

3.1 The Spot Market

We start our analysis by looking at the spot market in period 1. In order to do so we assume that only borrowers who have received a negative evaluation from the informed lender consider selling claims on the period 1 market and that these borrowers do not obtain any credit at all from the informed lender. In the next section we will see that this is without loss of generality.

Given that only borrowers with $s = L$ end up on the spot market, B's type can be fully characterized by his true quality $i \in \{L, H\}$. While i is known to the borrower, it is unobservable to the prospective lenders. Since lenders make zero profits, the interest rate that they demand for buying claims in a project in given by $r_M = 1/\hat{\theta}_M$ where $\hat{\theta}_M$ is the market's rational expectation of θ given that B decides to sell claims on the spot market.

The linear nature of the problem implies that a borrower on the spot market either does not take out any loan at all or he borrows as much as possible. If he decides not to pledge any future cash-flows to another bank, the size of his investment will be equal to his capital A and he receives an expected utility of

$$A\left(\rho_{np} + \theta_i \rho_p\right). \tag{3}$$

This utility under self-financing is larger for borrowers that have a high-quality project.

If, on the other hand, the borrower decides to take out a loan, then he will take out as much credit as possible. The total amount of credit that a borrower can obtain at a given interest rate is implicitly defined by the feasibility constraint $(A + q_M)\,\rho_p = q_M r_M$. This implies that

[13] In this respect the model is reminiscent of the literature on "up-or-out" clauses in labour contracts (e.g. Kahn and Huberman, 1988). Similar clauses in financial contracts are also considered by von Thadden (1995).

the borrower can invest at scale $S = A + q_M = \frac{A}{1-\rho_p\hat{\theta}_M}$ and receives an expected utility of

$$\left(\frac{A}{1-\rho_p\hat{\theta}_M}\right)\rho_{np}. \tag{4}$$

When selling claims on the spot market he promises all pledgable income to uninformed lenders. In exchange for this he can increase the scale of the project and hence his non-pledgable income.

Assume that both types i choose to take out a loan at $t = 1$. In this case the share of claims traded on the spot market that are of high quality is given by the probability that a good project receives a bad evaluation and ends up in need of spot market funding divided by the overall probability of a project ending up in need of spot market funding:

$$\alpha_M = \frac{Prob(s = L \cap i = H)}{Prob(s = L)} = \frac{\alpha(1-\alpha)(1-e)}{\alpha(1-\alpha)(1-e) + [(1-\alpha) - \alpha(1-\alpha)(1-e)]} = \alpha(1-e)$$

The market's rational expectation concerning a project's quality is hence given by $\hat{\theta}_M = \alpha_M\theta_H + (1-\alpha_M)\theta_L$. Whenever the average quality of borrowers on the spot market is sufficiently large, (4) is larger than (3) irrespective of i and everybody does indeed participate in the $t = 1$ market.

However, this does not hold true once the average quality of borrowers on the spot market drops below some threshold $\tilde{\theta}_M$. In this case lenders can no longer offer an interest rate that allows them to break even and still induces high types to borrow. Instead, any borrower with a good project chooses self-financing and we end up with a market for lemons where only low-quality debtors take out loans and pay an interest rate of $r_M = 1/\theta_L$. The threshold $\tilde{\theta}_M$ is pinned down by the interest rate at which borrowers with high-quality projects are indifferent between self-financing and taking out loans, which gives us

$$\tilde{\theta}_M = \theta_H/(\rho_p\theta_H + \rho_{np}).$$

In order to concentrate on the most interesting case, we will impose the following two assumptions throughout the rest of the paper:

Assumption 1. *The asymmetric information problem is "severe" relative to the surplus that can be generated by investing:*

$$\frac{\theta_H}{\theta_L} > \rho_{np} + \theta_H \rho_p.$$

Assumption 1 guarantees that $\tilde{\theta}_M > \theta_L$. It implies that high types will not find it attractive to take out a loan if they are taken to be of bad quality for sure and have to pay the corresponding interest rate. Conversely, if $\tilde{\theta}_M < \theta_L$ the asymmetric information problem would be rather mild. In this case the benefits of setting up the project at a larger scale would be sufficiently large to justify paying very high interest rates and adverse selection would never turn out to be a problem.

Assumption 2. *The share of good projects α is sufficiently high:*

$$\rho_{np} + \theta_H \rho_p > \frac{\theta_H}{\alpha\theta_H + (1-\alpha)\theta_L}.$$

This condition ensures that the spot market does not break down if uninformed lenders expect to face a random selection of projects, i.e. $\tilde{\theta}_M < \alpha\theta_H + (1-\alpha)\theta_L$. Under these two assumptions we can show that the spot market breaks down if and only if the level of transparency e exceeds a certain threshold:

Lemma 1. *There exists some level of transparency $\tilde{e} \in (0,1)$ such that high types who end up on the spot market take out a loan if and only if $e \leq \tilde{e}$ where*

$$\tilde{e} = 1 - \frac{1}{\alpha(\theta_H - \theta_L)} \left[\frac{\theta_H}{\rho_p \theta_H + \rho_{np}} - \theta_L \right].$$

Proof. See the appendix.

The expected quality of borrowers who consider taking out loans on the spot market is determined by two factors: The share of high-quality projects in the economy α and the quality of information available to the informed lender. If the informed lender is very effective at screening projects, uninformed lenders can be almost certain that any claims that end up being sold on the spot market are of low quality and there is a large stigma attached to borrowing on this market. Consequently, lenders demand a high interest rate and the spot market breaks down. However, limited information disclosure can ensure that the spot market works smoothly. Opacity increases the portion of high types who end up in need of spot market financing. This guarantees favourable interest rates and makes sure that in equilibrium high types do indeed trade on this market. Hence, as long as the level of transparency does not exceed some threshold $\tilde{e}$ the spot market will remain liquid.[14] Moreover, further reducing the level of transparency would further reduce the interest rate paid by borrowers on the spot market.

We will see that in case the spot market does not break down, the borrower would always prefer to be as transparent as possible. Nevertheless, it may pay for a borrower to choose intransparent financial structures ex-ante in order to prevent a market freeze.

3.2 Optimal Ex-ante Contracts

Having lined out how the spot market for credit works, we can now turn to the ex-ante contract that borrowers sign with an informed lender in period 0. For the time being, we will assume that e is exogenously given in order to fix ideas. We will call borrowers on whom a lender has received a positive signal ($s = H$) "approved" borrowers and those on whom a lender has received a negative signal ($s = L$) "disapproved" borrowers.

Recall that an ex-ante contract specifies an amount of credit $q^{\hat{s}}$ that a borrower receives in period 1 and a repayment $d^{\hat{s}}$ that he has to make in period 2, given that the informed lender reports $\hat{s} \in \{L, H\}$ as the outcome of the project evaluation. Without loss of generality, we assume that the lender reports his signal truthfully in equilibrium, i.e. $s = \hat{s}$. Since the market for ex-ante contracts is competitive we must have

$$\alpha(d^H\hat{\theta}^H - q^H) + (1-\alpha)(d^L\hat{\theta}^L - q^L) = 0 \tag{5}$$

where $\hat{\theta}^s$ denotes the expected quality of a borrower conditional on receiving signal s and where $\hat{\theta}^H > \hat{\theta}^L$ for all $e > 0$. At the same time, the lender must have an incentive to reveal his signal

[14] It is easy to check that $\hat{\theta}_M(\tilde{e}) = \tilde{\theta}_M$.

truthfully, which requires that

$$d^H \hat{\theta}^H - q^H \geq d^L \hat{\theta}^H - q^L \tag{6}$$

$$d^L \hat{\theta}^L - q^L \geq d^H \hat{\theta}^L - q^H. \tag{7}$$

Additionally, the contract must be feasible, i.e. the borrower can not pledge more income to a lender than the project can generate:

$$d^{\hat{s}} \leq \rho_p(A + q^{\hat{s}}) \qquad \forall \hat{s} \in \{H, L\} \tag{8}$$

We can check that constraint (6) must be binding in equilibrium. Otherwise, the lender could offer a contract that makes slightly higher profits on disapproved borrowers and slightly lower profits on approved borrowers. In expectation, this contract would transfer wealth towards those borrowers that can invest their wealth into more efficient investment opportunities. Hence, from an ex-ante perspective a borrower would strictly prefer this new contract. Moreover, we can ignore the second truth-telling constraint and check that it is satisfied in any optimal contract. Having summed up the relevant constraints that any contract must satisfy, we can now characterize a set of ex-ante contracts that may be optimal:

Proposition 1. *An optimal ex-ante contract will take either of the two following forms:*

- *It offers credit if and only if the lender has received a positive signal. Credit is priced fairly and approved borrowers promise all pledgable income to the informed lender.*
  $q^L = d^L = 0$, $q^H = d^H \hat{\theta}_H$ *and* $d^H = \rho_p \left(A + q^H\right)$.

- *It offers to fund borrowers irrespective of the signal* s*. All borrowers receive the same terms of funding and promise all pledgable income to the informed lender.*
  $q^{\hat{s}} = d^{\hat{s}} \left(\alpha\theta_H + (1-\alpha)\theta_L\right)$ *and* $d^{\hat{s}} = \rho_p \left(A + q^{\hat{s}}\right)$ *for all* $\hat{s} \in \{H, L\}$.

Proof. See the appendix.

Lenders on the spot market rationally expect that they will only trade with disapproved borrowers and charge a high interest rate that exceeds the cost of lending to approved borrowers.

