Runs versus Lemons:
Information Disclosure and Fiscal Capacity*

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Abstract

We argue that, during financial crises, governments are forced to choose between runs and lemons. Revealing information about bank asset quality can improve welfare by reducing adverse selection, but it can also create runs on weak banks. A credible fiscal backstop mitigates these risks and allows the government to pursue efficient but risky strategies of high disclosure. Our theory sheds light on optimal interventions and provides an explanation for the different choices that governments make during financial crises.

JEL: E5, E6, G1, G2.

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Governments play an important role in stopping or mitigating financial crises (Gorton, 2012). Governments use many tools to intervene in financial markets, but we can think of two broad classes of interventions. The first class involves guarantees, capital injections, etc. The common feature in these interventions is that they are backed by the fiscal capacity of the government. A second class of interventions includes stress test, assets quality reviews, regulatory assessments, etc. These interventions do not directly rely on the balance sheet of the government but on its ability to credibly disclose information. Historically, governments almost always use both types of interventions. Yet, the existing literature has only studied one or the other. Our goal in this paper is to provide a theory of optimal interventions using both guarantees and disclosure.

Beyond this normative motivation, there is also a positive one: governments with ample fiscal capacity seem to choose different disclosure strategies than governments with limited capacity. For instance, in May 2009, the Federal Reserve publicly reported the results of the Supervisory Capital Assessment Program (SCAP). The SCAP was an assessment of the capital adequacy, under adverse scenarios, of a large subset of US financial firms. The exercise is broadly perceived as having reduced uncertainty about the state of the US financial system and helped restore calm to financial markets. The Committee of European Banking Supervisors (CEBS) also conducted EU-wide stress tests from May to October 2009 but chose a very different disclosure. It first announced that it would not disclose the results. The exercise was repeated a year later and the results were published, but the scope of the test was limited, especially with regard to sovereign exposures. European stress tests were less effective than their US counterparts in restoring confidence to the financial sector. Several commentators and policy makers have suggested that the lack of a common fiscal backstop made it difficult for Europe to conduct the same rigorous stress tests as the U.S.\footnote{Ong and Pazarbasioğlu (2013) provide a thorough overview of the details and perceived success of SCAP and the CEBS stress tests. See Véron (2012) for a discussion of the challenges facing European policy makers.} This interpretation is consistent with our theory.

**Disclosure** We want our model to capture some of the main tradeoffs faced by policy makers during financial crises. Let us first discuss the disclosure of information about the health of financial firms. Disclosure is typically motivated by the need to “restore investor confidence in the health of financial firms.” We capture this idea using a simple model of adverse selection, following Akerlof (1970), Stiglitz and Weiss (1981) and Myers and Majluf (1984). Our economy is populated by financial intermediaries (“banks”) that differ in the quality of their existing assets. Banks privately observe the quality of their legacy assets. Banks must also raise additional funds in credit markets to invest in new projects, but the riskiness of the new loans depends on the quality of the legacy assets. Asymmetric information about the quality of existing assets therefore creates the potential for adverse selection. When average asset quality is high, adverse selection is limited and credit markets operate efficiently. When average asset quality deteriorates, however, credit markets can freeze. The key aggregate state variable in our economy is the fraction of banks with good legacy assets. If the fraction of bad banks is likely to be high, markets are likely to freeze, and
the government can improve welfare by disclosing information about asset quality.\footnote{The \textit{impact} of disclosure on efficiency is not obvious. Disclosure can hurt. However, it is always possible to find \textit{some} disclosure that helps, and full disclosure is trivially optimal (if feasible) since it restores symmetric information.}

Alleviating adverse selection therefore pushes the government to disclose information about banks' balance sheets. Why, then, not disclose as much as possible? We argue that an important cost of disclosure is the risk of triggering a run on weak banks. We follow the standard approach of Diamond and Dybvig (1983) and we assume that banks are funded with runable liabilities.\footnote{We have in mind all short term runable liabilities: MMMF, Repo, ABCP, and, of course, large uninsured deposits. In the model, for simplicity, we refer to intermediaries as banks and to liabilities as deposits.} If short term creditors (depositors) learn that a particular bank is weak, they might decide to run. Runs are inefficient for two reasons: there is a deadweight loss from liquidating assets, and liquidated banks cannot invest in new projects.

In our model, disclosure therefore involves a fundamental tradeoff between runs and lemons. We first consider the case of pure disclosure without any fiscal intervention. We solve for optimal disclosure in the spirit of Bayesian persuasion, as in Kamenica and Gentzkow (2011). The government chooses strategically the precision of the information it wants to generate without knowing the actual fraction of bad banks. The disclosure reveals both the aggregate state and some information about individual banks. We argue that this captures well the essence of stress tests and asset quality reviews. The strategic choices are whether to conduct a test or not, and how to design of the test (which variables to stress, how much to stress them, etc.). A government that does not want to reveal much information can simply not run a test, or run a weak one. We find that the planner's disclosure problem is typically non-convex and the optimal disclosure might be very low or very high. XXX OTHER INSIGHTS HERE? XXX

**Guarantees** We then introduce fiscal interventions. These interventions expose the balance sheet of the government to financial risks. The planner in our model must pay for its interventions with distortionary taxation, so it seeks to minimize the costs of its interventions. Specifically, the government provides deposit guarantees to stop bank runs and debt guarantees to unfreeze credit markets. The deposit guarantee is straightforward: it avoids runs and inefficient liquidation. Interventions in markets with adverse selection, on the other hand, are potentially difficult to analyze because they require solving a mechanism design problem with endogenous outside options, as explained in Philippon and Skreta (2012) and Tirole (2012). Fortunately, we can rely on these recent papers to show that the optimal intervention takes a simple form: the government provides a credit-enhancing guarantee to banks that need to borrow. Guarantees of this kind are indeed routinely observed during financial crises, and were used in the U.S. and in Europe in 2009. Deposit insurance and debt guarantees draw on the same fiscal backstop, so they create a tradeoff for the planner. We find that deposit insurance plays a prominent role because if a bank is run it looses its option to invest. In that sense, a government needs to worry about market freeze only after it has stopped large scale bank runs. XXX OTHER INSIGHTS HERE? XXX

The main contribution of our paper is then to analyze the interaction between fiscal capacity and disclosure.
Our two main insights can be summarized as follows. First, disclosure is (often) a high risk/high return strategy. Imposing meaningful transparency about balance sheets can quickly restore confidence and unfreeze credit markets. In many states of the world, when average assets quality is not too low, this essentially comes for free. But there are risks. If a government rolls out an ambitious stress test and it turns out that banks are in worse shape than expected, then this government could face a large scale bank run. The second key insight is that fiscal capacity provides insurance against the risks created by information disclosure. When fiscal capacity is ample, the planner commits to revealing information and, in case of bad news, provides guarantees to banks that are vulnerable to runs. When capacity is low, the planner prefers to avoid runs by not disclosing much information.

It is important to emphasize that none of these results could be obtained without the joint modeling effort in this paper. In the model, as in the real world, it is important that the same aggregate fundamental (the fraction of bad banks) determines both the risk of runs and the risk of a market freeze. It is also important to solve for the jointly optimal policy. Otherwise, one might think that disclosure and guarantees can be substitutes with respect to adverse selection. A government with strong fiscal capacity could guarantee bank debt and unfreeze markets without disclosing information. This is certainly true, but it is often not optimal, and it also misses the key prediction. The prediction is not that fiscal capacity always implies full disclosure. The key prediction, akin to a single crossing property, is that the optimal degree of disclosure increases with the fiscal capacity of the government. This prediction can only be understood in the context of an explicit model, such as the one we propose.

Our paper is organized as follows. Section 1 presents the model, and the decentralized equilibrium with no intervention. Section 2 focuses on the role of information disclosure by a benevolent planner. Section 3 discusses fiscal interventions. Section 4 combines information disclosure and fiscal interventions, and studies the optimal combination of the two types of policies. Section 5 concludes.

Related literature

We make two contributions relative to the literature. First, we model new lending and borrowing by banks in addition to bank runs. While existing papers capture some important aspects of information disclosure, they do not address what seems to be the main trade-off facing policy makers, between unfreezing credit markets and triggering bank runs.

Our second, and most important, contribution is to analyze the role of fiscal capacity in shaping information disclosure. Our model captures the idea that fiscal capacity is like an insurance policy that allows regulators to be more aggressive in their disclosure choices. Our model therefore provides an explanation for the difference in disclosure choices between Europe and the United States. Banking regulators in the US have a fiscal backstop and hence are more willing to run tougher stress tests. Banking regulators in Europe do not have a common fiscal backstop (or at least, did not have one during the financial crisis), and so are less willing to expose potential weaknesses in their banking system.
Our work builds on the rich literature that studies asymmetric information, following Akerlof (1970), Spence (1974), and Stiglitz and Weiss (1981). If no information is revealed by the planner, our economy resembles the one studied by Philippon and Skreta (2012) and Tirole (2012). The optimal policy to mitigate adverse selection is similar to theirs. Since we add bank runs to an economy with asymmetric information, we also build on the large literature started by Diamond and Dybvig (1983). Several recent papers shed light on how runs take place in modern financial systems: theoretical contributions include Uhlig (2010) and He and Xiong (2012); Gorton and Metrick (2012) provide a detailed institutional and empirical characterization of modern runs.

Several recent papers study specifically the trade-offs involved in revealing information about banks. Goldstein and Leitner (2013) focus on the Hirshleifer (1971) effect: revealing too much information destroys risk-sharing opportunities between risk neutral investors and (effectively) risk averse bankers. These risk-sharing arrangements also play an important role in Allen and Gale (2000). Shapiro and Skeie (2013) study reputation concerns by a regulator in an environment characterized by a trade-off between moral hazard and runs.

Another set of papers study disclosure in models of bank runs. In this class of models, disclosure is a way to break pooling equilibria. Whether disclosure is good or bad then depends on whether the pooling equilibrium is desirable: if agents pool on the “no run” equilibrium then there is no reason to disclose information. This is more likely to happen in good times as Carlsson and van Damme (1993) and Morris and Shin (2000) show. On the other hand, in bad times, agents might run on all the banks, in which case it is better to disclose information to save at least the good banks. This is the basic result of Bouvard et al. (2012), who also consider ex-ante disclosure rules that allow pooling across macroeconomic states. Parlato (2013) studies an economy with aggregate risk where more precise information about realizations of the aggregate state can lead to more bank runs.

In our setting, banks are not able to credibly disclose information about their type. Alvarez and Barlevy (2014) study a model of contagion in a banking network where moral hazard limits efficient investment. They show that private disclosure choices are not always efficient and that mandatory disclosure can improve welfare. The focus of the paper is different from ours. They only consider perfect or no disclosure, and they focus on contagion. Gorton and Ordoñez (2014) consider a model where crises occur when investors have an incentive to learn about the true value of otherwise opaque assets.

Our paper also relates to the theoretical literature on bank bailouts. Gorton and Huang (2004) argue that the government can bail out banks in distress because it can provide liquidity more effectively than private investors. Diamond and Rajan (2005) show that bank bailouts can backfire by increasing the demand for liquidity and causing further insolvency. Diamond (2001) emphasizes that governments should only bail out the banks that have specialized knowledge about their borrowers. Farhi and Tirole (2012) examine bailouts in a setting in which private leverage choices exhibit strategic complementarities due to the monetary policy reaction. Corbett and Mitchell (2000) discuss the importance of reputation in a setting where a bank’s decision to participate in a government intervention is a signal about asset values, and Philippon and Skreta (2012) formally analyze optimal interventions.
when outside options are endogenous and information-sensitive. Mitchell (2001) analyzes interventions when there is both hidden action and hidden information. Landier and Ueda (2009) provide an overview of policy options for bank restructuring. Philippon and Schnabl (2013) focus on debt overhang in the financial sector. Diamond and Rajan (2012) study the interaction of debt overhang with trading and liquidity. In their model, the reluctance to sell assets leads to a collapse in trading which increases the risks of a liquidity crisis.

Goldstein and Sapra (2014) review the literature on the disclosure of stress tests results. They explain that stress tests differ from usual bank examinations in four ways: (i) traditional exams are backward looking, while stress tests project future losses; (ii) the projections under adverse scenarios provide information about tail risks; (iii) stress tests use common standards and assumptions, making the results more comparable across banks; (iv) unlike traditional exams that are kept confidential, stress tests results are publicly disclosed. They list two benefits of disclosure: (i) enhanced market discipline; and (ii) enhanced supervisory discipline. Our model is based on yet another benefit: the unfreezing of the credit market. They list four costs of disclosure: (i) disclosure might prevent risk-sharing through the Hirshleifer (1971) effect, which is the focus of Goldstein and Leitner (2013); (ii) improving market discipline is not necessarily good for ex-ante incentives; (iii) disclosure might trigger runs; (iv) disclosure might reduce the ability of regulators to learn from market prices, as in Bond et al. (2010). Our model is based on cost (iii).

1 Model

1.1 Technology, preferences, and information

There are three dates, \( t = 0, 1, 2 \), and one good (consumption) at every period. The economy is populated by a continuum of households, a continuum of mass 1 of financial intermediaries (banks), and a government. Figure 1 summarizes the timing of decisions and events in the model, which are explained in detail below.

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Figure 1: Model Timing

\[ t = 0 \]  \[ t = 1 \]  \[ t = 2 \]
- Government announces disclosure policy
- Aggregate state is realized and private signals are observed
- Households may run on banks and Government may intervene to prevent liquidation
- Credit markets open
- Surviving banks borrow in credit markets and invest
- Government may intervene in credit market
- Payoffs are realized
- Government levies taxes
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Households are risk-neutral and their utility depends only on consumption at \( t = 2 \). They receive an endowment
\(\tilde{y}_1\) at \(t = 1\). At periods 0 and 1 they have access to a storage technology that pays one unit of consumption at \(t = 2\) per unit invested. There is no discounting. This allows us to treat total output at \(t = 2\) (which equals total consumption) as the measure of welfare that the government seeks to maximize.

Banks are indexed by \(i \in [0, 1]\) and may be of either good (\(g\)) or bad (\(b\)) type. A fraction \(\theta\) of banks are of type \(g\). Banks have pre-existing long-term assets and short-term liabilities. Legacy assets determine the quality of the bank. They deliver a payoff \(a = A_i^t\) for \(i \in \{g, b\}\) at \(t = 2\). We refer to short-term liabilities as deposits for simplicity, but they are also meant to include money market funds, repo, etc. The short-term demand liabilities entitle a depositor to 1 at any time, and \(D > 1\) at \(t = 2\). Demand deposits are senior to any other claims on the bank, and may be withdrawn at any time. This induces a maturity mismatch problem, and makes banks vulnerable to runs. Banks have access to a liquidation technology that yields \(\delta \in [0, 1]\) units of the consumption good per unit of asset liquidated. The liquidation value of assets is \(\delta A_i^t\) for \(i \in \{g, b\}\). In the event of a run, banks use this liquidation technology to meet depositors' demand for funds.  

At \(t = 1\), banks receive investment opportunities that cost a fixed amount \(k\) and deliver a random payoff \(v\) at \(t = 2\). For simplicity, we assume that payoffs are binary: \(v = V\) with probability \(q\) and 0 with probability \(1 - q\), and do not depend on the bank type. We impose the following ordering:

**Assumption 1:** *Good banks are fundamentally safe, while bad banks are fundamentally risky.*

\[
A^g - \frac{k}{q} > D > A^b > 0,
\]

This assumption implies that the existing debt of bad banks is risky: if bad banks do not invest, or if they invest and the project fails, they are unable to repay their senior debt. On the other hand, the legacy assets of good banks are large enough to cover all potential liabilities, including liabilities issued at \(t = 1\) to finance new investments, even if investors are pessimistic about the quality of the pool of borrowers (in which case, as we will shortly discuss, the interest rate would be \(1/q\)).

At \(t = 0\), the government chooses and announces its disclosure policy before it observes the aggregate state. The aggregate state, \(\theta\), is the fraction of good banks. After the aggregate state is realized, banks learn their types privately. The aggregate state follows a distribution \(\pi(\theta)\) with support \([\underline{\theta}, \bar{\theta}] \subset [0, 1]\). All agents observe the aggregate state, as well as the binary public signal \(s_i \in \{0, 1\}\) for each bank \(i\). Good banks always receive the signal \(s = 1\), whereas bad banks receive \(s = 0\) with probability \(p\), \(p \in [0, 1]\)\(^6\):

\[
\Pr(s_i = 1 \mid i = g) = 1
\]

\(^4\) We can interpret \(\delta\) as the equilibrium outcome of a fire-sale process that can potentially depend on the magnitude of the fire-sale, or the quantity of the asset that is liquidated/number of institutions that liquidate.

\(^5\) See Philippou and Skreta (2012) for a discussion of the general case.

\(^6\) A previous version of the model used symmetric signals with precision \(p \equiv \Pr(s_i = 1 \mid i = g) = \Pr(s_i = 0 \mid i = b)\). The current setup is both more amenable to analysis and has the feature that while false positives (a bad bank receiving a good signal) are possible, false negatives are not (a good bank never receives a bad signal), which resembles real-world concerns about the accuracy of stress tests.
\[ \Pr(s_i = 0 \mid i = b) = p \]

When we introduce optimal information disclosure in Section 2, the precision of the signal \( p \) will be chosen by
the government as its disclosure policy. For the remainder of this section, we take the precision of the signal \( p \) as exogenous, and describe the equilibrium absent government intervention. We assume throughout that banks
themselves are not able to credibly disclose any information about the quality of their assets. In our environment
this will be the case if, for example, information disclosed by banks is unverifiable by outsiders or if disclosure is
sufficiently costly.\(^7\) Given the complexity of bank balance sheets, the apparent failure of rating agencies and audit
firms to produce accurate information regarding the state of bank balance sheets leading up to and during the
financial crisis, and the reportedly large costs of complying with the post-crisis reporting environment\(^8\), we believe
this assumption is reasonable.

Given the realization of the aggregate state and the signal for each bank, agents form posterior probabilities of
each bank being good. A bank receiving the bad signal is known to be bad with certainty, whereas a bank receiving
the good signal may be good or bad. Denoting by \( n_e \) the mass of banks receiving the signal \( s \):

\[
\begin{align*}
    n_0 &= p(1-\theta) \\
    n_1 &= \theta + (1-p)(1-\theta)
\end{align*}
\]

Agents know the true fraction of good banks \( \theta \). Let \( z \) denote the posterior belief that a bank is good if it receives
the good signal. Then, Bayesian consistency requires that

\[
\begin{align*}
n_0 \times 0 + n_1 \times z &= \theta \\
\Rightarrow z &= \Pr(i = g \mid s_i = 1) = \frac{1}{1 + \frac{1-\theta}{\theta} (1-p)}
\end{align*}
\]

Note that this posterior probability depends on both the precision of the signal \( p \) and the realization of the aggregate
state \( \theta \). Based on this information, depositors might decide to run on banks or not. If a bank is run, it must liquidate
its assets to satisfy its depositors. If a bank survives, it receives an investment opportunity at period 1.

\(^7\)In their survey of the literature on the corporate information environment, \(^7\) review five conditions that underpin the "unraveling result" (all private information is disclosed because agents with favorable information want to avoid being pooled with inferior types) established by Grossman (1981) and Milgrom (1981): (1) disclosure is costless to the firm; (2) investors know that the firm has private information; (3) all investors interpret the firm's disclosure in the same way and the firm knows how investors will interpret the firm's disclosure; (4) the firm can credibly disclose its private information; and (5) the firm cannot commit ex-ante to a certain disclosure policy.

1.2 Bank runs

Depositors can withdraw their deposits from banks at any time. If this happens before \( t = 2 \), banks have to liquidate assets. The liquidation technology is inefficient: it yields \( \delta \in [0, 1] \) per unit of asset liquidated. To simplify the analysis, we assume that banks that make use of this technology lose the investment opportunity at \( t = 1 \).

We do not explicitly model households with liquidity shocks that motivate the existence of deposit contracts in the first place, nor do we address the question of when a planner, assuming that it could, would choose to suspend convertibility. This is a well studied issue and the trade-offs are well understood (see Gorton (1985), for example). When liquidity demand is random, suspending convertibility is socially costly. We assume that these costs are large enough that the government prefers to guarantee deposits. Note also that “deposits” in the model include short-term wholesale funding, whose suspension would be difficult to implement in any case.

We denote by \( \lambda \) the fraction of assets that is liquidated and by \( x \) the fraction of depositors in a given bank that run. If a fraction \( \lambda \) of a bank’s assets are liquidated, the cash flows are \( \delta \lambda A^t \) at the time of liquidation, and \((1 - \lambda)A^t \) at \( t = 2 \). The bank can satisfy its customers if \( \delta \lambda A^t \geq x \). We assume that, under a full run, good banks are safe and bad banks are not.

**Assumption 2:** Good banks are liquid, while bad banks are not

\[
\delta A^g > 1, \quad \delta A^b < 1
\]

Consider the decision problem of a depositor in a bank that is known to be good. Withdrawing early yields 1 with certainty even if every other depositor runs. Waiting yields the minimum of the promised payment \( D \) and a pro-rata share of the residual value of the bank:

\[
\min \left( D, \frac{(1 - \lambda)A^g}{1 - x} \right)
\]

When a full run occurs, \( x = 1 \) and \( \lambda = \frac{1}{\delta A^g} < 1 \), so the above expression is always equal to \( D \). The implication is that even if every other depositor runs, a depositor prefers to wait because \( D > 1 \), so the unique equilibrium for a bank known to be good is no run, \( x = 0 \) and \( \lambda = 0 \).

For bad banks, we have that \( \delta A^b < 1 \), and so \( \lambda = 1 \) when \( x = 1 \). That is, the bank has no assets left to repay depositors who decide to wait in case of a full run. This means that a full run is an equilibrium. Since the type of a bank is private information, the run decision is a function of the (posterior) belief about the quality of a bank. Clearly, if \( x = 1 \), no run is the only equilibrium. It is possible to derive a threshold posterior belief \( z^D \) above which no run is the unique equilibrium. This threshold must be such that depositors with this belief are indifferent between running and waiting if all other depositors run. This indifference condition is given by

\[
x + (1 - x) \delta A^b = zD
\]
Rearranging yields
\[
z^R = \frac{\delta A_k}{D + \delta A^k - 1}
\]  
(1)

For beliefs in the set \([0, z^R]\) multiple equilibria exist. For simplicity, we select the run equilibrium for any bank whose posterior belief falls in the multiple equilibrium region. What matters for our results is that a run is possible in that range, not that it is certain. We summarize our results in the following lemma.

**Lemma 1.** Depositors run on any bank whose perceived quality falls below \(z^R\).

**Proof.** See above. \(\square\)

### 1.3 Credit market and investment in period 1

Banks receive investment opportunities at time 1. We assume that these investments have positive net present value, and that households' endowment \(\bar{y}_1\) is enough to sustain full investment.

**Assumption 3:** Investment projects have a positive net present value, and households have enough resources to sustain investment by all banks

\[
E[u] = qV > k \quad \text{and} \quad \bar{y}_1 > k
\]

Banks must raise \(k\) externally in order to invest. The important point is that lenders care about the quality of legacy assets. There are several ways to motivate this. For simplicity, we follow Philippon and Skreta (2012) in assuming that only total income at period 2, \(y = a + v\) is contractible.\(^8\) Under standard assumptions, we have the following standard result in optimal contracting:

**Lemma 2.** Debt is an optimal contract to finance investment at time 1.

**Proof.** See Nachman and Noe (1994) and Philippon and Skreta (2012). \(\square\)

Let \(j = 0, 1\) be an indicator denoting the investment decision, and let \(r\) denote the (gross) interest rate on new loans. The respective payoffs of depositors, new lenders, and equity holders are:

\[
y_D^j = \min(a + v \cdot j, D)
\]

\[
y^j = \min(a + v \cdot j, r_k \cdot j)
\]

\[
y^e = a + v \cdot j - y^j - y_D^j
\]

Note that these payoffs capture the idea that deposits are senior, and equity holders are residual claimants.