Hence, it is optimal for informed lenders to lend as much as possible to approved borrowers. At the same time, the informed lender must have an incentive to report his signal s truthfully. One way to achieve this is by offering a contract that makes zero profits on approved borrowers and that grants no credit to disapproved borrowers. For this contract the informed lender has no incentive to misreport a good signal as a bad one and borrowers with a negative evaluation can turn to the spot market to obtain funding. Since the informed lender always makes zero profits on approved borrowers he offers more advantageous conditions if the level of transparency is higher and an approved borrower is more likely to have high quality projects.

Alternatively, the lender can offer funding to borrowers with an unfavorable rating, too. But if he does so, he must grant them credit at advantageous conditions that do not reflect the true risk of lending to them. Approved borrowers have to cover the corresponding losses via a repayment that lies above the actuarially fair one. When misreporting a good signal as a bad one the lender would lose out on the profits that he makes on approved borrowers in case he truthfully reveals his information. Additionally, if disapproved borrowers receive subsidized credit there is less the lender can gain by reporting to have received a bad signal. This explains why in general, contracts under which approved borrowers cross-subsidize disapproved borrowers may ensure that a lender has an incentive to reveal his information truthfully. The linear nature of the borrower's problem implies that if it is optimal to grant credit to disapproved borrowers, then it is optimal to grant them as much credit as possible without violating the feasibility constraint (8).[15] In this case the truth-telling constraint requires the cross-subsidy from approved to disapproved borrowers to be particularly high and financing conditions do not depend on the lender's signal at all.

So there are two types of contracts a borrower may sign. He either chooses a contract that makes use of the lender's soft information but that may leave the borrower in need of spot market funding. Or he can sign a contract that never requires him to turn to a spot market that may be subject to adverse selection. However, this kind of contract can not make use of the lender's information and offers the same terms of funding regardless of the lender's information. Which contract a borrower chooses clearly depends on the terms of trade offered on the spot

[15] We abstract from the knife-edge case in which the borrower is indifferent between a continuum of different contracts stipulating different levels of q^L. This simplification does not affect any of our results.

markets. As we have seen in the last section, these terms depend on the borrower's choice of transparency, so for different levels of e a different ex-ante contract may be optimal.

Proposition 2. *There exists a threshold $\hat{e} \geq \tilde{e}$ such that*

- *if $e \in (\tilde{e}, \hat{e})$ the borrower signs an ex-ante contract that offers funding irrespective of s.*
- *if $e \notin (\tilde{e}, \hat{e})$ he signs a contract that only offers funding in case the lender observes $s = H$.*

Proof. See the appendix.

Interestingly there is no monotonic relationship between e and the appeal of either type of contract. While a contract that conditions on the lender's information is optimal for very small and very high levels of transparency, for intermediate levels of e a contract that offers the same conditions regardless of the lender's information is optimal.

To understand why this is the case, let us look at the effects of transparency in more detail. We denote the borrower's expected utility in case he signs an ex-ante contract that only grants credit in case of a positive signal by $W(e)$. For $e = 0$ the informed lender's signal is completely uninformative. Hence, uninformed lenders offer the same conditions as informed ones and B's utility does not depend on the signal s. The same holds true for a contract that never exposes B to the spot market. The borrower's utility under this second kind of contract is therefore given by $W(0)$ and is independent of e.

First, consider the case where $e \leq \tilde{e}$. In this case a spot market breakdown will never be an issue. At the same time, transparency is beneficial since it allows the financial sector to direct funds to the more efficient projects: Slightly increasing the scale of the more efficient projects while reducing the scale of the less efficient ones would always be socially beneficial. Improved transparency allows the banking sector to do just that. Since projects of approved borrowers become increasingly likely to be of type $i = H$, an approved borrower can obtain higher prices when pledging his future income to the informed lender and can use the additional funds to increase the scale of his project. Disapproved borrowers on the other hand need to pay higher interest rates on the spot market and, hence, need to reduce the size of their investments.[16] This

[16] An additional advantage of information disclosure is that it increases the probability that good projects (i.e. projects with $i = H$) are the ones financed at a large scale.

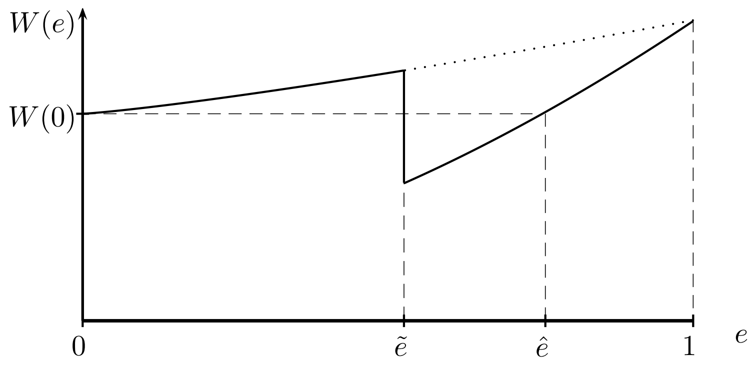

Figure 2: Welfare as a Function of Transparency.

implies that $W'(e) > 0$. So for all $e \in (0, \tilde{e}]$ we have $W(e) > W(0)$ and signing a contract that forces disapproved borrowers to turn to the spot market is optimal.[17]

Now consider the case where $e > \tilde{e}$. Once the level of transparency exceeds $\tilde{e}$, the spot market breaks down and borrowers with good projects who end up on this market will not take out a loan. Since borrowers bear the cost of this inefficiency, the borrower's expected utility $W(e)$ drops discontinuously at $\tilde{e}$ (see Figure 2). This explains why signing a contract that does not condition on the lender's information and that guarantees a utility of $W(0)$ may instead be optimal. However, conditional on the spot market being frozen, the expected utility is increasing in e again. Moreover, for $e \to 1$ it is always optimal to sign a contract that may leave a borrower in need of spot market financing. If $e \to 1$ making use of the lender's (very precise) information has substantial benefits in terms of allocative efficiency. Moreover, even though a market breakdown is inevitable, its costs are negligible. Screening by the informed lender is almost perfect and very few good investment projects end up in need of spot market funding. So the fact that these projects will only be implemented at a limited scale due to informational asymmetries is not very costly from an ex-ante perspective. Note that the dotted line in Figure 2 describes welfare in a hypothetical scenario where all borrowers that do not receive funding from an informed lender can be forced to trade on the spot market. Hence, the cost of a market breakdown is given by the vertical distance between the dotted and the solid line.

Taken together, these observations imply that in relative terms, being exposed to the spot

[17]Since all pledgable income ends up with the lenders and lenders make zero profits, this efficiency gain of transparency materializes in a larger average scale of the investment projects.

market is most costly for an intermediate set of transparency levels $(\tilde{e}, \hat{e})$. In these cases it is optimal to sign a contract that does not condition on the lender's information but allows the borrower to circumvent the spot market.[18]

Given the structure of optimal ex-ante contracts, it is easy to see that our assumption that contracts with uninformed lenders are signed in period 1 is without loss of generality. Instead of trading with uninformed lenders in period 0, a borrower might as well sign an ex-ante contract that does not condition on $\hat{s}$. In either case he receives the same financing terms with certainty.[19]

We have seen that for a given level of transparency e, the borrower faces a choice between foregoing all of the benefits of information disclosure by signing an ex-ante contract where payments do not depend on $\hat{s}$ or signing a contract that may force him to seek credit on a spot market which is subject to asymmetric information. In the next section we allow the borrower to choose his level of financial transparency. This enables the borrower to limit the amount of information disclosure. If the information released to lenders is sufficiently imprecise, this reduces the stigma attached to a borrower who has to resort to uninformed lenders and may prevent a spot market breakdown.

4 Optimal Opacity

In this section we assume that the borrower can not only choose what kind of contract he signs, but he can also choose the level of transparency of his project e, e.g. by structuring claims in a more or less transparent fashion. Effectively, this allows a borrower to choose his preferred point on the x-axis of Figure 2. However, there is still an upper bound $\overline{E}$ on the amount of information that he *can* disclose. For the rest of the paper, we will restrict attention to the interesting case where $\overline{E} > \tilde{e}$. In this case, the lender faces a potential trade-off between increasing allocative efficiency by disclosing more information and ensuring market liquidity.[20]

[18] We can show that the interval $(\tilde{e}, \hat{e})$ is non-empty if θ_L is sufficiently small relative to θ_H. If $\theta_L \to (\theta_H/(\rho_{np} + \theta_H \rho_p) - \alpha\theta_H)/(1-\alpha)$ low levels of transparency suffice to lead to a breakdown of the spot market. For these levels of transparency a market breakdown is particularly costly and it is optimal to circumvent the spot market.

[19] Moreover, it is impossible to write a forward contract in which the borrower commits to trade with an uninformed lender in case of a negative report since contracts with the informed lender are unobservable.

[20] It is easy to see that if $\overline{E} \leq \tilde{e}$ a borrower would always disclose as much information as possible and sign a contract that may leave him in need of spot market funding.

Proposition 3. *If the borrower can choose the level of transparency from some interval* $(0, \overline{E}]$ *he will always sign a contract that may leave him in need of spot market financing. There exists a threshold* $\tilde{E} \in (\tilde{e}, 1)$ *such that*

- *if* $\overline{E} > \tilde{E}$ *a borrower discloses as much information as possible:* $e = \overline{E}$.
- *if* $\overline{E} \leq \tilde{E}$ *a borrower chooses to be less-than-perfectly transparent:* $e = \tilde{e}$.

Proof. See the appendix.

If the borrower can choose the level of financial transparency, he will always sign a contract that may leave him in need of spot market funding. This ensures that good projects receive more generous funding than bad projects and good projects are implemented at a larger scale. At the same time, by disclosing sufficiently coarse information, the borrower could always ensure that the spot market remains liquid.

Now consider the level of transparency the borrower optimally chooses. If $\overline{E}$ is larger than some threshold $\tilde{E}$, then it is possible to disclose very precise information which results in large benefits in terms of allocative efficiency. Projects that are likely to be of high quality receive generous terms of funding and can be set up at a large scale, while less profitable investments are financed at a smaller scale. At the same time, while the spot market may break down due to asymmetric information, the cost of a market breakdown is small since only few good projects end up without funding in period 1. From an ex-ante perspective, the fact that these borrowers will not take out any loans is not very costly. Hence, it is optimal to disclose as much information as possible. But if $\overline{E}$ is small and screening is bound to be imprecise anyway, a borrower optimally restricts transparency to reduce the stigma attached to turning to the spot market. A low level of transparency convinces uninformed lenders that they are not at a large informational disadvantage relative to informed lenders. Uninformed lenders are hence prepared to lend at conditions at which borrowers with good projects still take out loans, which prevents a market breakdown. In particular, the borrower chooses the largest transparency level that does not lead to a market breakdown, $e = \tilde{e}$. Doing so results in an expected utility of $W(\tilde{e})$ and is strictly more attractive than choosing a slightly larger e, which would lead to a breakdown of

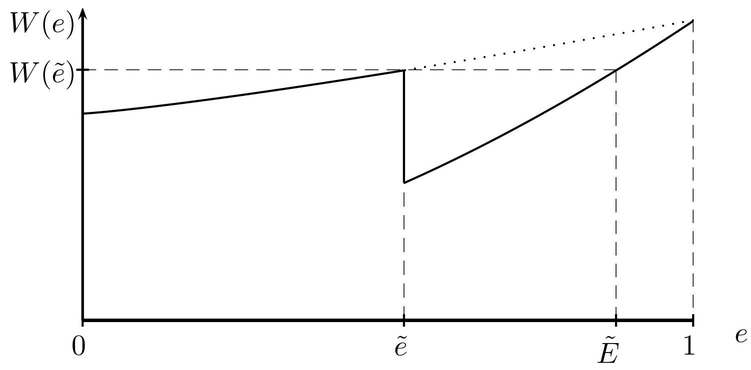

Figure 3: The Optimal Level of Transparency.

the spot market (see Figure 3).[21]

The key insight from our model is that borrowers may have an incentive to *voluntarily* restrict information disclosure and that this incentive is stronger in situations where there are strong exogenous constraints on information disclosure ($\overline{E}$ is low). Put differently, there is a fundamental convexity in the returns to information disclosure. If a borrower can enable an informed lender to distinguish between projects of different quality with high precision, he should always try to do so. But if disclosure is bound to be imprecise anyway due to technological constraints, it may be optimal to make even less information available.

This is consistent with the observation that in the run-up to the recent financial crisis, claims were frequently structured in ways that made them highly intransparent and that this practice was particularly common in market segments that we would expect to be always subject to non-negligable informational asymmetries. In particular, 45% of the collateral that backed Collateralized Debt Obligations (CDOs), which were widely believed to be highly opaque financial products, consisted of subprime mortgages (Fender, Tarashev and Zhu, 2008). We would expect a bank to be unable to disclose the precise value of any portfolio of subprime mortgages to outside investors, e.g. because it has private information about its underwriting standard. Hence, if the bank wants to raise funds by selling claims on these mortgages to an outside party, it may

[21] We can show that $\tilde{E} > \hat{e}$. In Section 3.2 a borrower faced the choice between an ex-ante contract that makes use of the lender's information but leads to a breakdown of the spot market and a contract that does not condition on any information at all. Now the borrower only needs to reduce the amount of information disclosure in order to avoid a market freeze. Hence, preventing a market breakdown becomes less costly. The borrower can enjoy a utility of $W(\tilde{e})$ instead of $W(0)$ and will choose to prevent a market breakdown more often.

prefer to make even less information available by packaging these products in CDOs. Our model may help us explain *why* these claims were structured in an opaque fashion. However, we do not attempt to look at the consequences that this opacity may have on financial stability.

In relation to the existing literature on opacity, our key contributions are twofold. First, we show under which circumstances opacity is likely to be optimal. This is important in order to understand why opacity was common in the subprime mortgage market, while it is arguably less common in other markets. Second, we show that opacity can be optimal even if it *increases* informational asymmetries between contracting parties. While the borrower always learns his type perfectly, opacity reduces the amount of information that an informed lender receives. Moreover, in equilibrium uninformed lenders know that they lend only to those borrowers who received an unfavorable evaluation. The less precise the information of an informed lender, the less an uninformed lender can learn from the fact that he is trading with a particular borrower. Nevertheless, a positive amount of opacity may be optimal because it reduces the stigma of those borrowers who have to resort to a spot market for credit. This effect is very different from the model considered by Dang, Gorton and Holmström (2009) where opacity is optimal since it *reduces* informational asymmetries.

Part II: Government Intervention and Market Support

We have seen that the danger of a market breakdown can have considerable efficiency costs. Either asymmetric information does indeed lead to a freeze of the spot market and prevents the best projects from being set up at a large scale. Or borrowers reduce transparency in order to prevent a market breakdown, which comes at efficiency costs of its own. In this part we consider how the government can intervene in ways that keep the spot market liquid. The government interventions we consider are a stripped-down version of Tirole (2012) and resemble the original plans for the Troubled Asset Relief Program discussed by the US government in 2008. We refer to such interventions as 'market support'. Our key contribution is to analyze how such interventions affect the ex-ante incentives for information disclosures. The model of opacity that we have presented above offers a good setting to do so. In this model borrowers voluntarily restrict the amount of information they disclose, so there is scope for policy interventions to increase (or, in theory, decrease) information disclosure.

We extend our baseline model in the following way to allow for government interventions. Before uninformed lenders make their offers, a government can enter the spot market and acts like an ordinary (uninformed) lender by publicly offering to purchase claims at an interest rate of r_G.[22] Subsequently, uninformed lenders post r_M. Once both rates have been posted borrowers who are in need of spot market funding decide which offer to accept (if any) and make their investments. We assume that the government sets this interest rate so as to maximize social surplus and does not have to make zero profits, since it can use tax revenues to cover losses incurred on the spot market. However, taxation creates a deadweight-loss of $\lambda - 1 > 0$. The precise timing is shown in Figure 4.

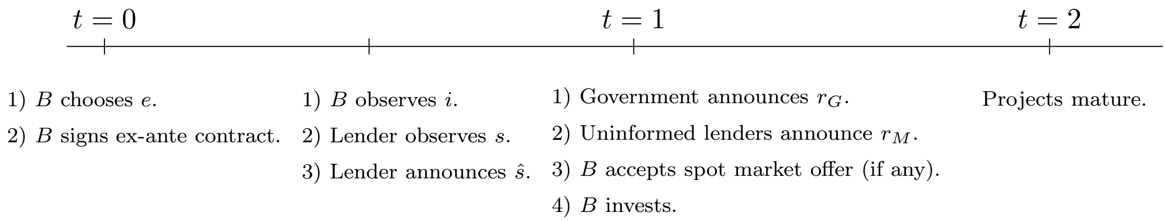

Figure 4: Timing of the Game with Government Interventions.

As before, a borrower can not pledge any income to more than one lender, so the maximal amount of credit he can obtain from the government q_G is implicitly defined by

$$\left(A + q^{\hat{s}} + q_M + q_G\right)\rho_p = d^{\hat{s}} + q_M r_M + q_G r_G.$$

Throughout the rest of the paper, we assume that there is a continuum of ex-ante identical borrowers. This is not essential for any of our results but simplifies exposition.[23] Moreover, we assume that the distortive cost of taxation is sufficiently high:

[22] We can show that offering a single, linear interest rate r_G at which borrowers can obtain credit from the government is indeed an optimal mechanism if the government can not limit borrowers' access to the spot market.

[23] If there is a continuum of borrowers the government will fund a deterministic mass of projects rather than funding an individual borrower with a certain probability.

Assumption 3. *The cost of public funds is not too low:*

$$\lambda > \underline{\lambda} = \frac{\rho_{np}}{1 - \rho_p \theta_H}.$$

Assumption 3 implies that even if the government could be perfectly sure to face high types, public funds are too expensive for the government to want to transfer wealth to borrowers unconditionally. Any intervention that ensures the liquidity of the spot market involves some degree of transfers from the government to borrowers. This assumption allows us to to concentrate on the interesting case where there is a trade-off between subsidizing borrowers and preventing a spot market freeze.

Proposition 4. *The government only considers intervening if the spot market would otherwise break down. If it intervenes, it offers an interest rate of $r_G = 1/\tilde{\theta}_M$. Uninformed lenders offer the same interest rate $r_M = r_G$ and a share $\tilde{\alpha}_M$ of the projects that are financed by private lenders is of high quality, where*

$$\tilde{\alpha}_M = \alpha_M(\tilde{e}) = \frac{\theta_H - \left(\rho_{np} + \rho_p \theta_H\right)\theta_L}{\left(\rho_{np} + \rho_p \theta_H\right)\left(\theta_H - \theta_L\right).}$$

Proof. See the appendix.