\(^8\)Tirole (2012) assumes that new projects are subject to moral hazard, so banks must pledge their existing assets as collateral. One could also assume that bankers can repudiate their debts, engage in risk shifting, etc. All these frictions motivate the role of existing assets as collateral for new loans and they are equivalent in our framework.
Adverse selection arises from the fact that banks know their own type, and therefore the payoffs of their legacy assets \( a \), while lenders do not. Lenders have a belief about the type of a bank, given by \( z \), defined above. This belief pins down the interest rate they will charge. Under Assumption 1, the debt issued by good banks is safe even at the highest possible interest rate. Good banks know that they always pay back their debts, and so the fair interest rate would be \( r = 1 \). For a given interest rate, good banks find it profitable to borrow at rate \( r \) and invest if and only if

\[
A^g - D + qV - rk \geq A^g - D
\]

This inequality implies a maximum interest rate \( r^g \) above which good banks would decide not to invest:

\[
r \leq r^g = \frac{qV}{k}
\]  \( (2) \)

Bad banks earn nothing if they do not invest since their existing assets are insufficient to repay their depositors. As a result, they always want to invest. The question is whether there is enough income to repay the new lenders. Even in the absence of asymmetric information, underinvestment by bad banks could occur due to debt overhang, as in Philippon and Schnabl (2013). We ensure that this is not the case by imposing \( q \geq \frac{k}{V+A^b-D} \), which guarantees that

\[
A^b - D + V - \frac{k}{q} \geq 0
\]

So lenders break even by lending at rate \( 1/q \) to a bad bank.

We are interested in situations where information asymmetry induces adverse selection in the credit market. This happens when the interest rate for bad banks, \( q^{-1} \), exceeds the maximum interest rate at which good types are willing to invest: \( q^{-1} > r^g \), which is equivalent to imposing \( q \leq \sqrt{\frac{k}{V}} \).

Assumption 3: There is potential for adverse selection in the credit market

\[
\frac{k}{V-(D-A^b)} < q < \sqrt{\frac{k}{V}}
\]

Adverse selection models often feature multiple equilibria. For instance, if lenders expect only bad banks to invest, they set \( r = q^{-1} \) and indeed, at that rate, good banks would not participate. We rule this out by assuming that, in case multiple equilibria exist, the best pooling equilibrium is selected.\(^{10}\) If both good and bad types invest for a certain posterior belief \( z \), the interest rate must satisfy the break-even condition for the lender (whose outside option is zero net return storage)

\[
k = zrk + (1 - z) qrk;
\]

\(^{10}\) When we consider credit market interventions, this assumption is without loss of generality because the government would always be able to costlessly implement the best pooling by setting the interest rate appropriately.
which can be rearranged to yield
\[ r(z) = \frac{1}{z + (1 - z)q}. \]

Note that for good types to invest, the interest rate must satisfy equation (2). Equating good banks’ participation constraint with lenders’ break-even constraint we can define a threshold posterior \( z^f \) such that good banks invest if and only if \( z > z^f \):
\[ z^f = \frac{\frac{b}{q} - q}{1 - q}. \]

When \( z < z^f \), only the bad types invest, and the interest rate is \( r = \frac{1}{q} \).

We summarize the credit market equilibrium in the following lemma.

**Corollary 3.** The credit market at period 1 is characterized by a cutoff \( z^f \) about the perceived quality of any pool of banks. When \( z > z^f \), both good and bad types invest, and the interest rate is \( r(z) = \frac{1}{z + (1 - z)q} \). When \( z < z^f \), only bad types invest, and the interest rate is \( r^b = \frac{1}{q} \).

**Proof.** See above. \( \square \)

### 1.4 Equilibrium without government interventions

We have shown that Bayesian updating of a common prior belief \( \theta \) with realizations of a binary signal with precision \( p \) results in two posterior belief categories: banks are revealed to be either bad with certainty or good with probability \( z(\theta, p) \). Absent government intervention, banks that receive the bad signal always suffer runs. Equilibrium is characterized by how \( z \) compares to \( z^R \) and \( z^f \), and the mass of banks in each category. Because banks that are run cannot invest, the case \( z^R > z^f \) is not interesting.\(^{12}\) We therefore make the following natural assumption:

**Assumption 4.** The threshold for bank runs is strictly smaller than the threshold for full investment: \( z^R < z^f \), which requires
\[ \frac{\delta A^b}{D + \delta A^b - 1} \leq \frac{\frac{b}{q} - q}{1 - q}. \]

The equilibrium regions are depicted in Figure 2: banks with posterior belief lower than \( z^R \) (the run region, \( R \)) suffer a run; banks with posterior belief in the \([z^R, z^f]\) interval are not run on, but credit markets for these banks are affected by adverse selection (\( L \)); finally, all banks with belief greater than \( z^f \) invest, since credit markets for these banks are free from adverse selection (full investment region, \( I \)).

Since banks that receive the bad signal always suffer runs, there are 3 possible outcomes, depending on the values of \( \theta \) and \( p \).

\(^{11}\)We assume here that depositors do not observe new borrowing decisions by banks. As a result, bad types can invest without creating a run. We have also solved the model under the alternative assumption.

\(^{12}\)In this case, bank runs would be so severe as to completely “clean” the credit market from any adverse selection.
This figure illustrates the equilibrium thresholds: for posteriors below $z^R$, banks suffer runs ($\mathcal{R}$). For posteriors between $z^R$ and $z^I$, the economy faces suboptimal investment, as only bad banks invest ($\mathcal{L}$). For posteriors above $z^I$, all banks invest without facing adverse selection in credit markets ($\mathcal{I}$).

Figure 3: Low $\theta$ (bad macro news)

This figure illustrates the posterior belief $z(\theta, p)$ and mass of banks $n_\nu(\theta, p)$ for $s = \{0, 1\}$ at each posterior. Precision $p$ is taken as exogenous, and the realization of $\theta$ is low. The outcome is $\mathcal{L}$: credit markets for banks that received the good signal feature adverse selection (leading to suboptimal investment).

1. All banks suffer a run, $z(\theta, p) \leq z^R, \mathcal{R}$;

2. Banks with the good signal face adverse selection, $z^R \leq z(\theta, p) \leq z^I, \mathcal{L}$;

3. All banks with the good signal fully invest, $z^I \leq z(\theta, p), \mathcal{I}$.

For a given precision of the signal $p$, the outcome depends on the realization of $\theta$. Figures 3 and 4 illustrate two possible outcomes depending on the realization of $\theta$: if the realization of this random variable is low (a scenario we call “bad macro news”), not only the mass of banks with the bad signal is high, but the posterior beliefs for banks with the good signal is low. If the realization is high (“good macro news”) the posterior will be higher and more mass will be placed on the good signal posterior.

More concisely, we can characterize the equilibrium for any pair $(\theta, p)$ using two thresholds: the minimum
This figure illustrates the posterior belief $z(\theta, p)$ and mass of banks $n_s(\theta, p)$ for $s = \{0, 1\}$ at each posterior. Precision $p$ is taken as exogenous, and the realization of $\theta$ is high. The outcome is $I$: all banks that receive the good signal invest efficiently.

(aggregate) state for which banks with the good signal avoid a run

$$\theta^R(p) = \min \{ \theta \mid z(\theta, p) \geq z^R \}$$  \hspace{1cm} (4)

and the minimum (aggregate) state for which all banks that receive the good signal invest

$$\theta^I(p) = \min \{ \theta \mid z(\theta, p) \geq z^I \}$$  \hspace{1cm} (5)

The precision of the signal $p$ defines these thresholds, against which the realization of $\theta$ is compared to determine the equilibrium outcome. The thresholds, and the possible equilibrium regions, are depicted in Figure 5 for $\theta, p \in [0, 1]$.

We summarize the description of the equilibrium without government intervention in proposition 4.

**Proposition 4.** With no government intervention, the private equilibrium is characterized by two thresholds $\theta^R(p), \theta^I(p)$ such that

1. If $\theta \leq \theta^R(p)$, banks with signal $s = 1$ suffer a run, $R$

2. If $\theta \in [\theta^R(p), \theta^I(p)]$, banks with signal $s = 1$ face adverse selection in the credit market, $L$

3. If $\theta \geq \theta^I(p)$, all banks with signal $s = 1$ fully invest regardless of their type, $I$.

The thresholds are

$$\theta^R(p) = \frac{1 - p}{1/z^R - p}$$

$$\theta^I(p) = \frac{1 - p}{1/z^I - p}$$

and satisfy
This figure illustrates the equilibrium regions in the \((p, \theta)\) space. The dashed line is the investment threshold, \(\theta^I(p)\) and the solid line is the run threshold \(\theta^R(p)\).

1. \(\theta^R(p) \geq \theta^I(p)\)

2. \(\frac{d\theta^j(p)}{dp} < 0, \ j \in \{R, I\}\)

Proof. See Appendix B.

In the presentation of the model we abstract from the possibility that banks issue equity either voluntarily or after being required to do so by the government. Issuing equity is not an equilibrium outcome at any stage of the model. At \(t = 1\) there are two motives for equity issuance: to finance the new investment opportunity or, for bad banks, to prevent default in the final period. By lemma 2, financing the new investment opportunity by issuing equity is suboptimal. Since default in the final period is not socially costly (a feature that could easily be changed), the planner has no incentive to require bad banks to issue equity at \(t = 1\). At \(t = 0\), before the realization of bank-specific signals but after banks know their types, bad banks may wish to issue equity to reduce leverage and prevent a run if they receive the low signal. Attempting to do so would signal their type, which would lead to a run. The final possibility is that, anticipating the possibility of runs, banks issue equity before knowing their types. This is equivalent to allowing banks to optimize their capital structure, which is outside the scope of this paper.

### 1.5 Welfare

New projects have positive net present value, bank runs entail costly asset liquidation, and taxation is distortionary. This means that in the first-best equilibrium, every bank invests and there is no distortionary taxation. First-best
ex-ante welfare can then be written as

\[ W^{FB} = \mathbb{E}[\theta] A^\theta + (1 - \mathbb{E}[\theta]) A^b + \bar{y}_1 + qV - k \]  (6)

Because of runs and adverse selection, the laissez-faire equilibrium may fall short of the first best. The government in our model has access to two technologies to modify the equilibrium: a disclosure technology to reveal information about a bank’s assets, and the ability to raise taxes at period 2 to provide deposit guarantees or to intervene in the credit market.

The disclosure policy is characterized by a choice of \( p \), the precision of the public signals. We assume that the government chooses \( p \) at \( t = 0 \), before the aggregate state of the economy (the fraction of good banks \( \theta \)) is realized. The advantage of disclosure, or increasing precision, is that by providing more precise information about bad banks, it may mitigate adverse selection in credit markets. In so doing however, the government will be causing runs on bad banks. This policy is described in more detail in section 2.

Fiscal interventions are described in greater detail in section 3. To pay for the costs of honoring its guarantees of bank liabilities, the government levies distortionary taxes at \( t = 2 \). We assume that the deadweight costs of taxation are quadratic, and scaled by a parameter \( \gamma \). Denoting by \( \Psi \) the costs of fiscal interventions, the total welfare loss from taxation is \( \gamma \Psi^2 \).

Since households are risk-neutral, aggregate welfare coincides with aggregate output net of distortionary costs. Given the realization of the aggregate state \( \theta \), a signal precision \( p \), and government intervention with net cost \( \Psi \), ex-post welfare can be written as:

\[ w(\theta, p, \Psi) = \bar{y}_1 + p (1 - \theta) \delta A^b \\
+ 1 [z(\theta, p) < z^R] [\theta \delta A^\theta + (1 - p) (1 - \theta) \delta A^b] \\
+ 1 [z(\theta, p) \geq z^R] [\theta A^\theta + (1 - p) (1 - \theta) (A^b + qV - k)] \\
+ 1 [z(\theta, p) \geq z^I] \theta (qV - k) \\
- \gamma \Psi^2 \]  (7)

There are three sources of losses relative to the first best. The first is the inefficient liquidation of assets and foregone investment opportunities for banks that are run on. The second is the foregone investment due to adverse selection when \( z(\theta, p) < z^I \). The final term is the deadweight loss of taxation. For a given signal \( p \), we can write expected welfare as the expectation over all possible realizations of \( \theta \).

\[ W(p) = \int_{\theta} \pi(\theta) w(\theta, p, \Psi) \, d\theta = \mathbb{E}_{\theta}[w(\theta, p, \Psi)] \]  (8)
Information Disclosure

We model disclosure as the optimal choice by the government of the precision \( p \in [0, 1] \) of binary signals about bank types, which is decided prior to the realization of the aggregate state \( \theta \) (the fraction of good banks in the economy\(^{13}\)). We regard the choice of \( p \) as capturing a government's choice of informativeness of a stress test or asset quality review. We assume the government can commit to truthfully disclose the results of the stress test in the sense that, having chosen \( p \), agents observe the realizations of signals without any further distortion.

The trade-off faced by the government in choosing the informativeness of disclosure is that by increasing the precision of the signal it raises (in expectation) the perceived quality \( z \) of banks that receive the good signal, thereby increasing expected investment by good banks. This comes at the cost of revealing some banks to be bad and therefore causing runs: recall that banks that receive the bad signal are run with certainty.

In addition, if the distribution of \( \theta \) has mass below \( z^R \), disclosure can also prevent runs on good banks, since in this case the realization of \( \theta \) may be lower than \( \theta^R (p) \) (the threshold below which banks with the good signal are run). In what follows, we abstract from this possibility in order to more sharply characterize the tradeoff between runs and adverse selection. In particular, we specialize our analysis to the case \( \{ \theta, \tilde{\theta} \} = \{ z^R, z^I \} \). The distribution \( \pi (\theta) \) therefore has no mass below the run threshold belief \( z^R \), so banks that receive the good signal are never run\(^{14}\). The threshold \( \theta^R (p) \) becomes irrelevant and the equilibrium regions in \( (p, \theta) \) space are as depicted in 6.

The government's disclosure problem, before the aggregate state \( \theta \) is realized, can be formulated as

$$\max_{p \in [0, 1]} \mathbb{E}_\theta [w (\theta, p, 0)]$$

(9)

where \( w (\theta, p, 0) \) is the ex-post welfare function defined in (7) without any government spending, \( \Psi = 0 \), since we ignore fiscal policy for now.

For the specialized case, we can write expected welfare as

$$\mathbb{E}_\theta [w (\theta, p, 0)] = \mathbb{E} [1 - \tilde{\theta} (p) A^b + (1 - p) (A^b + qV - k)] + \mathbb{E} [\theta^\alpha A^g + (qV - k) \int_{\max[\theta^R(p), z^I]}^{z^I} \theta d\Pi (\theta)]$$

(10)

where \( \Pi (\theta) \) is the cumulative distribution function of \( \theta \). Rearranging, the welfare function consists of two parts: returns from legacy assets

$$\mathbb{E} [1 - \theta^\alpha A^b (1 - p (1 - \delta)) + \mathbb{E} [\theta^\alpha A^g]$$

\(^{13}\)Alternatively, we can interpret \( \tilde{\theta} \) as being the market's prior regarding the state of the banking system, and the government choosing the precision of the stress test while being unaware of the market’s perceptions regarding the quality of the banking system.

\(^{14}\)We can think of this specialized problem as a subgame of a larger model, where the government first observes whether a system-wide run is about to take place or not, and if not carries out a stress test (and other interventions). The more general model and its properties are analyzed in Appendix C.
and returns from new investment at \( t = 1 \),

\[(qV - k) \left( (1 - p) \mathbb{E}[1 - \theta] + \int_{\max[\theta^I(p), z^R]}^{z^I} \theta d\Pi(\theta) \right)\]

The returns to legacy assets depend on how many bad banks are revealed to be so by the stress test: the assets of these banks are liquidated, returning \( \delta A^b \). Good banks are never run on, so payoffs from the legacy assets of good banks are always \( A^g \). As for investment, bad banks that pass the stress test (of which there are \((1 - p) \mathbb{E}[1 - \ell]\)) invest with certainty. Good banks may or may not invest depending on whether the realization of \( z \) exceeds \( z^I \); the probability of this event is the final term in the return to new investment, \( \int_{\max[\theta^I(p), z^R]}^{z^I} \theta d\Pi(\theta) \). To further develop intuition about the costs and benefits of disclosure, Propositions 5 and 6 provide results on optimal disclosure in the absence of runs and lemons, respectively.

**Proposition 5.** If there are no runs, welfare is weakly increasing in \( p \) (strictly increasing for \( p : \theta^I(p) > z^R \)), and full disclosure is optimal.

**Proof.** See Appendix B.

In the absence of runs, welfare is strictly increasing in \( p \) for low levels of disclosure: disclosing information increases the average quality of banks with the good signal, decreasing the probability that credit markets will be affected by adverse selection. Beyond a certain level of \( p \), which we denote \( p^m \) (\( p^m : \theta^I(p^m) = z^R = \theta \)), the average quality of the banks with the good signal will be so high that they invest with certainty in every state of the world.
Figure 7: Expected mass at $\mathcal{L}$ and $\mathcal{R}$, $\theta \sim \mathcal{U}[z^R, z^L]$

This figure plots the expected mass in region $\mathcal{L}$ (banks with posterior belief in the $[z^R, z^L]$ interval) and region $\mathcal{R}$ (banks with posterior belief in the $[0, z^R]$ interval) as a function of $p$, assuming a uniform distribution for the aggregate state $\pi(\theta) = \mathcal{U}[z^R, z^L]$.

Increasing $p$ yields no further benefits, so in the absence of runs the planner is indifferent between disclosure choices in $[p^m, 1]$.

\[
p^m : \theta^L(p^m) = z^R \Rightarrow p^m = \frac{z^L - z^R}{z^L(1 - z^R)} \in (0, 1)
\]

**Proposition 6.** If there is no adverse selection, welfare is strictly decreasing in $p$ and no disclosure is optimal.

**Proof.** See Appendix B. \qed

Absent adverse selection, the only effect of disclosure is that banks that are revealed to be bad suffer runs. Figure 7 represents the trade-off graphically: it plots the expected mass of banks that are affected by adverse selection, and the expected mass of banks that are expected to suffer a run, as a function of $p$. The mass of banks that are expected to suffer a run is strictly increasing in $p$, as $p = 1$ corresponds to the extreme case in which the signal is perfect and no bad bank receives the good signal. The mass of banks that are expected to suffer from adverse selection is decreasing until $p^m$, after which disclosure is already high enough that the pool of banks with the good signal invests efficiently even for low realizations of $\theta$.

We proceed to characterize the problem with runs and lemons. We first establish that there exists an interior upper bound on the amount of disclosure that the planner chooses.

**Proposition 7.** In the economy with runs and lemons, the planner never sets $p > p^m$.

**Proof.** See Appendix B. \qed
This result follows immediately from the previous propositions: increasing disclosure over \( p^m \) offers no benefits from unfreezing markets, while still causing bad banks to suffer runs, so the planner will never optimally choose a level of disclosure beyond \( p^m \). We now characterize the solution to the disclosure problem in terms of the properties of the distribution for the aggregate state. Proposition 8 describes the government’s optimal disclosure policy for different characteristics of the distribution \( \pi(\theta) \).

**Proposition 8.** Let

\[
\chi(\theta) = \frac{\pi^I(\theta)}{\pi(\theta)}
\]

If \( \chi(\theta) \geq \frac{3s^I - 1}{1 - z^I}, \forall \theta \in [z^R, z^I] \), welfare is a strictly concave function in \([0, p^m]\), and the optimal level of disclosure solves the first-order condition

\[
\pi[\theta^I(p)] \theta^I(p)(qV - k) \left[ -\frac{d\theta^I(p)}{dp} \right] - E[1 - \theta] \left[ (1 - \delta) A^h + qV - k \right] = 0
\]

If \( \chi(\theta) \leq \frac{3s^R - 1}{1 - z^R}, \forall \theta \in [z^R, z^I] \), welfare is a strictly convex function in \([0, p^m]\). The optimal level of disclosure is \( p = 0 \) if and only if

\[
p^m \geq \frac{E[\theta]}{E[1 - \theta] \left[ \frac{(1 - \delta) A^h}{qV - k} + 1 \right]}
\]  \hspace{1cm} (11)

and is \( p = p^m \) otherwise.

**Proof.** See Appendix B. \( \square \)

The intuition for the above results is as follows: one can see \( \chi(\theta) \) as a measure of the slope of the density function for the aggregate state at \( \theta \). A distribution with a high \( \chi(\theta) \) will tend to have an increasing pdf, and a high average; and so the aggregate state is, on average, high. When the distribution of \( \theta \) has a lot of mass to the right, choosing a small amount of disclosure entails a lower cost of runs (since there will be less bad banks on average), while ensuring full investment by the (large) mass of good banks in almost every state of the world. So the planner has an incentive to choose an interior solution, since the benefits are large and the costs are small. On the other hand, when \( \chi(\theta) \) is low, the distribution will tend to have a lot of mass to the left: there will be, in expectation, a larger share of bad banks. In this case, the trade-off between costs and benefits of disclosure is less favorable: given a low prior \( \theta \), the planner needs to disclose a larger number of bad banks to push the posterior above \( z^I \). This entails causing runs on a larger number of bad banks, and so the costs are higher. Furthermore, there is a small number of good banks, and so the benefits of unfreezing the markets for these are also smaller. The Proposition shows that, in this case, the welfare function is convex and the planner chooses either no disclosure at all, \( p = 0 \), or the upper bound \( p^m \). As condition 11 illustrates, the choice depends on how large \( p^m \) is relative to parameters of the model. If \( p^m \) is very large, then disclosure involves causing runs on a large amount of banks, and so no disclosure is optimal.
Figure 8: Densities $\pi(\theta) = \beta \theta^\chi$

This figure plots the shape of different pdf's of the type $\beta \theta^\chi$, for different values of $\chi$.

To illustrate these claims, Figure 9 plots the (normalized) expected welfare function for different distributions of the aggregate state. We focus on distributions of the form $\pi(\theta) = \beta \theta^\chi$ for $\chi \in \mathbb{R}$, where $\beta$ is a normalizing constant, $\beta = \frac{\chi^{\chi+1}}{(\chi+1)(\chi+2)}$. Note that, in this case, we have that $\chi(\theta) = \chi$ is a constant. Given our baseline calibration (see A), $\chi = -1.5$ is chosen to generate a convex welfare function, and $\chi = 7$ generates a concave welfare function.

$\chi = 0$ is the uniform distribution on $[z^R, z^\Gamma]$, and does not satisfy either of the sufficiency conditions. In this case, we can use the following corollary to 8 to show that the welfare function is first convex, and then concave in the $[0, p^n]$ interval.

**Corollary 9.** Assume that $\pi(\theta) = \beta \theta^\chi$ (where $\beta$ is an appropriate normalizing constant that depends on $\chi$). Then, 1) Expected welfare is strictly concave for $\chi \geq \frac{3^{1/2} - 1}{1 - z^f}$, 2) Expected welfare is strictly convex for $\chi \leq \frac{3^{1/2} - 1}{1 - z^f}$; 3) For $\chi \in \left[\frac{3^{1/2} - 1}{1 - z^f}, \frac{3^{1/2} - 1}{1 - z^f}\right]$, welfare is convex for $p \in \left[0, \frac{1}{2} (3 - 1/z^f - \chi(1/z^f - 1))\right]$ and concave for $[\frac{1}{2} (3 - 1/z^f - \chi(1/z^f - 1)), p^n]$.