As a consequence of Assumption 3 the government does not have any incentive to subsidize borrowers by offering particularly low interest rates. It will only consider intervening if doing so is necessary to prevent a spot market breakdown. Moreover, if it intervenes it offers an interest rate that is just low enough to induce all borrowers to trade on the spot market, $r_G = 1/\tilde{\theta}_M$. Whenever both commercial lenders and the government are active on the spot market, we must have $r_M = r_G$ since borrowers must be indifferent between taking money from the government or commercial lenders. Finally, if commercial lenders find it optimal to offer the same interest rate as the government the quality of claims offered to these lenders must be $\tilde{\alpha}_M$, which ensures that commercial lenders make zero profits.

Key to the existence of the equilibrium is that borrowers are indifferent whom to accept funding from, so the distribution of borrowers across lenders is not pinned down by the borrowers' individual rationality constraint. In equilibrium, the projects that the government funds are of lower quality than the ones that are financed by commercial lenders. The government incurs losses, while uninformed lenders offer the same interest rate and make zero profits. The government effectively subsidizes trade on the spot market, which keeps the market liquid.

There are a large number of distributions of borrowers across lenders that ensure that a share $\tilde{\alpha}_M$ of the projects that are financed by private lenders is of high quality. One particular distribution is the following. The government funds *only* bad projects. Moreover, the number of projects that it funds is just sufficient to ensure that a fraction $\tilde{\alpha}_M$ of the remaining projects is of high quality. More specifically, the government finances a fraction $\left(1 - \frac{\alpha_M(e)}{\tilde{\alpha}_M}\right)$ of the projects that do not receive funding from informed lenders and makes a loss of $\left(\tilde{\theta}_M - \theta_L\right) \frac{A\rho_p}{1-\rho_p\tilde{\theta}_M}$ on each borrower that it trades with. It is easy to see that the number of (bad) projects that are funded by the government is decreasing in the share of good projects on the spot market $\alpha_M(e)$.

In addition to the equilibrium sketched in the paragraph above, there is a large number of other equilibria which differ with respect to the probability with which a given borrower sells claims to the government.[24] However, all of these equilibria result in the same aggregate allocations. Hence, concentrating on the equilibrium described above is without loss of generality. In this equilibrium, borrowers trade with the government as rarely as possible.

Commitment Solution

We start by considering the case where the government announces an intervention policy before borrowers choose e and is able to commit to it. Without loss of generality, we assume that an intervention policy simply consists of a set of transparency levels for which the government will keep the spot market liquid by offering to buy claims at an interest rate of $r_G = 1/\tilde{\theta}_M$.

The cost of an intervention is increasing in the level of transparency. Since for higher levels of e the average quality of claims on the spot market is lower, the government has to purchase more bad claims at a loss to ensure that the average quality of claims offered to commercial

[24] We could shift any random set of borrowers from the commercial lenders to the government. This would not affect the quality of the remaining projects on the spot market and hence r_M. In particular, there exists an equilibrium in which the spot market is inactive and all borrowers that are not funded by an informed lender obtain funds from the government. While in this equilibrium we may have $r_G < r_M$, the equilibrium would have the same consequences for welfare as the one we consider.

lenders is $\tilde{\alpha}_M$ and that the spot market remains liquid. Hence, a government might want to announce a maximal level of transparency e for which it is prepared to offer market support. However, it turns out that this is never the case.

Proposition 5. *Assume the government can commit to an intervention policy. It offers market support regardless of borrowers' choice of transparency if the cost of public funds λ is weakly below $\overline{\lambda}^c(\overline{E})$. Otherwise it does not offer any intervention at all. Whenever the government does offer market support, borrowers choose the maximal feasible level of transparency $e = \overline{E}$.*

Proof. See the appendix.

A borrower who wants to ensure that the government intervenes will will always choose the highest e for which the government is prepared to step in. A higher level of transparency allows a borrower to benefit from more advantageous conditions if he obtains funding from an informed lender. If, however, he needs to turn to the spot market, he can borrow at an interest rate of $1/\tilde{\theta}_M$ regardless of e. This implies that the government can effectively choose the level of e that borrowers implement by announcing an appropriate maximum transparency level. Moreover, while the fiscal cost of an intervention is linearly increasing in e, the borrowers' utility is convex in e. Hence, for larger values of e an intervention becomes increasingly attractive from a social perspective and whenever the the government chooses to offer an intervention, it intervenes regardless of e.

However, we still have to consider whether the government finds it optimal to offer market support at all. Recall that absent any government intervention, a borrower chooses limited transparency in order to guarantee the integrity of the spot market if and only if $\overline{E} \leq \tilde{E}$. In this case, the government is prepared to intervene whenever the benefits of increases transparency exceed the fiscal cost of market support, i.e. if

$$\left[\frac{1}{1-\rho_p\hat{\theta}^H(\overline{E})} - \frac{1}{1-\rho_p\hat{\theta}^H(\tilde{e})}\right]\frac{\alpha}{1-\alpha}A\rho_{np} \geq$$

$$\lambda\left(1 - \frac{\alpha_M(\overline{E})}{\tilde{\alpha}_M}\right)\left[\frac{\rho_p\left(\tilde{\theta}_M - \theta_L\right)}{1-\rho_p\tilde{\theta}_M}\right]A. \quad (9)$$

The threshold $\overline{\lambda}^c(\overline{E})$ denotes the highest cost of public funds for which this condition is satisfied.

Now, consider the case where $\overline{E} > \tilde{E}$: If the government decides not to intervene, borrowers choose maximal transparency and the spot market freezes. In this case an intervention does not affect the level of transparency that borrowers choose, but it prevents a market breakdown. This is socially beneficial and justifies the cost of an intervention if λ is sufficiently small, i.e. if

$$\left[\frac{1}{1-\rho_p\tilde{\theta}_M} - \frac{1}{1-\rho_p\theta_L}\right](1-\alpha_M(\overline{E}))A\rho_{np} \geq \lambda\left(1 - \frac{\alpha_M(\overline{E})}{\tilde{\alpha}}\right)\left[\frac{\rho_p\left(\tilde{\theta}_M - \theta_L\right)}{1-\rho_p\tilde{\theta}_M}\right]A. \quad (10)$$

Again, the threshold $\overline{\lambda}^c(\overline{E})$ denotes the level of λ for which the condition is satisfied with equality. Note that in case $\overline{E} > \tilde{E}$ the benefit of an intervention is restricted to borrowers with bad projects who end up on the spot market. High types who end up on the spot market receive a utility that is equal to the one they could obtain by borrowing at a rate of $1/\tilde{\theta}_M$ regardless of whether the government intervenes or not. For this interest rate they are indifferent between taking out a loan or choosing self-financing. But the participation of high types in the spot market has a positive externality on low types who are now able to borrow at a considerably lower interest rate.

Henceforth, we will call an intervention "unconditional" if the government is prepared to offer market support regardless of a borrower's level of transparency and "conditional" otherwise. More generally, we will refer to an intervention as "larger" if borrowers have chosen more transparent financial structures, since in this case the government needs to buy a larger number of claims in order to keep the spot market working.

No Commitment Solution

Let us now consider the problem faced by a government that lacks commitment power. In this case the government can not convince borrowers that it will follow any policy that is not ex-post optimal. Hence, without loss of generality we can assume that the government only decides to intervene once borrowers have chosen their level of transparency e. The key difference to the case where the government has commitment power is that now, borrowers can strategically choose their level of transparency in order to affect the government's decision whether to intervene or not. In the case with commitment power, this decision was taken by the government ex-ante and could no longer be influenced by the borrowers.

Proposition 6. *Assume the government can not commit to an intervention policy. It ensures that the spot market for credit remains intact if and only if* $e \leq \hat{E}^{nc}$ *where* $\hat{E}^{nc}$ *is implicitly defined by*

$$\alpha_M(\hat{E}^{nc}) = \frac{\lambda\left(1-\rho_p\theta_L\right)-\rho_{np}}{\lambda\left(1-\rho_p\theta_L\right)-\tilde{\alpha}_M\rho_{np}}\tilde{\alpha}_M.$$

If $\overline{E} \leq \tilde{E}$ *borrowers always choose the highest level of transparency that induces the government to intervene. If* $\overline{E} > \tilde{E}$ *borrowers choose the highest level of transparency that induces the government to intervene if* $\lambda \leq \overline{\lambda}^{nc}(\overline{E})$ *and choose maximal transparency otherwise.*

Proof. See the appendix.

The government will always be prepared to intervene if borrowers have chosen sufficiently low levels of transparency, i.e. $\hat{E}^{nc} > \tilde{e}$. If the level of transparency is sufficiently close to $\tilde{e}$, the government only has to buy an arbitrarily small number of bad claims at a loss in order to prevent a full-scale market freeze. For low costs of public funds the government will even be prepared to intervene regardless of the level of transparency that borrowers have chosen ($\hat{E}^{nc} > \overline{E}$). However, $\hat{E}^{nc}$ is decreasing in λ and for higher values of λ the government will only be prepared to intervene conditionally on the borrower not having chosen too high a transparency level.

In order to determine whether the government will end up intervening in equilibrium we now have to consider the question of which level of transparency borrowers actually choose to adopt. Let us first look at the case where $\overline{E} \leq \tilde{E}$ and absent any government intervention a borrower would choose to limit transparency in order to guarantee the integrity of the spot market. A government intervention allows borrowers to disclose additional information without provoking a breakdown of the spot market and borrowers will always choose the maximal level of transparency for which the government is willing to intervene. If λ is sufficiently small this may be the maximal feasible level of transparency. However, for larger costs of public funds a borrower can only disclose intermediate amounts of information.