*Proof.* See Appendix B.

The densities are shown in Figure 8. To focus on the shape of the welfare function, we plot welfare minus its average value over $p$.

For $\chi = -1.5$, welfare is convex for $p \leq p^n$; moreover, it is nonlinear, first decreasing and then increasing. Given our calibration, no disclosure is the optimum. For $\chi = 0$, no disclosure is also the optimal solution, but welfare is no longer strictly convex, becoming concave after a certain point. Finally, for $\chi = 7$, welfare is strictly concave and

---

15In our baseline calibration, $z^R = 0.25$ and $z^\Gamma = 0.75$. The thresholds are $-1/3$ and $5$ for convexity and concavity, respectively.
the optimal level of disclosure is interior. Figure 10 plots the variance of welfare for these three cases, as a function of the level of disclosure. The variance is non-monotonic in all cases, first increasing with \( p \) and then decreasing. The reason is that for low levels of \( p \), the economy will face no runs and a market freeze with certainty. Thus the only risk arises from the quality composition of the banking sector. As \( p \) increases, the planner exposes the economy to runs of uncertain size, as well as to the probability that markets may unfreeze, and both of these terms add more uncertainty on top of the quality composition. For \( p \) high enough, however, the planner knows that the market freeze is resolved almost certainly, and so the variance actually decreases. Beyond \( p^m \), increasing disclosure only contributes to generating runs whose size depends on \( \theta \). This means that the only risk concerns bad banks, which can either generate a payoff that equals their asset value discounted by the liquidation parameter, or their full asset payoff plus the net investment payoff. Thus the planner only contributes to increasing the variability of payoffs beyond this point.

### 3 Fiscal Interventions

In this section we analyze the fiscal interventions that the government can use to mitigate adverse selection and bank runs abstracting for now from information disclosure. We model the government's fiscal constraints as a convex cost of fiscal intervention scaled by a parameter \( \gamma \) which we refer to as the government's fiscal capacity. Unlike disclosure, fiscal interventions are undertaken after the aggregate state \( \theta \) is realized.
3.1 Optimal Intervention in Credit Markets

In the region $z \in [z^R, z^b]$ where banks do not suffer runs, but where credit markets are affected by adverse selection, the government may want to intervene to unfreeze credit markets and increase investment. Philippon and Skreta (2012) and Tirole (2012) study how to design such an intervention in order to minimize its cost for tax payers. In our setup, we have the following result.

**Proposition 10.** The cost of intervention in markets with adverse selection equals the informational rents paid to informed parties. Under the assumptions of this model, direct lending by the government, or the provision of guarantees on privately issued debts, are constrained efficient.

**Proof.** See Philippon and Skreta (2012). □

The proposition says that if the government chooses to intervene, it should either lend directly to the banks, or it should provide guarantees on new debts. Since banks with the bad signal suffer a run lose the investment opportunity, they never receive support in the credit markets, but any bank that receives the good signal is a potential beneficiary of this policy. For a given posterior on banks with the good signal $z$, the optimal policy consists of choosing a number of banks $\alpha$ and guaranteeing loans made to those banks at interest rate $r = r^g = \frac{q^V}{k}$, so that good banks become willing to invest. Note that the policy always consists on either setting $r = r^g$ or doing nothing, since (as explained below) setting $r \in \left(r^g, \frac{1}{4}\right]$ is costly on average for the government and does not contribute to mitigating adverse selection. Setting $r < \frac{q^V}{k}$ is also costly and cannot increase investment further.
For a particular bank with posterior $z$, the cost of implementing the program is

$$z(k - r^2 k) + (1 - z)(k - qr^2 k) = z(k - qV) + (1 - z)(k - q^2 V)$$

the cost is strictly positive as long as $z \leq z^f$. The net marginal benefit of implementing this program is given by

$$z(qV - k)$$

Note that the benefit is increasing in $z$, while the costs are decreasing in $z$. The total cost of the credit guarantee program is given by

$$w^b = \alpha \{ k - qV \{ \mathbb{E} [ (\theta, p) (1 - q) + q] \}}$$

(12)

Ex-post welfare with a credit market policy $\alpha$ is

$$w(\theta, p, \Psi^h) = \bar{y} + n_0 (\theta, p) \delta A^b$$

$$+ 1 \{ z (\theta, p) < z^f \} \{ n_1 (\theta, p) - \alpha \} \{ z (\theta, p) A^g + [1 - z (\theta, p)] (A^b + qV - k) \}$$

$$+ \alpha \{ z (\theta, p) A^g + [1 - z (\theta, p)] A^b + qV - k \}$$

$$+ 1 \{ z (\theta, p) \geq z^f \} \{ n_1 (\theta, p) \{ z (\theta, p) A^g + [1 - z (\theta, p)] A^b + qV - k \} \}$$

$$- \gamma (\Psi^h)^2$$

The first line corresponds to the endowment and to the banks that suffer a run because they receive the bad signal. The second and third lines correspond to the case where $z < z^f$ and banks with the good signal invest suboptimally. In this situation, the government can choose to support a mass $\alpha$ of banks: for these banks, there is full investment.

The fourth line corresponds to $z \geq z^f$, in which case there is no need for a government intervention since the market is not frozen. Finally, the last line corresponds to the deadweight loss generated by government expenditures on credit market intervention.

Since the intervention is ex-post, the government takes the aggregate state $\theta$ and the precision signal $p$ as given\(^ {16}\) when choosing the size of the intervention, solving the following program

$$\max_{\alpha \in [\bar{\alpha}, \underline{\alpha}(\theta, p)]} w (\theta, p, \Psi^h)$$

The following proposition summarizes the solution to this program:

\(^ {16}\)In section 4 we analyze fiscal policy and information disclosure jointly.
Figure 11: Optimal Credit Guarantee, $\hat{\theta} \sim \mathcal{U}[z^R, z^I]$

This figure depicts the optimal credit guarantee policy in the $(p, \theta)$ space for a uniform $\theta$, $x = 0$. The colors represent different levels of $\alpha/n_1(\theta, p)$, the percentage of banks with the good signal that are supported.

Proposition 11. The optimal credit guarantee policy is $\alpha = 0$ for $z \geq z^f$ and

$$\alpha = \frac{z(\theta, p)(qV - k)}{2\gamma(k - qV[z(\theta, p)(1 - q) + q]^3} \in [0, n_1(\theta, p)]$$

for $z < z^f$.

Proof. See Appendix B. \hfill \Box

When $z < z^f$ and the credit market is frozen, the optimal policy consists of supporting a mass of banks that is equal to the ratio of marginal benefits to marginal costs, adjusted by the total marginal cost of government spending. Figure 11 plots the optimal policy in the $(p, \theta)$ space, taking into account that the policy is chosen after uncertainty is resolved. The shape of the $\theta^f(p)$ locus is evident: above $\theta^f(p)$, there is no adverse selection, and the government does not intervene. There is full credit support to the immediate southwest of the locus, and it gradually diminishes as both $p$ and $\theta$ decrease. As these two variables decrease, so does $z(\theta, p)$, the posterior belief on the average quality of the banks that receive the good signal. The marginal benefits of this policy are increasing in $z(\theta, p)$, and the marginal costs are decreasing in this variable, so the policy becomes more expensive as either $p$ or $\theta$ decrease.

3.2 Deposit Guarantees

The government may also intervene to prevent liquidation by banks that receive the bad signal and are therefore susceptible to runs. Preventing runs on these banks is desirable both because liquidation is costly in itself, and because banks that are run on are unable to invest at $t = 1$. 

25
To prevent runs, the government announces deposit guarantees for a mass of banks $\beta$ that have received the bad signal. For these banks, the government guarantees to repay depositors the contractual deposit amount $D$ at $t = 2$. By offering this guarantee, the government prevents asset liquidation by assuming the risk of the deposit contract: it commits to pay $D$ to the depositors, and demands $D$ from the bank. As in the decentralized equilibrium, some banks may be unable to repay their senior debt, in which case the guarantee is costly for the government.

The cost of guaranteeing the deposits for a bad bank is

$$D - [qD + (1 - q) A^b]$$

That is, the government spends $D$, the amount it guarantees. Bad banks invest with certainty: if the investment is successful, which happens with probability $q$, the bank is solvent and thus able to repay the full amount of the guarantee, $D$. With probability $1 - q$, the investment opportunity fails and the government receives the value of the bank's legacy assets $A^b$, in which case the government makes a loss (since it had guaranteed $D > A^b$). It is therefore costly to guarantee deposits for bad banks, in expectation.

The net benefit of guaranteeing the bank is

$$(1 - \delta) A^b + (qV - k)$$

The benefit has two components: first, legacy assets are not liquidated which entails a net benefit of $(1 - \delta) A^b$ and, second, bad banks that are saved always invest in the project.

The total cost of the deposit guarantee policy is

$$\Psi^d = \beta (1 - q) (D - A^b)$$ (14)

and ex-post welfare is

$$w(\theta, p, \Psi^d) = \tilde{y}_1 + [n_0 (\theta, p) - \beta] \delta A^b + \beta (A^b + qV - k)$$

$$+ 1 \left[ z(\theta, p) < z^* \right] n_1 (\theta, p) \left\{ z(\theta, p) A^b + [1 - z(\theta, p)] (A^b + qV - k) \right\}$$

$$+ 1 \left[ z(\theta, p) \geq z^* \right] n_1 (\theta, p) \left\{ z(\theta, p) A^b + [1 - z(\theta, p)] A^b + qV - k \right\}$$

$$- \gamma (\Psi^d)^2$$ (15)

The first line has the endowment, the mass of banks that suffer a run and are not saved, $n_0 (\theta, p) - \beta$, and the bad banks that receive the guarantee and would otherwise suffer a run. The second and third lines correspond to the group of banks that receive the good signal, and the final line are government costs for the program. The
Figure 12: Optimal Deposit Guarantee, \( \theta \sim U[\theta^R, \theta^L] \)
\[
\beta/n_0, \text{ Deposit policy}
\]

This figure depicts the optimal deposit guarantee policy in the \((p, \theta)\) space for a uniform \(\theta, \chi = 0\). The colors represent different levels of \(\beta/n_0(\theta, p)\), the percentage of banks with the bad signal that are supported.

government solves the following program for this ex-post intervention

\[
\max_{\beta \in [0, n_0(\theta, p)]} \ w(\theta, p, \Psi^d)
\]

and the optimal policy is summarized in 12.

**Proposition 12.** The optimal deposit guarantee for bad banks satisfies

\[
\beta = \frac{(1 - \delta) A^b + (qV - k)}{2\gamma[(1 - q) (D - A^b)]^2} \in [0, n_0(\theta, p)]
\]

**Proof.** See Appendix B. \(\Box\)

The general form of the optimal policy is very similar to that described in the case of the credit guarantee: the optimal mass of banks to be saved is given by the ratio between the marginal benefits and the marginal costs of the policy. In this case, these no longer depend on either \(\theta\) or \(p\) because this policy only applies to banks receiving the bad signal, which are known to be bad. Figure 12 depicts the optimal deposit policy (the fraction \(\beta/n_0\) of banks that are saved from liquidation) in \((p, \theta)\) space. Recall that the number of runs is strictly increasing in \(p\): for low values of disclosure, the mass of banks that suffers a run is small, and hence the amount of relative support is large. It gradually decreases as \(p\) increases.
3.3 Combining deposit insurance and credit guarantees

To complete our description of equilibrium with fiscal intervention, we characterize the ex-post welfare function when the government can use both policies.

\[
W(\theta, p, \Psi) = \bar{y}_1 + [n_0(\theta, p) - \beta]\delta A^k + \beta (A^k + qV - k) \\
+ 1 \left[ z(\theta, p) < z^I \right] \{n_1(\theta, p) - \alpha \left[ z(\theta, p) A^k + (1 - z(\theta, p)) (A^k + qV - k) \right] \} \\
+ \alpha \left[ z(\theta, p) A^k + (1 - z(\theta, p)) A^k + qV - k \right] \\
+ 1 \left[ z(\theta, p) \geq z^I \right] n_1(\theta, p) \left[ z(\theta, p) A^k + (1 - z(\theta, p)) A^k + qV - k \right] \\
- \gamma(\Psi)^2
\]

where \(\Psi = \Psi^k + \Psi^d\) is total spending. The first line corresponds to the welfare gains of the deposit guarantee policy, the second and third lines to the welfare gains of the credit policy. The fourth line corresponds to the case in which there is no adverse selection, so credit market intervention is required. The final line corresponds to the deadweight costs of total spending.

Optimal joint fiscal policy is the solution to

\[
\max_{\alpha, \beta} W(\theta, p, \Psi) \tag{16}
\]

s.t. \(\beta \in [0, n_0(\theta, p)]\)

\(\alpha \in [0, n_1(\theta, p)]\)

The government chooses \(\alpha, \beta\) to maximize (16) subject to the constraints that the supported masses cannot exceed the size of the respective categories. Optimal joint fiscal policy is summarized by Proposition 13 and depicted in Figure 13. The optimal policy consists of comparing the marginal benefits of the two policies, and first exhausting the policy that yields the highest marginal benefit to cost ratio. Only if that policy is exhausted is the second ever used. In general, it is not possible to rank the two policies, as the marginal benefits and costs of the credit support policy depend on \(z(\theta, p)\), and thus on the realization of the aggregate state.

**Proposition 13. (Optimal Joint Fiscal Policy)** Define \(z^*\) as

\[
z^* = z^I \frac{1}{1 + \left(1 - \frac{k}{qV}\right) \frac{(\bar{z} - A^k)}{(1 - \delta)(A^k + qV - k)}} < z^I
\]
Then, the optimal joint fiscal policy is as follows: for \( z(\theta, p) < z^c \), the planner exhausts the deposit policy first

\[
\beta = \max \left\{ 0, \min \left\{ n_0(\theta, p), \frac{MB_\beta}{2\gamma MC_\beta} \right\} \right\}
\]

\[
\alpha = \max \left\{ 0, \min \left\{ n_1(\theta, p), \frac{MB_\alpha}{2\gamma MC_\alpha} - \frac{MC_\alpha n_0(\theta, p)}{MC_\alpha} \right\} \right\}
\]

for \( z(\theta, p) \in [z^c, z^f] \), the planner exhausts the credit policy first

\[
\alpha = \max \left\{ 0, \min \left\{ n_3(\theta, p), \frac{MB_\alpha}{2\gamma MC_\alpha} \right\} \right\}
\]

\[
\beta = \max \left\{ 0, \min \left\{ n_0(\theta, p), \frac{MB_\beta}{2\gamma MC_\beta} - \frac{MC_\alpha n_1(\theta, p)}{MC_\beta} \right\} \right\}
\]

and for \( z(\theta, p) > z^f \), only the deposit policy is used

\[
\beta = \max \left\{ 0, \min \left\{ n_0(\theta, p), \frac{MB_\beta}{2\gamma MC_\beta} \right\} \right\}
\]

where

\[
MB_\alpha = 1 \left[ z(\theta, p) < z^f \right] z(\theta, p) (qV - k)
\]

\[
MB_\beta = (1 - \delta) A^b + qV - k
\]

and

\[
MC_\alpha = k - qV [z(\theta, p) (1 - q) + q]
\]

\[
MC_\beta = (1 - q) (D - A^b)
\]

Proof. See Appendix B. \(\Box\)

While the marginal costs and benefits of the deposit policy are parametric, since this policy only applies to bad banks, the costs and benefits of the credit policy depend on \( z(\theta, p) \). Since this policy applies to both bad and good banks, the composition of the class of banks that received the good signal matters. This policy is more attractive the greater the perceived quality of the banks that received the good signal, and so will be prioritized for combinations of \( \theta \) and \( p \) that result in a greater \( z(\theta, p) \). The joint policies are illustrated in Figure 13. The top panel depicts the fraction of good banks that are supported with the credit policy: once again, the shape of the \( \theta^f(p) \) is evident. There is no support required to the northeast of that locus. Support is greatest around the locus, when \( p \) and \( \theta \) are not very low, and hence the perceived quality of the banks that received the good signal is relatively high. Moving southwest, \( z(\theta, p) \) decreases, and support ceases. The bottom panel shows \( \beta / n_0(\theta, p) \), the fraction of banks that are
optimally supported with the deposit policy. The result that $\beta$ is prioritized for either high or low levels of $z(\theta, p)$ is evident in the figure: for high levels of $z(\theta, p)$, there is no market freeze and the deposit policy thus becomes the only useful fiscal instrument, while for low levels of $z(\theta, p)$, the benefit-to-cost ratio for the deposit policy is greater than that of the credit policy.

The amount of fiscal support is evidently decreasing in fiscal capacity $\gamma$. Figure 14 illustrates the expected mass of banks supported by each policy as a function of the fiscal capacity parameter $\gamma$. The left panel plots the expected credit policy support, $E_\theta[\alpha(\theta, p)]$, while the right panel plots the expected deposit policy support $E_\theta[\beta(\theta, p)]$ for different levels of disclosure, $p = \{0, 0.5, 1\}$. For $p = 0$, a market freeze is certain, and no runs occur. Thus the level of credit support is at a maximum, and the level of deposit support is zero. For $p = 1$, the other polar case, all banks have their types revealed: there is no adverse selection so credit support is not needed, and the deposit policy is at its most active for all $\gamma$. For the intermediate case, both policies are used.

4 Disclosure with Fiscal Interventions

Having described the optimal ex-ante disclosure and ex-post fiscal policies separately, we characterize the problem of a government that has access to both types of policies. Note that the analysis of optimal fiscal policy undertaken in Section 3 applies: since fiscal policy is set after aggregate uncertainty has been realized, it is also set for a given level of disclosure $p$; the previous section characterized fiscal policy for arbitrary pairs $(p, \theta)$. The problem becomes then to choose the optimal signal precision $p$, taking as given the ex-post choice of fiscal policy. Formally, the
Figure 14: Optimal Joint Fiscal Policy, $\theta \sim \mathcal{U}[z^R, z^I]$

This figure depicts the optimal joint fiscal policy as a function of the fiscal capacity parameter $\gamma$, for different values of $p$. The left panel plots the expected number of banks that receive credit support, while the right panel plots the expected number of banks that receive deposit support.

The government’s problem can be written as

$$\max_{p \in [0,1]} \mathbb{E}_\theta \left[ \max_{\alpha, \beta} w(\theta, p, \Psi) \right]$$

subject to

$$\beta \in [0, n_0(\theta, p)], \forall p, \theta$$

$$\alpha \in [0, n_1(\theta, p)], \forall p, \theta$$

where the ex-post welfare function is defined in (16).

**Proposition 14.** Disclosure is weakly greater when fiscal policy is available.

**Proof.** See Appendix. \qed

**Proposition 15.** When welfare is concave or convex, optimal disclosure is decreasing in $\gamma$.

**Proof.** See Appendix. \qed

The top left panel of Figure 15 depicts the optimal choice of disclosure $p^*$ as a function of $\gamma$, for $\theta \sim \mathcal{U}[z^R, z^I]$. Optimal disclosure is (weakly) decreasing in $\gamma$: high fiscal capacity translates into greater capability to provide credit and deposit guarantees - to “mop up” in case a bad state of the world materializes, leading the government to choose high levels of disclosure. As $\gamma$ increases, and fiscal capacity becomes more limited, the government starts choosing intermediate levels of disclosure, finally opting for no disclosure, $p = 0$, for $\gamma$ high enough. The top right panel depicts the likelihood of each outcome, conditional on the optimal disclosure policy: for high levels of fiscal
capacity, the government ensures that the full investment region, I, is the most likely. As the costs of intervention increase, the planner discloses less and less and the dominant outcome becomes N, a market freeze. This is also reflected in the bottom left panel, which plots expected government spending $E_q[\psi]$ given the optimal disclosure rule $p^*$. For low levels of $\gamma$, the planner chooses high disclosure, unfreezing markets and creating runs: it, therefore, offers plenty of deposit guarantees and does not use the credit support program extensively. As the optimal level of disclosure decreases, the planner no longer needs to offer deposit guarantees, but increases the expected support in terms of the credit program. The final panel plots expected welfare, which is decreasing in $\gamma$ as we would expect.

To better understand the trade-offs faced by the planner, Figure 16 plots expected welfare with and without fiscal policy. The chosen levels of fiscal capacity, $\gamma = 10$ and $\gamma = 30$ imply full and interior disclosure as optimal policies, respectively. While in the baseline parametrization, the government chooses not to disclose at all, $p = \frac{1}{2}$, the availability of fiscal policy increases the incentives to disclose since the government becomes capable of solving both the runs and adverse selection problems directly. This creates the incentives to optimally take on some more...
risk, and choosing an optimal $p \geq \frac{1}{2}$, where runs are possible in equilibrium. Figure ?? plots variance of welfare for the considered cases. Note that for $p = \frac{1}{2}$, the variance of welfare with policy is strictly greater than the variance of welfare without policy: with no policy, there is no uncertainty, but once credit policies become available, the size of the intervention depends on the realization of $\theta$, and is thus uncertain. For all other values of $p$, however, the fiscal backstop substantially reduces the variance of welfare. The role of fiscal capacity as insurance is also highlighted in this figure: at the optimal levels of disclosure when fiscal capacity is available, the implied variance of welfare is strictly greater than the one chosen by the planner in the absence of fiscal policy.

5 Conclusion

Our main result is that a planner’s fiscal capacity is a key determinant of the optimal disclosure policy. When fiscal capacity is high, it is optimal for the planner to reveal information and provide deposit guarantees to at least a subset of banks that are vulnerable to runs, such that these banks survive and are able to invest in profitable projects. When capacity is low, the planner prefers to avoid runs by not disclosing much information, and then mitigate the resulting adverse selection in the credit market by providing credit guarantees.

In an extension to our main result, we consider the effect of increasing the probability of a “disaster scenario” in which every bank suffers a run, and we find that our logic still applies. The result can be reversed if: (i) Runs are costly enough, and (ii) the probability of a system-wide run is high enough. This reversal can be rationalized
by noting that if a system-wide run is very costly, the planner prefers to ensure that at least some banks survive by fully disclosing the types of all banks, whereas a planner with some fiscal capacity can afford to disclose less information in order to take advantage of the pooling of bad with good institutions.

These apparently contradictory results can be reconciled by the insight that fiscal capacity provides insurance against the adverse effects of information disclosure, and that increasing the risk of a disaster scenario changes the nature of the gamble involved in disclosing information. When there is no possibility of a system-wide run, the safest option that is associated with a certain outcome is not to disclose any information. The alternative is to subject the economy to a run of uncertain size. As the probability of a system-wide run increases, the payoff from this otherwise safe scenario comes to dominate the planner's expected payoff, and full disclosure - which prevents system-wide runs by ensuring the survival of the good banks - becomes the safe choice. Interpreting fiscal capacity as insurance, a planner that has better access to fiscal resources will be more willing to accept this gamble.

Our model can help shed light on the different approaches towards disclosure and stress testing that were adopted on either side of the Atlantic. It is generally accepted that stress tests in the US involved greater levels of disclosure in Europe. Our model suggests that this difference in policies is related to the asymmetry in fiscal capacities between the two regions.
A Parameters used in examples

To generate the figures, we use the parametrization in the table below.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A^g$</td>
<td>Good Assets</td>
<td>10.3</td>
</tr>
<tr>
<td>$A^b$</td>
<td>Bad Asset</td>
<td>0.9</td>
</tr>
<tr>
<td>$D$</td>
<td>Deposits</td>
<td>1.6</td>
</tr>
<tr>
<td>$V$</td>
<td>Project Payoff</td>
<td>10.9</td>
</tr>
<tr>
<td>$q$</td>
<td>Prob. Success</td>
<td>0.2</td>
</tr>
<tr>
<td>$k$</td>
<td>Investment Cost</td>
<td>1.8</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Recovery Rate</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Unless otherwise noted, most examples use $\gamma = 5, \theta = z^R, \delta = z^I$.