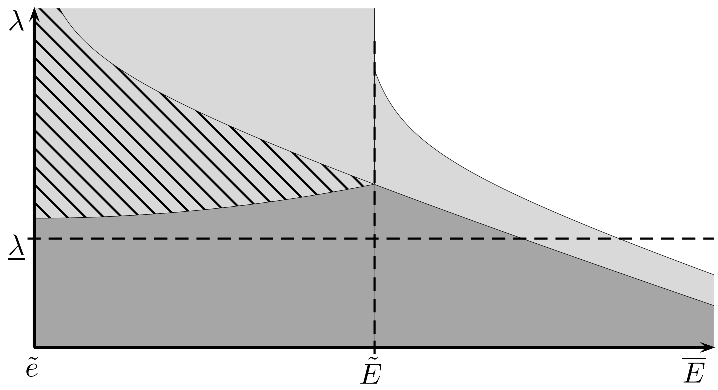

Figure 5: Government Interventions with/without Commitment.

Instead, assume that $\overline{E} > \tilde{E}$ so absent any intervention, a borrower would choose to disclose as much information as possible. This allows the borrower to enjoy the benefits that information disclosure has on allocative efficiency (but results in a freeze of the spot market). In this case a borrower will only choose to make use of a government intervention if he does not have to restrict the level of transparency too much in order to do so. This is the case if λ is small and the government is prepared to intervene even for high levels of transparency. If on the other hand λ is large, the government can only be induced to offer very limited interventions. If the borrower preferred to disclose as much information as possible in the absence of a government intervention, he will still do so now and will not make use of any government support.

The most important difference to the case where the government has commitment power is that without commitment, the government may end up offering 'conditional' interventions in equilibrium.[25] The reason why such limited interventions can occur is that they are a direct result of extortionary practices. By choosing intermediate levels of transparency, borrowers reduce the cost of an intervention. But more importantly, they increase the cost of a market breakdown in case the government fails to intervene. If transparency is low, a large number of high types do not receive funding from an informed lender. If the spot market breaks down and the government does not intervene, these borrowers do not take out loans, which comes at a high

[25]Since the government does not announce any intervention policy ex-ante, the term 'conditional' intervention may be slightly unintuitive. It refers to the fact that borrowers rationally *expect* that the government will only intervene for certain levels of transparency. Hence, there is an *implicit* conditionality in the availability of an intervention.

cost in terms of efficiency. Hence, by making the alternative to an intervention less appealing, borrowers can force the government into action ex-post.

In order to understand the effect of commitment power in more detail, we can now compare the the cases with and without commitment power and summarize our results.

Proposition 7. *If the government is unable to commit to a policy, it offers weakly larger interventions in equilibrium. Nevertheless, if α is sufficiently large for any $\overline{E} \leq \tilde{E}$ there is a non-empty set $\lambda \in [\underline{\lambda}, \overline{\lambda}^c(\overline{E})]$ for which the the government offers unconditional market support even if it can commit to a policy ex-ante.*

Proof. See the appendix.

A summary of the optimal policies is given in Figure 5. The dark area depicts situations in which the government will offer unconditional interventions regardless of whether it has commitment power or not. The dashed area describes situations in which a government would like to commit to a laissez-faire policy but will end up offering unconditional interventions if it is unable to do so. The light gray area corresponds to parameter constellations in which a government that lacks commitment power will end up offering conditional interventions (i.e. $\hat{E}^{nc} < \overline{E}$), while a government with commitment power does not offer any intervention at all. Finally, the white area depicts situations in which the government never intervenes in equilibrium.

In order to see that the government will offer weakly larger interventions in equilibrium if it has no commitment power, let us first consider the case where $\overline{E} \leq \tilde{E}$. Absent any intervention, a borrower would restrict information disclosure. Hence, if a government can commit to an intervention policy, it will compare the benefits of an intervention to the alternative of limited information disclosure. However, if the government is unable to commit to a policy, a borrower can choose to adopt maximal transparency before the government decides on an intervention policy. Now the government compares the benefits of an intervention to the alternative of a market breakdown. For $\overline{E} \leq \tilde{E}$ a market breakdown is more costly than limiting information disclosure and a government that lacks commitment power is hence more likely to offer unconditional interventions than a government that can commit to a policy. Moreover, in case the government lacks commitment power, it can still be induced to offer small interventions even if λ is too high for the government to intervene irrespective of e. By choosing a level of transparency that is sufficiently close to $\tilde{e}$ a borrower can always force the government to offer some (potentially small) intervention.

Let us now turn to situations where $\overline{E} > \tilde{E}$. In this case a government will compare the benefits of an intervention to the alternative of a market breakdown even if it can commit to a policy. So a government with commitment power will offer unconditional market support if and only if a government that lacks commitment power would do so. However a government that lacks commitment power will still be prepared to offer conditional interventions even if it can not be induced to intervene irrespective of e. Borrowers will choose to benefit from such interventions whenever the government is prepared to offer sufficiently large interventions (i.e., if λ is not too large). Conversely, if the government is only prepared to offer very small interventions, borrowers prefer to adopt maximal transparency and choose to forgo the benefits of a government intervention.

It is often argued that while supporting financial markets may be ex-post optimal, a government might want to rule out interventions ex-ante in order not to create incentives for banks to rely on such support. Proposition 7 verifies this intuition by showing that borrowers can create situations in which the government feels compelled to intervene ex-post, even though it would prefer to commit to a laissez-faire policy ex-ante. But there are still situations in which market support is optimal even from an ex-ante perspective. Either because government interventions prevent an inevitable market breakdown. Or because they induces borrowers to disclose more information, making the financial sector less opaque. The latter effect is particularly interesting, since it implies that offering market support may be optimal because of the incentives that it creates ex-ante.[26]

[26]Proposition 7 shows that a government finds it ex-ante optimal to intervene if α is sufficiently large, the cost of public funds is sufficiently low and an intervention increases transparency (i.e., $\overline{E} \leq \tilde{E}$). While we do not provide any conditions for the case where an intervention prevents an inevitable market breakdown (i.e., $\overline{E} > \tilde{E}$), interventions may be ex-ante optimal in this case, too.

Conclusion

We have seen that banks may choose to design purposefully opaque financial claims in order to limit the amount of information that an informed lender can obtain. If an informed lender possesses less precise information, there is less of a stigma attached to having to resort to uninformed lenders. This increases the price uninformed lenders are prepared to pay for claims they know have previously been rejected by an informed lender and can ensure the liquidity of a spot market for financial claims. Opacity can have a positive effect on market liquidity even though it increases informational asymmetries between contracting parties. This insight contributes to our understanding of why many financial institutions decide to issue opaque claims or choose intransparent accounting practices even though these practices reduce the financial sector's ability to allocate funds towards the most efficient projects.

Most importantly, we have shown that there is a fundamental non-concavity in the returns to information disclosure. If borrowers can disclose very precise information, they will always choose to do so. But if information disclosure is bound to be imprecise anyway, borrowers may find it optimal to make even less information available as to prevent a breakdown of the spot market for funding. This is consistent with the fact that opaque financial claims were particularly prevalent in market segments where we would expect claims to be inherently hard to value, such as the subprime mortgage business.

Finally, we have seen that in a framework where banks optimally choose to be intransparent, government interventions that ensure market liquidity can have desirable ex-ante effects. If borrowers expect the government to prevent a market freeze in the future, they are prepared to disclose more information, which increases the allocative efficiency of the financial sector. However, there are also situations in which interventions that are optimal ex-post are inefficient from an ex-ante perspective since banks choose levels of transparency that are excessive from a social perspective. Hence, in some situations a government may want to commit to a 'no support' policy. This is consistent with concerns that while government interventions in financial markets may be optimal ex-post, they may induce market participants to rely on such interventions in ways that are detrimental to social welfare.

A Mathematical Appendix

Proof of Lemma 1. Without loss of generality, we can assume that lenders on the spot market offer an interest rate in the interval $[1/\theta_H, 1/\theta_L]$ in equilibrium since otherwise they would make losses (profits) irrespective of the market composition. Hence, borrowers with bad projects will always trade on the spot market: By condition (1) we know that $\rho_{np} + \theta_L \rho_p < \frac{\rho_{np}}{1-\rho_p\theta_L}$ and if it is beneficial to take out a loan at an interest rate of $1/\theta_L$, it is optimal to do so for all lower interest rates.

If both types of borrowers decide to borrow on the spot market lenders offer an interest rate of $r_M = 1/\hat{\theta}_M(e) = 1/(\theta_L + \alpha(1-e)(\theta_H - \theta_L))$ and make zero profits. Assumption 2 ensures that for $e = 0$ high types do indeed borrow on the spot market, while Assumption 1 implies that they would prefer autarky if $e = 1$. Since taking out loans becomes monotonously less attractive in the interest rate there is a unique threshold $\tilde{e} \in (0,1)$ such that high types will indeed take out a loan on the spot market whenever $e \leq \tilde{e}$. This threshold is implicitly defined by $A(\rho_{np} + \rho_p\theta_H) = \frac{\rho_{np}A}{1-\rho_p\hat{\theta}_M(\tilde{e})}$. It is easy to verify that for all $e < \tilde{e}$ the equilibrium is unique.