B Proofs

Proof of Proposition 4

Proof. Let the realization of the aggregate state and the precision of the signal be some arbitrary $(\theta, p) \in [\bar{\theta}, \tilde{\theta}] \times [0, 1]$. This realization induces the posterior belief $z(\theta, p)$ for banks that received the good signal. Following Lemma 1, we know that banks that received the bad signal always suffer a run, since the posterior belief regarding their quality is $0 < z^R$. According to the same result, banks that receive the good signal suffer a run if and only if

$$z(\theta, p) \leq z^R \iff \theta \leq \frac{1 - p}{1/z^R - p} = \theta^R(p)$$

Likewise, following 3, these banks suffer from adverse selection in credit markets (but no run) if and only if

$$z(\theta, p) \in [z^R, z^I] \iff \theta \in \left[ \frac{1 - p}{1/z^R - p}, \frac{1 - p}{1/z^I - p} \right]$$

and so we define $\theta^I(p) = \frac{1 - p}{1/z^I - p}$. To show the first part, we note that

$$\theta^R(p) \leq \theta^I(p) \iff z^R \leq z^I$$

strictly for $p \neq 1$, which follows from our assumptions. To show the second part, note that

$$\frac{d\theta^j(p)}{dp} = -\frac{1/z^j - 1}{(1/z^j - p)^2} < 0, \quad j = R, I$$

strictly, as long as $z^j < 1$.  

\[\square\]
Proof of Proposition 5

Proof. Without runs, welfare is

\[ E_\theta [w(\theta, p, 0)] = E[\theta] A^p + E[1 - \theta] (A^b + qV - k) + \int_{\max[\theta^f(p), x^n]}^{z^n} \theta(qV - k) \, d\Pi(\theta) \]

The derivative of welfare with respect to \( p \) is

\[ 1 \left[ \theta^f(p) \geq z^n \right] \pi \left[ \theta^f(p) \right] \theta^f(p) (qV - k) \left[ -\frac{d\theta^f(p)}{dp} \right] \geq 0 \]

and it is strictly positive for \( p : \theta^f(p) \geq z^n \), and zero otherwise. Welfare is then weakly increasing in \( p \), and so full disclosure is (weakly) optimal. \( \square \)

Proof of Proposition 6

Proof. Without adverse selection, expected welfare can be written as

\[ E_\theta [w(\theta, p, 0)] = pE[1 - \theta] \delta A^b + E[\theta] (A^p + qV - k) + (1 - p)E[1 - \theta] (A^b + qV - k) \]

The derivative with respect to \( p \) is

\[-E[1 - \theta] [(1 - \delta) A^b + qV - k] < 0\]

strictly negative for \( p \in [0, 1] \). Therefore, \( p = 0 \) is optimal. \( \square \)

Proof of Proposition 7

Proof. Welfare with runs and lemons is given by 10. The derivative of expected welfare with respect to \( p \) is

\[ \frac{dE_\theta [w(\theta, p, 0)]}{dp} = 1 \left[ \theta^f(p) \geq z^n \right] \pi \left[ \theta^f(p) \right] \theta^f(p) (qV - k) \left[ -\frac{d\theta^f(p)}{dp} \right] - E[1 - \theta] [(1 - \delta) A^b + qV - k] \]

The first term is only positive for \( p \leq p^m \), while the second term is always negative. Thus welfare is strictly decreasing for \( p > p^m \). \( \square \)

Proof of Proposition 8

Proof. For any distribution \( \pi(\theta) \), the derivative of expected welfare with respect to \( p \) is

\[ \frac{dE_\theta [w(\theta, p, 0)]}{dp} = 1 \left[ \theta^f(p) \geq z^n \right] \pi \left[ \theta^f(p) \right] \theta^f(p) (qV - k) \left[ -\frac{d\theta^f(p)}{dp} \right] - E[1 - \theta] [(1 - \delta) A^b + qV - k] \]
We can write the second derivative of expected welfare with respect to \( p \) as

\[
\frac{d^2 E_\phi [w (\theta, p, 0)]}{dp^2} = -1 \left[ \theta \left( p \right) \geq z^R \right] (qV - k) \pi \left[ \theta \left( p \right) \right] \left\{ \left( \frac{d \theta \left( p \right)}{dp} \right)^2 + \frac{\theta \left( p \right) \left[ \frac{d \theta \left( p \right)}{dp} \right]}{\pi \left[ \theta \left( p \right) \right]} \right\} + \theta \left( p \right) \frac{d^2 \theta \left( p \right)}{dp^2}
\]

Replace for the derivatives of \( \theta \left( p \right) \) and simplify to obtain

\[
\frac{d^2 E_\phi [w (\theta, p, 0)]}{dp^2} = 1 \left[ \theta \left( p \right) \geq z^R \right] (qV - k) \pi \left[ \theta \left( p \right) \right] \frac{\left( 1/z^I - 1 \right)}{\left( 1/z^I - p \right)^4} \left[ 3 - 1/z^I - \chi \left( \theta \left( p \right) \right) (1/z^I - 1) - 2p \right]
\]

(19)

Note that all the terms except for the last one are strictly positive for \( p \leq p^m \). The shape of the welfare function is therefore determined by the sign of this last term. For the welfare function to be strictly concave, we need this term to be strictly negative for any \( p \). This is equivalent to

\[
3 - 1/z^I - \chi \left( \theta \left( p \right) \right) (1/z^I - 1) - 2p < 0 \iff \chi \left( \theta \left( p \right) \right) > \frac{3 - 1/z^I - 2p}{1/z^I - 1}
\]

Note that the RHS is strictly decreasing on \( p \). It is then enough to show that

\[
\min_p \chi \left( \theta \left( p \right) \right) > \max_p \frac{3 - 1/z^I - 2p}{1/z^I - 1} = \frac{3z^I - 1}{1 - z^I}
\]

So that a sufficient (but not necessary) condition for this to be satisfied is to ensure that

\[
\chi (\theta) > \frac{3z^I - 1}{1 - z^I}, \forall \theta
\]

In this case, the expected welfare function is strictly concave on \([0, p^m]\), and so the first-order condition is sufficient and necessary for the optimum

\[
\frac{d E_\phi [w (\theta, p, 0)]}{dp} = \pi \left[ \theta \left( p \right) \right] \theta \left( p \right) (qV - k) \left[ -\frac{d \theta \left( p \right)}{dp} \right] - E [1 - \theta] \left[ (1 - \delta) A^b + qV - k \right] = 0
\]

Equivalently, we can establish a sufficient condition for convexity by ensuring that the last term of 19 is strictly positive. This happens, whenever

\[
\chi \left( \theta \left( p \right) \right) < \frac{3 - 1/z^I - 2p}{1/z^I - 1}
\]

It is enough to show that

\[
\max_p \chi \left( \theta \left( p \right) \right) < \min_p \frac{3 - 1/z^I - 2p}{1/z^I - 1} = \frac{3z^R - 1}{1 - z^R}
\]

A sufficient, but not necessary, condition for this is to ensure that

\[
\chi (\theta) < \frac{3z^R - 1}{1 - z^R}, \forall \theta
\]
In this case, due to strict convexity of the welfare function, the optimum must be at one of the boundaries of the opportunity set. These are 0 and \( p^n \). We can evaluate expected welfare at each of these points and compare the values

\[
\begin{align*}
    E_\theta [w(\theta, p = 0, 0)] &= E_\theta [A^\theta + E[1-\theta] (A^b + qV - k)] \\
    E_\theta [w(\theta, p = p^n, 0)] &= E_\theta [A^\theta + qV - k] + p^n E[1-\theta] A^b + (1-p^n) E[1-\theta] (A^b + qV - k)
\end{align*}
\]

The planner prefers not to disclose, \( p = 0 \), if and only if

\[
E_\theta [w(\theta, p = 0, 0)] \geq E_\theta [w(\theta, p = p^n, 0)]
\]

\[
p^n \geq \frac{E_\theta [A^\theta]}{E[1-\theta]} \frac{1}{1 + \frac{(1-\theta)A^b}{qV - k}}
\]

\( \square \)

**Proof of Corollary 9**

**Proof.** 1) and 2) follow directly from the proof to Proposition 8. To show 3), note that the term whose sign determines the concavity or convexity of welfare is now given by

\[
3 - 1/z^I - \chi (1/z^I - 1) - 2p
\]

and so it is strictly decreasing in \( p \). For \( \chi \in \left[\frac{3z^I - 1}{1-z^I}, \frac{3z^I - 1}{3-z^I}\right] \), this term is strictly positive for \( p = 0 \) and strictly negative for \( p = p^n \). It crosses zero at

\[
p^c = \frac{1}{2} \left[3-1/z^I - \chi (1/z^I - 1)\right]
\]

So welfare is convex for \( p \in [0, p^c] \) and concave for \( p \in [p^c, p^n] \). \( \square \)

**Proof of Proposition 11**

**Proof.** The first-order condition follows from taking the derivative of (13) with respect to \( \alpha \),

\[
1 \left[ z(\theta, p) < z^I \right] z(\theta, p) (qV - k) - 2\gamma \alpha [k - qV (z(\theta, p) (1-q) + q)]^2 \leq 0
\]

The first term (marginal benefits) is zero for \( z(\theta, p) \geq z^I \) and positive otherwise. The second term (marginal costs)
is always positive. This means that the optimal policy is \( \alpha = 0 \) for \( z(\theta, p) \geq z^I \), and interior otherwise

\[
\alpha = \frac{z(\theta, p)(qV - k)}{2\gamma[k - qV(z(\theta, p)(1 - q) + q)]^2}
\]

up to being contained in the \([0, n_0(\theta, p)]\) interval.

Proof of Proposition 12

Proof. The first-order condition follows from taking the derivative of 15 with respect to \( \beta \),

\[
[(1 - \delta)A^b + qV - k] - 2\gamma\beta[(1 - q)(D - A^b)]^2 \leq 0
\]

The optimal policy is then

\[
\beta = \frac{(1 - \delta)A^b + qV - k}{2\gamma[(1 - q)(D - A^b)]^2}
\]

up to being contained in the \([0, n_0(\theta, p)]\) interval.

Proof of Proposition 13

Proof. Define the marginal benefits and marginal costs for each policy as

\[
MB_{\alpha} \equiv 1 \left[z(\theta, p) < z^I\right] z(\theta, p)(qV - k)
\]

\[
MB_{\beta} \equiv (1 - \delta)A^b + qV - k
\]

and

\[
MC_{\alpha} \equiv k - qV[z(\theta, p)(1 - q) + q]
\]

\[
MC_{\beta} \equiv (1 - q)(D - A^b)
\]

The first-order conditions with respect to each of the policies are

\[
\alpha : \frac{MB_{\alpha}}{MC_{\alpha}} - 2\gamma\Psi \leq 0
\]

\[
\beta : \frac{MB_{\beta}}{MC_{\beta}} - 2\gamma\Psi \leq 0
\]

where \( \Psi = \alpha MC_{\alpha} + \beta MC_{\beta} \) is total fiscal spending.