Instead, consider the case where $e > \tilde{e}$. The lowest interest rate that lenders can offer without making losses is given by $1/(\theta_L + \alpha(1-e)(\theta_H - \theta_L))$. However, for this rate high types will choose autarky and only low types take out loans. Since lenders have to make zero profits this implies that in equilibrium they have to offer an interest rate of $r_M = 1/\theta_L$. □

Proof of Proposition 1. First, let us show that for any optimal contract, constraint (6) must be binding. Consider otherwise. In this case the lender could reduce q^L by one unit and d^L by ρ_p units while increasing q^H by $\frac{1-\alpha}{\alpha}$ units and d^H by $\frac{1-\alpha}{\alpha}\frac{\hat{\theta}^L}{\hat{\theta}^H}\rho_p$ units, where $\hat{\theta}^L = \theta_L + \alpha(1-e)(\theta_H - \theta_L)$ and $\hat{\theta}^H = \theta_H - (1-\alpha)(1-e)(\theta_H - \theta_L)$. This change of the contract leaves the profits of the lender unaffected and allows disapproved borrowers to obtain the same amount of credit on the spot market. Moreover, it relaxes the constraint (7) and the feasibility constraint (8) for approved borrowers. Finally, it is easy to check that it increases the ex-ante expected utility of the borrower even if an approved borrower doesn't take up additional credit on the spot market. So (6) must be binding. For now, we will ignore condition (7) and we will check at the end that it is indeed satisfied in our candidate optimum. Substituting the zero profit condition into (6) gives us the relations $q^L = d^L\,(\alpha\theta_H + (1-\alpha)\theta_L)$ and $q^H = \hat{\theta}^H d^H - (1-\alpha)(\hat{\theta}^H - \hat{\theta}^L)d^L$.

In any equilibrium we must have $r_M > 1/\hat{\theta}^H$. Otherwise, it would be optimal to set $q^L = 0$, disapproved borrowers would borrow on the spot market and uninformed lenders would make negative profits. This implies that the marginal interest rate that approved borrowers have to pay when we increase the loan they receive from the informed lender $\partial d^H/\partial q^H$ is strictly smaller than the interest rate on the spot market. Hence, approved borrowers trade exclusively with the informed lender and borrow as much as possible. Using the feasibility constraint (8) we get $q^H = \frac{1}{1-\hat{\theta}^H\rho_p}\left(A\hat{\theta}^H\rho_p - (1-\alpha)(\hat{\theta}^H - \hat{\theta}^L)d^L\right)$. We can check that irrespective of whether borrowers with good projects decide to drop out of the spot market or not, the borrower's ex-ante expected utility is linear in q^L. This implies that the borrower will either choose a contract that has $q^L = 0$, or a contract that has the largest feasible q^L. In the first case we get $q^L = d^L = 0$, $q^H = \frac{\hat{\theta}^H\rho_p}{1-\hat{\theta}^H\rho_p}A$ and $d^H = \frac{\rho_p}{1-\hat{\theta}^H\rho_p}A$. In the latter case we get $q^L = q^H = \frac{(\alpha\theta_H+(1-\alpha)\theta_L)\rho_p}{1-(\alpha\theta_H+(1-\alpha)\theta_L)\rho_p}A$ and $d^L = d^H = \frac{\rho_p}{1-(\alpha\theta_H+(1-\alpha)\theta_L)\rho_p}A$, i.e. the terms of credit are independent of $\hat{s}$. It is easy to verify that both contracts do indeed satisfy condition (7). Without loss of generality we can assume that uninformed lenders expect the quality of borrowers who are in need of new funding at $t = 1$ to be $\hat{\theta}^L$. While this belief is not uniquely pinned down by rational expectations in case the spot market is inactive in equilibrium, any equilibrium that can be supported by some off-equilibrium belief can also be supported by a belief that the expected quality of borrowers in need of funds is $\hat{\theta}^L$. □

Proof of Proposition 2. Let us denote the borrower's expected utility in case he signs a contract that depends on $\hat{s}$ and in case both types of borrowers participate in the spot market by $W^L(e) = A\rho_{np}\left[\frac{\alpha}{1-\rho_p\hat{\theta}^H} + \frac{(1-\alpha)}{1-\rho_p\hat{\theta}_M}\right]$. We get

$$\frac{\partial W^L(e)}{\partial e} = A\rho_{np}\left[\frac{(1-\alpha)\alpha\rho_p}{\left(1-\rho_p\hat{\theta}^H\right)^2} - \frac{(1-\alpha)\alpha\rho_p}{\left(1-\rho_p\hat{\theta}_M\right)^2}\right](\theta_H - \theta_L) > 0 \tag{11}$$

for all $e \in [0,1]$. If the borrower signs an ex-ante contract that does not condition on $\hat{s}$, his expected utility is given by $W^L(0)$: The utility is the same as if the signal of the informed lender contained no information at all. In either case the borrower will be offered an interest rate of

$1/(\alpha\theta_H + (1-\alpha)\theta_L)$ irrespective of s. This implies that it must be optimal to sign a contract that depends on $\hat{s}$ for all $e \in [0, \tilde{e}]$ since in these cases both types of borrowers do indeed participate in the spot market.

Instead, assume the borrower signs a contract that conditions on $\hat{s}$ and a borrower with a good project who ends up on the spot market doesn't take out a loan. This type of borrower receives a utility equal to the level he could obtain by borrowing at a rate of $1/\tilde{\theta}_M$ since for this interest rate he is indifferent between borrowing on the spot market and choosing autarky. So we can express the expected utility of a borrower as $W^{BD}(e) = A\rho_{np}\left[\frac{\alpha}{1-\rho_p\hat{\theta}^H} + \frac{(1-\alpha)(1-\alpha_M)}{1-\rho_p\theta_L} + \frac{(1-\alpha)\alpha_M}{1-\rho_p\tilde{\theta}_M}\right]$. Since $\alpha_M(1) = 0$ and $\hat{\theta}_M(1) = \theta_L$ we get $W^{BD}(1) = W^L(1)$. Hence, if $e \to 1$ it is always optimal to sign an ex-ante contract that conditions on $\hat{s}$ instead of signing a contract that does not depend on $\hat{s}$ and receiving a utility of $W^L(0)$. Next, let us look at the marginal effect of transparency on B's expected utility in case high types abstain from trading on the spot market:

$$\frac{\partial W^{BD}(e)}{\partial e} = A\rho_{np}\left[\frac{\rho_p\alpha(1-\alpha)(\theta_H - \theta_L)}{\left(1-\rho_p\hat{\theta}^H\right)^2} + \frac{(1-\alpha)\alpha}{1-\rho_p\theta_L} - \frac{(1-\alpha)\alpha}{1-\rho_p\tilde{\theta}_M}\right]$$

$$= \alpha(1-\alpha)A\rho_{np}\left[\frac{\rho_p(\theta_H - \theta_L)}{\left(1-\rho_p\hat{\theta}^H\right)^2} - \frac{\rho_p\left(\tilde{\theta}_M - \theta_L\right)}{(1-\rho_p\theta_L)\left(1-\rho_p\tilde{\theta}_M\right)}\right] > 0 \quad (12)$$

Since (12)>(11) there exists some $\breve{e} > 0$ such that $W^L(0) = W^{BD}(\breve{e})$. The borrower strictly prefers a contract that doesn't depend on $\hat{s}$ for all $e \in (\tilde{e}, \hat{e})$ where $\hat{e} = \max\{\tilde{e}, \breve{e}\}$. For these levels of transparency the spot market does indeed break down and $W^{BD}(e) < W^L(0)$. As $\theta_L \to (\theta_H/(\rho_{np} + \theta_H\rho_p) - \alpha\theta_H)/(1-\alpha)$ we get $\tilde{e} \to 0$ and the interval $(\tilde{e}, \hat{e})$ is non-empty. □

Proof of Proposition 3. The proof is straightforward and follows along the lines of Proposition 2. We can easily check that whenever the borrower does not choose maximal transparency, he will set $e = \tilde{e}$ to maximize the gains from information disclosure while still keeping the spot market liquid. So we only have to compare the utility $W(\overline{E})$ to $W(\tilde{e})$ Since $W^{BD}(1) = W^L(1) > W^L(\tilde{e})$, full information disclosure is always optimal if $\overline{E} \to 1$. By the same logic as before, there exists some $\tilde{E} > \tilde{e}$ such that $W^L(\tilde{e}) = W^{BD}(\tilde{E})$. So the borrower restricts information disclosure if $\overline{E} \leq \tilde{E}$ and discloses all information if $\overline{E} > \tilde{E}$. Since $W^L(\tilde{e}) > W^L(0)$

we know that $\tilde{E} > \hat{e}$. $\square$

Proof of Proposition 4. Borrowers who end up without funding from an informed lender will accept credit from whoever offers the lowest interest rate. Hence, if the government buys any claims we must have $r_G \leq r_M$. This requires that $r_G \leq 1/\hat{\theta}_M(e)$ since otherwise lenders could make a profit by marginally undercutting r_G. Since commercial lenders always make zero profits and borrowers take out loans at an interest rate of r_G, any equilibrium with a given r_G results in the same welfare and the same losses incurred by the government. So w.l.o.g. we can assume that all borrowers on the spot market trade with the government.

Let us show that conditional on spot market liquidity, the government offers the highest possible interest rate since it has no incentive to subsidize borrowers. Assume the spot market remains liquid. In this case welfare on the spot market is given by

$$W_s = \left(\frac{r_G}{r_G - \rho_p}\right) A\rho_{np} + \lambda \left(\frac{r_G}{r_G - \rho_p}\right) A\rho_p \left(\hat{\theta}_M - \frac{1}{r_G}\right)$$

and we get

$$\frac{\partial W_s}{\partial r_G} = -\frac{\rho_p}{(r_G - \rho_p)^2} A\rho_{np} - \lambda \left(\frac{\hat{\theta}_M {\rho_p}^2}{(r_G - \rho_p)^2} - \frac{\rho_p}{(r_G - \rho_p)^2}\right) A.$$

This is positive whenever $\lambda > \frac{\rho_{np}}{1-\hat{\theta}_M}$, which is true by Assumption 3. Similarly, we can show that conditional on a spot market breakdown the government still offers the highest possible interest rate. This implies that the government will only offer an interest rate that is different from the one that prevails without any intervention (i.e., $r_G < 1/\hat{\theta}_M(e)$) if the spot market would otherwise break down. If the government intervenes in such a way, then it offers the highest interest rate that does not jeopardize spot market liquidity: $r_G = 1/\tilde{\theta}_M$. Commercial lenders have no incentive to undercut the interest rate offered by the government and an equilibrium where the government buys all claims does indeed exist.

However, it is easy to see that there are also equilibria in which private lenders purchase a positive amount of claims and offer an interest rate of $r_M = r_G$. In these equilibria a subset of borrowers with an expected quality of $\tilde{\theta}_M$ sells claims to commercial lenders and these lenders make zero profits. The losses incurred by the government remain unaffected.

$\square$

Proof of Proposition 5. It is easy to see that a borrower who wants the government to intervene always chooses the highest level of transparency for which the government is prepared to intervene. For any $e \in [0, \tilde{e}]$ the government is inactive and we already know that the borrowers utility is increasing in e. Moreover, for all e up to the maximal level for which the government is willing to intervene, the borrower's expected utility is increasing in e, too. A higher level of transparency results in more attractive conditions offered by informed lenders while the interest rate on the spot market is $1/\tilde{\theta}_M$ and does not depend on e.

This implies that the government can effectively choose the level of e that borrowers implement by announcing an appropriate maximum transparency level.

$$\max_e W = \left[\alpha \frac{1}{1-\rho_p \hat{\theta}^H(e)} + (1-\alpha)\frac{1}{1-\rho_p\tilde{\theta}_M}\right] A\rho_{np} \\ - (1-\alpha)\lambda\left(1-\frac{\alpha_M(e)}{\tilde{\alpha}}\right)\left[\frac{\rho_p\left(\tilde{\theta}_M-\theta_L\right)}{1-\rho_p\tilde{\theta}_M}\right] A.$$

Using the fact that $\hat{\theta}^H(e) = \theta_H - (1-\alpha)(1-e)\left(\theta_H - \theta_L\right)$ we can easily see that the optimisation problem is globally convex: While the cost of larger market interventions is linear in e, the benefit of increased transparency is convex. So the government will either not intervene at all, or it will offer market support for all $e \leq \overline{E}$.

Since the government is prepared to intervene regardless of the level of transparency we do not have to consider whether the borrower does indeed want to make sure that the government intervenes.

In order to derive the conditions under which the government is willing to offer market support, we have to compare the losses the government makes in case of an intervention to the change in the expected utility of borrowers. In case the government doesn't intervene and $\overline{E} \leq \tilde{E}$ borrowers would voluntarily restrict information disclosure in order to ensure that the spot market for debt does not break down. So the condition for an intervention is given by equation (9). If on the other hand $\overline{E} > \tilde{E}$ borrowers would choose to disclose as much information as possible in case the government announces not to intervene. In this case the condition for an intervention is given by (10). In either case we can solve for a threshold $\overline{\lambda}^c$ such that the government intervenes if and only if $\lambda \leq \overline{\lambda}^c$. $\square$

Proof of Proposition 6. Assume that borrowers have chosen a level of transparency $e > \tilde{e}$, i.e. absent any intervention the spot market would freeze. The government intervenes whenever the benefit from preventing a market freeze exceeds the cost of an intervention:

$$\left[\frac{1}{1-\rho_p\tilde{\theta}_M} - \frac{1}{1-\rho_p\theta_L}\right] A\rho_{np}(1-\alpha_M(e)) \geq \lambda \left(1 - \frac{\alpha_M(e)}{\tilde{\alpha}_M}\right) \left[\frac{\rho_p\left(\tilde{\theta}_M - \theta_L\right)}{1-\rho_p\tilde{\theta}_M}\right] A. \tag{13}$$

The benefit of an intervention is restricted to low types who end up in need of new funds. Approved borrowers will still receive credit from their informed lender and high types that end up on the spot market receive the same level of utility no matter if they choose autarky or if they borrow at an interest rate of $1/\tilde{\theta}_M$. The cost of an intervention on the other hand is given by the share of claims that the government needs to buy times the loss that it makes on each claim. We can check that there exists a lower bound on $\alpha_M(e)$ that guarantees that a government will be prepared to intervene if and only if $\alpha_M(e)$ is larger than this lower bound. Solving for $\alpha_M(e)$ gives us the expression given in the proposition. Since $\alpha_M(e)$ is decreasing in e, the lower bound on $\alpha_M(e)$ translates into an upper bound on e which we denote by $\hat{E}^{nc}$. Since $\tilde{\alpha}_M < 1$ it is easy to see that $\hat{E}^{nc} > \tilde{e}$.

By the same argument as in the proof of Proposition 5, the borrowers expected utility is increasing over the interval $[0, \hat{E}^{nc}]$. Moreover, while the borrower's expected utility drops discontinuously once he chooses $e > \hat{E}^{nc}$ and no longer benefits from an intervention, his expected utility increases monotonically again over the interval $(\hat{E}^{nc}, \overline{E}]$. So the borrower will either choose $e = \hat{E}^{nc}$ or $e = \overline{E}$. He prefers to choose $e = \hat{E}^{nc}$ if and only if

$$\frac{\alpha}{1-\rho_p\hat{\theta}^H(\overline{E})} + \frac{(1-\alpha)\alpha_M(\overline{E})}{1-\rho_p\tilde{\theta}_M} + \frac{(1-\alpha)(1-\alpha_M(\overline{E}))}{1-\rho_p\theta_L} \leq \frac{\alpha}{1-\rho_p\hat{\theta}^H(\hat{E}^{nc})} + \frac{(1-\alpha)}{1-\rho_p\tilde{\theta}_M}$$

where again we use the fact that under a market freeze high types that end up on the spot market receive the same utility as if they were to borrow at a rate of $r_M = 1/\tilde{\theta}_M$.

From the definition of $\tilde{E}$ we know that for all $\overline{E} \leq \tilde{E}$

$$\frac{\alpha}{1-\rho_p \hat{\theta}^H(\overline{E})} + \frac{(1-\alpha)\alpha_M(\overline{E})}{1-\rho_p \tilde{\theta}_M} + \frac{(1-\alpha)(1-\alpha_M(\overline{E}))}{1-\rho_p \theta_L} \leq \frac{\alpha}{1-\rho_p \hat{\theta}^H(\tilde{e})} + \frac{(1-\alpha)}{1-\rho_p \tilde{\theta}_M}.$$

Since $\hat{E}^{nc} > \tilde{e}$ we know that for all $\overline{E} \leq \tilde{E}$ the borrower will indeed prefer to choose $e = \hat{E}^{nc}$. However, in case $\overline{E} > \tilde{E}$ the condition is satisfied if and only if $\hat{E}^{nc}$ is sufficiently close to $\overline{E}$. Since $\hat{E}^{nc}$ is decreasing in λ this will be the case whenever the cost of public funds is sufficiently low. □

Proof of Proposition 7. Consider the case where $\overline{E} \leq \tilde{E}$. By the definition of $\tilde{E}$ we know that for all $\overline{E} \leq \tilde{E}$

$$\frac{\alpha}{1-\rho_p \hat{\theta}^H(\overline{E})} + \frac{(1-\alpha)\alpha_M(\overline{E})}{1-\rho_p \tilde{\theta}_M} + \frac{(1-\alpha)(1-\alpha_M(\overline{E}))}{1-\rho_p \theta_L} \leq \frac{\alpha}{1-\rho_p \hat{\theta}^H(\tilde{e})} + \frac{(1-\alpha)}{1-\rho_p \tilde{\theta}_M}.$$

or simply

$$\left[\frac{1}{1-\rho_p \tilde{\theta}_M} - \frac{1}{1-\rho_p \theta_L}\right](1-\alpha_M(\overline{E})) \geq \frac{\alpha}{(1-\alpha)}\left[\frac{1}{1-\rho_p \hat{\theta}^H(\overline{E})} - \frac{1}{1-\rho_p \hat{\theta}^H(\tilde{e})}\right].$$

So whenever (9) is satisfied, equation (13) is satisfied for $e = \overline{E}$, too. Hence, whenever a government with commitment power offers (unconditional) interventions, a government that lacks commitment power will do so, too. Moreover, a government that lacks commitment power may intervene even if a government with commitment power does not find it optimal to do so.

In case $\overline{E} > \tilde{E}$ a government with commitment power will intervene if and only if condition (10) holds. This condition coincides with (13) evaluated at $e = \overline{E}$. So a government with commitment power will offer unconditional interventions if and only if a government without commitment power will do so. While under some circumstance a government that lacks commitment will offer interventions that are limited in size, a government with commitment power will never offer such conditional interventions.

We can easily check that the threshold $\overline{\lambda}^c(\overline{E})$ is increasing in $\overline{E}$ for all $\overline{E} \in \left(\tilde{e}, \tilde{E}\right)$. So in order to show that $\overline{\lambda}^c(\overline{E}) > \underline{\lambda}$ for all $\overline{E} \in (\tilde{e}, \tilde{E}]$ it is sufficient to show that $\lim_{\overline{E} \to \tilde{e}} \overline{\lambda}^c(\overline{E}) > \underline{\lambda}$.

In the limit the intervention needed to ensure market liquidity becomes arbitrarily small and will be welfare-increasing whenever

$$\rho_{np}\frac{(\theta_H-\theta_L)}{\left(1-\rho_p\hat{\theta}^H(\tilde{e})\right)^2}-\frac{\overline{\lambda}^c(\tilde{e})}{\tilde{\alpha}_M}\frac{\left(\tilde{\theta}_M-\theta_L\right)}{1-\rho_p\tilde{\theta}_M}=0$$

or $\overline{\lambda}^c(\tilde{e})=\frac{\rho_{np}^2}{\left(1-\rho_p\hat{\theta}^H(\tilde{e})\right)^2}\frac{1}{\left(\rho_{np}+\theta_H\rho_p\right)}$ which is increasing in α. Moreover,

$$\lim_{\alpha\to 1}\overline{\lambda}^c(\tilde{e})=\frac{\rho_{np}^2}{\left(1-\rho_p\theta_H\right)^2}\frac{1}{\left(\rho_{np}+\theta_H\rho_p\right)}>\underline{\lambda}.$$

So there exists an $\alpha<1$ such that $\overline{\lambda}^c(\overline{E})>\underline{\lambda}$ for all $\overline{E}\in(\tilde{e},\tilde{E}]$. □

B Screening contracts

In Section 2 we assumed that informed lenders do not offer screening contracts, i.e. for any report $\hat{s}$ they offer a unique set of payments $(q^{\hat{s}},d^{\hat{s}})$. We now relax this assumption, but we assume that whenever both types of borrowers are indifferent between two terms of financing, they will accept the same terms. We will show that under this tie-breaking rule there is indeed always an optimal contract in which for a given report $\hat{s}$ all borrowers accept the same terms (irrespective of i). Hence, the assumption that the lender offers only one set of payments for each $\hat{s}$ is without loss of generality.

Without loss of generality we assume that for a given report $\hat{s}$ the informed lender asks the borrower to choose between two options $(q_H^{\hat{s}},d_H^{\hat{s}})$ and $(q_L^{\hat{s}},d_L^{\hat{s}})$ at $t=1$ where in equilibrium a borrower with $i=H$ chooses the first option and a borrower with $i=L$ chooses the latter one. Whenever $r_M\leq 1/\tilde{\theta}_M$ all borrowers complement their contract with credit taken up on the outside market and pledge all of their future earnings to lenders. This implies that their utility is independent of i for any given option. It follows that each types i must receive the same level of utility for both options. Given our tie-breaking rule, this implies that both types must accept the same terms of financing, i.e. $q_H^{\hat{s}}=q_L^{\hat{s}}$ and $d_H^{\hat{s}}=d_L^{\hat{s}}$.

Let us now assume that $r_M>1/\tilde{\theta}_M$. In this case only low types take out extra credit on the spot market, while high types receive a strictly larger expected utility by not pledging any of their income to uninformed lenders. This implies that lenders may be able to implement separation by offering contracts that restrict the amount of credit granted to borrowers who claim to be of type $i = H$. Any such contract must satisfy the following incentive compatibility constraints:

$$(q_H^{\hat{s}} + A)\rho_{np} + \theta_H \left[(q_H^{\hat{s}} + A)\rho_p - d_H^{\hat{s}}\right] \geq (q_L^{\hat{s}} + A)\rho_{np} + \theta_H \left[(q_L^{\hat{s}} + A)\rho_p - d_L^{\hat{s}}\right]$$

and

$$\left(q_L^{\hat{s}} + A + \left[\frac{(q_L^{\hat{s}} + A)\rho_p - d_L^{\hat{s}}}{r_M - \rho_p}\right]\right)\rho_{np} \geq \left(q_H^{\hat{s}} + A + \left[\frac{(q_H^{\hat{s}} + A)\rho_p - d_H^{\hat{s}}}{r_M - \rho_p}\right]\right)\rho_{np}$$

for all $\hat{s} \in \{H, L\}$. If we simplify these constraints and take into account that an informed lender has to make zero profits and has to have an incentive to announce his signal truthfully, we get the following system of constraints that any contract has to satisfy:

$$d_H^H - d_L^H \geq \left(q_H^H - q_L^H\right) r_M \tag{14}$$

$$\left(\rho_{np} + \theta_H \rho_p\right)\left(q_H^H - q_L^H\right) \geq \theta_H \left(d_H^H - d_L^H\right) \tag{15}$$

$$d_H^L - d_L^L \geq \left(q_H^L - q_L^L\right) r_M \tag{16}$$

$$\left(\rho_{np} + \theta_H \rho_p\right)\left(q_H^L - q_L^L\right) \geq \theta_H \left(d_H^L - d_L^L\right) \tag{17}$$

$$\begin{aligned} &\alpha_H\theta_H d_H^H + (1-\alpha_H)\theta_L d_L^H - \alpha_H q_H^H - (1-\alpha_H)q_L^H \geq \\ &\alpha_H\theta_H d_H^L + (1-\alpha_H)\theta_L d_L^L - \alpha_H q_H^L - (1-\alpha_H)q_L^L \end{aligned} \tag{18}$$

$$\begin{aligned} &\alpha_L\theta_H d_H^L + (1-\alpha_L)\theta_L d_L^L - \alpha_L q_H^L - (1-\alpha_L)q_L^L \geq \\ &\alpha_L\theta_H d_H^H + (1-\alpha_L)\theta_L d_L^H - \alpha_L q_H^H - (1-\alpha_L)q_L^H \end{aligned} \tag{19}$$

$$\begin{aligned} &\alpha\left[\alpha_H\theta_H d_H^H + (1-\alpha_H)\theta_L d_L^H - \alpha_H q_H^H - (1-\alpha_H)q_L^H\right] + \\ &(1-\alpha)\left[\alpha_L\theta_H d_H^L + (1-\alpha_L)\theta_L d_L^L - \alpha_L q_H^L - (1-\alpha_L)q_L^L\right] = 0 \end{aligned} \tag{20}$$

In order to show that there exists a pooling equilibrium in case $r_M = 1/\theta_L$ we proceed in three steps: Step 1): Conditions (14) and (15) (or, equivalently, (16) and (17)) can be reexpressed as $(\rho_{np} + \theta_H \rho_p)(q_H^{\hat{s}} - q_L^{\hat{s}}) \geq \theta_H (d_H^{\hat{s}} - d_L^{\hat{s}})$ and $\frac{\theta_H}{\theta_L}(q_H^{\hat{s}} - q_L^{\hat{s}}) \leq \theta_H (d_H^{\hat{s}} - d_L^{\hat{s}})$. Since $(\rho_{np} + \theta_H \rho_p) < \frac{\theta_H}{\theta_L}$ these conditions can only be jointly satisfied if $q_H^{\hat{s}} \leq q_L^{\hat{s}}$ and $d_H^{\hat{s}} \leq d_L^{\hat{s}}$ for all $\hat{s} \in \{H, L\}$.

Step 2): For now, we will assume that (19) is always satisfied. We will check at the very end that (19) is indeed satisfied in our candidate optimum. Assume that (14) is not binding. In this case the lender could reduce q_L^H by one unit and d_L^H by ρ_p units while increasing q_H^H by $\frac{(1-\alpha_H)}{\alpha_H}$ units and d_H^H by $\frac{\theta_L}{\theta_H}\frac{(1-\alpha_H)}{\alpha_H}\rho_p$ units. This change increases the borrower's expected utility while leaving (18) and (20) unaffected. Moreover, the proposed change relaxes condition (15). This implies that (14) must be binding for any optimal contract. Similarly, assume that (16) is not binding. In this case the lender could reduce q_L^L by one unit and d_L^L by ρ_p units while increasing q_H^L by $\frac{(1-\alpha_L)}{\alpha_L}$ units and d_H^L by $\frac{\theta_L}{\theta_H}\frac{(1-\alpha_L)}{\alpha_L}\rho_p$ units. This increases a lender's expected utility while leaving (20) unaffected. Moreover, the proposed change relaxes (18) and (17).

Step 3): Let us now reduce $q_L^{\hat{s}}$ by one unit and $d_L^{\hat{s}}$ by r_M units. This leaves conditions (14) and (16) unchanged and since $r_M = 1/\theta_L$ conditions (18) and (20) remain unaffected, too. So the change does not influence the borrower's expected utility and is feasible unless (15) and (17) become binding. This will be the case when $q_H^{\hat{s}} = q_L^{\hat{s}}$ and hence $d_H^{\hat{s}} = d_H^{\hat{s}}$. Moreover, in Section 3.2 we have shown that for any optimal contract that has $q_H^{\hat{s}} = q_L^{\hat{s}}$ and $d_H^{\hat{s}} = d_L^{\hat{s}}$ condition (19) is satisfied. So we can replace any contract by a contract that does equally well and has both types i obtain the same terms of financing.

Informed lenders can always hand out less credit to low types and have them take out more credit on the spot market instead. In case of a market breakdown lenders on the spot market make zero profits when dealing with low types. Hence, the informed lender can change the ex-ante contract in a fashion that leaves both, the utility of low types and his own profits for any given announcement $\hat{s}$ constant. So the reduction in $q_L^{\hat{s}}$ does neither affect the informed lender's profits, nor his incentive to reveal his information truthfully. This implies that the informed lender might as well offer the same amount of credit to high and low types. However, incentive compatibility on the side of the borrower implies that in this case the repayments have to be the same for both types, too, and we end up with pooling between different types that received the same signal s.

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