Consider first the situation in which \( z \geq z^I \). Then, \( MB_{\alpha} = 0 \), and the FOC for \( \alpha \) reads

\[-2\gamma\Psi \leq 0\]
with a strict inequality if \( c > 0 \). This implies that \( \alpha = 0 \) is optimal. We then have that \( \Psi = \beta MC_{\beta} \), and the FOC for \( \beta \) becomes
\[
\beta = \frac{MB_{\beta}}{2\gamma MC_{\beta}^2} \in [0, n_0(\theta, p)]
\]

Consider now the case in which \( z < z^f \). In this case, both policies yield positive marginal benefits. First, note that the marginal benefits of each policy are constant and positive, while marginal costs are increasing from 0. Thus setting \( \alpha = 0 \) and \( \beta = 0 \) cannot be optimal, as the planner could benefit from raising at least one of the policies. Furthermore, the first-order conditions form a linear system of inequalities, and depend on the controls \( \alpha, \beta \) only through the total spending term. The policies solve the following system of inequalities
\[
MC_{\alpha, \alpha} = \frac{1}{2\gamma MC_{\alpha}} - MC_{\beta, \beta}, \quad \alpha \in [0, n_1(\theta, p)]
\]
\[
MC_{\beta, \beta} = \frac{1}{2\gamma MC_{\beta}} - MC_{\alpha, \alpha}, \quad \beta \in [0, n_0(\theta, p)]
\]

This is equivalent to solving a demand system for substitute goods: the planner will choose the policy that yields the best marginal benefit to marginal cost ratio up to capacity, and only then choose the following policy. Consider first the case in which
\[
\frac{MB_{\alpha}}{MC_{\alpha}} \geq \frac{MB_{\beta}}{MC_{\beta}}
\]

This condition is equivalent to
\[
z(\theta, p) \geq z^f \frac{1}{1 + \left(1 - \frac{k}{qV} \right) \frac{(p - A^*)}{(1 - \delta)A^*qV - k}} \equiv z^c
\]

In this case, the planner sets \( \alpha \) first, since it yields a greater benefit-to-cost ratio. The optimal \( \alpha \) satisfies
\[
\alpha = \max \left\{ 0, \min \left\{ n_1(\theta, p), \frac{MB_{\alpha}}{2\gamma MC_{\alpha}^2} \right\} \right\}
\]
and the optimal \( \beta \) becomes active only if \( \alpha \) is at capacity. We can write the optimal choice as
\[
\beta = \max \left\{ 0, \min \left\{ n_0(\theta, p), \frac{MB_{\beta}}{2\gamma MC_{\beta}^2} - \frac{MC_{\alpha}}{MC_{\beta}} n_1(\theta, p) \right\} \right\}
\]

The opposite case, in which \( \beta \) yields the greater marginal benefit to cost ratio occurs when \( z(\theta, p) \leq z^c < z^f \). In this case, the policies are analogous
\[
\beta = \max \left\{ 0, \min \left\{ n_0(\theta, p), \frac{MB_{\beta}}{2\gamma MC_{\beta}^2} \right\} \right\}
\]
\[ \alpha = \max \left\{ 0, \min \left\{ n_1(\theta, p), \frac{MB_\alpha}{2\gamma MC_\beta} - \frac{MC_\beta}{MC_\alpha} n_0(\theta, p) \right\} \right\} \]

It is possible to tighten this characterization. First, define

\[ \theta^c(p) : \frac{z(\theta^c(p), p)}{z^c} = \frac{1 - p}{1/z^c - p} \]

Note then that for \( \theta \leq \theta^c(p) \), \( \beta(\theta, p) \) is set first. Furthermore, it is set to a value that does not depend on the state, \((\theta, p)\). This means that we can easily obtain the threshold \( \theta \) beyond which \( \beta(\theta, p) \) hits its upper bound. \( \beta(\theta, p) \) hits the upper bound when

\[ \frac{MB_\beta}{2\gamma MC_\beta} \geq n_0(\theta, p) = p(1 - \theta) \]

\[ \theta \geq 1 - \frac{1}{p} \frac{MB_\beta}{2\gamma MC_\beta} = \theta^d(p) \]

We can then characterize the optimal policy as: for \( \theta \in [0, \theta^d(p)] \), the optimal policy consists of setting an interior \( \beta(\theta, p) \), and \( \alpha(\theta, p) = 0 \). For \( \theta \in [\theta^d(p), \theta^c(p)] \), the optimal policy consists of setting \( \beta(\theta, p) = n_0(\theta, p) \) and \( \alpha(\theta, p) > 0 \). Finally, we can do the same for the interval in which \( \alpha(\theta, p) \) is preferred. This case is slightly more complicated, since the marginal benefits and costs of this policy also depend on \((\theta, p)\). We can show that the region for which the planner sets \( \alpha(\theta, p) \geq n_1(\theta, p) \) is given by

\[ \frac{z(\theta, p)(qV - k)}{2\gamma[qV(1 - q)]^2 (z^i - z(\theta, p))^2} \geq \theta + (1 - p)(1 - \theta) \]

\[ 0 \geq \theta^2 (1 - px^f)^2 - \theta \left( 2(1 - p)x^f(1 - p)x^f + \frac{qV - k}{2\gamma[qV(1 - q)]^2} \right) + [(1 - p)x^f]^2 \]

The roots of the above inequality are

\[ \theta = \left\lfloor \frac{2(1 - px^f)(1 - p)x^f + \frac{qV - k}{2\gamma[qV(1 - q)]^2}}{2(1 - px^f)^2} \right\rfloor \pm \sqrt{\left( \frac{2(1 - px^f)(1 - p)x^f + \frac{qV - k}{2\gamma[qV(1 - q)]^2}}{2(1 - px^f)^2} \right)^2 - 4\left( (1 - p)x^f \right)^2 (1 - px^f)^2} \]

\[ = \left\lfloor \frac{(1 - p)x^f + \frac{qV - k}{4\gamma[qV(1 - q)(1 - px^f)]^2}}{1 - px^f} \right\rfloor \pm \sqrt{\left( \frac{(1 - p)x^f + \frac{qV - k}{4\gamma[qV(1 - q)(1 - px^f)]^2}}{1 - px^f} \right)^2 - \left( \frac{1 - p}{1 - px^f} \right)^2} \]

Let \( \theta^{\alpha^-}(p) \) denote the negative root and \( \theta^{\alpha^+}(p) \) the positive one. Note that the positive root is strictly greater than \( \theta^I(p) \): but the planner does not use \( \alpha(\theta, p) \) in that case. Let then \( \theta^{\alpha}(p) = \theta^{\alpha^-}(p) \). We can then characterize fiscal policy as follows: for \( \theta \in [\theta^c, \theta^{\alpha}(p)] \), the planner does not exhaust \( \alpha(\theta, p) \), and thus \( \beta(\theta, p) = 0 \). For
\[ \theta \in [\theta^a(\theta), \theta^f(\theta)], \text{ the planner exhausts the credit policy and sets } \beta(\theta, p) > 0. \]

Proof of Proposition 14

Proof. First, we note that we can write the disclosure problem as follows

\[
\max_{p \in [0,1]} \mathbb{E}_\theta \left[ \max_{\alpha, \beta} w(\theta, p, \Psi) \right] = \max_{p \in [0,1]} \left\{ \mathbb{E}_\theta [w(\theta, p, 0)] + \mathbb{E}_\theta \left[ MB_\beta \beta(\theta, p) \right] + \mathbb{E}_\theta \left[ 1 \left[ z(\theta, p) < z^f \right] MB_\alpha \alpha(\theta, p) \right] - \gamma \mathbb{E} \left[ MB_\beta \beta(t) \right] \right\}
\]

where \( \mathbb{E}_\theta [w(\theta, p, 0)] \) is the welfare function that we analyzed in the case of disclosure only, and \( \alpha(\theta, p), \beta(\theta, p) \) are the optimal policies derived in the previous section. This means that the FOC for disclosure will now be

\[
\frac{d\mathbb{E}_\theta [w(\theta, p, \Psi)]}{dp} = \frac{d\mathbb{E}_\theta [w(\theta, p, 0)]}{dp} + \mathbb{E}_\theta \left[ \frac{d\beta(\theta, p)}{dp} (MB_\beta - 2\gamma MC_\beta \Psi(\theta, p)) \right] + \mathbb{E}_\theta \left[ \frac{d\alpha(\theta, p)}{dp} \left( 1 \left[ z(\theta, p) < z^f \right] MB_\alpha(\theta, p) - 2\gamma MC_\alpha(\theta, p) \Psi(\theta, p) \right) \right] + \mathbb{E}_\theta \left[ \alpha(\theta, p) \left( 1 \left[ z(\theta, p) < z^f \right] \right) MB_\alpha(\theta, p) \right] \frac{dMB_\alpha(\theta, p)}{dp} + \mathbb{E}_\theta \left[ \alpha(\theta, p) \left( 1 \left[ z(\theta, p) < z^f \right] \right) MB_\alpha(\theta, p) \right] \frac{dMB_\alpha(\theta, p)}{dp} \frac{d\theta^f(p)}{dp} MB_\alpha(\theta^f(p), p) \alpha(\theta^f(p), p)
\]

The term in the first line is the original derivative. The term in the last line is equal to zero, since the optimal policy prescribes no credit support in the absence of a market freeze \( \alpha(\theta^f(p), p) = 0 \). The term in the second line is weakly positive. To see this, note that at an interior optimum, we have that the second factor is equal to zero, since it equals the first-order condition for \( \beta \)

\[ MB_\beta - 2\gamma MC_\beta \Psi(\theta, p) = 0 \]

So this term is non-zero when the above first-order condition is either negative or positive. When the first-order condition is negative, the planner finds it optimal to set \( \beta(\theta, p) = 0 \), and so the derivative \( \frac{d\beta(\theta, p)}{dp} \) is zero. When it is positive, it means that this policy is constrained above, or

\[ \beta(\theta, p) = n_0(\theta, p) \Rightarrow \frac{d\beta(\theta, p)}{dp} = 1 - \theta > 0 \]

Since the term in the second line is the expectation of terms that are either zero or positive, it is non-negative. The term in the third line can be shown to be weakly positive as well. To see this, note that it is composed of two terms: the second term in the sum can be shown to be strictly positive, since

\[ \frac{dMB_\alpha(\theta, p)}{dp} = (qV - k) \frac{dz(\theta, p)}{dp} > 0 \]
\[ \frac{dMC_\alpha(\theta, p)}{dp} = -qV (1 - q) \frac{dz(\theta, p)}{dp} < 0 \]
while the first term will be either zero or negative. Following an argument similar to the one for the term on the second line, we can show that the first term is zero whenever $\alpha(\theta, p) < n_1(\theta, p)$. The only instances in which this term is non-zero is when $\alpha(\theta, p) = n_1(\theta, p)$. Generally, we can write this term as

$$E_\theta \left[ \frac{d\alpha(\theta, p)}{dp} \left( 1 [z(\theta, p) < z^*] MB_\alpha - 2\gamma MCA_\alpha \Psi(\theta, p) \right) \right] = - \int_{\alpha(\theta, p) = n_1(\theta, p)} (1 - \theta) \left( 1 [z(\theta, p) < z^*] MB_\alpha(\theta, p) - 2\gamma MCA_\alpha(\theta, p) \right) q \Psi$$

and we have, for the second term, that

$$E_\theta \left[ \alpha(\theta, p) \left( 1 [z(\theta, p) < z^*] \frac{dMB_\alpha(\theta, p)}{dp} - 2\gamma \Psi(\theta, p) \frac{dMCA_\alpha(\theta, p)}{dp} \right) \right] \geq \int_{\alpha(\theta, p) = n_1(\theta, p)} \alpha(\theta, p) \frac{dz(\theta, p)}{dp} [qV - k + 2\gamma \Psi(\theta, p) qV]$$

This means that we can write the sum as

$$E_\theta \left[ \frac{d\alpha(\theta, p)}{dp} \left( 1 [z(\theta, p) < z^*] MB_\alpha(\theta, p) - 2\gamma MCA_\alpha(\theta, p) \Psi(\theta, p) \right) \right] + E_\theta \left[ \alpha(\theta, p) \left( 1 [z(\theta, p) < z^*] \frac{dMB_\alpha(\theta, p)}{dp} - 2\gamma \Psi(\theta, p) \frac{dMCA_\alpha(\theta, p)}{dp} \right) \right] \geq - \int_{\alpha(\theta, p) = n_1(\theta, p)} (1 - \theta) \left( 1 [z(\theta, p) < z^*] MB_\alpha(\theta, p) - 2\gamma MCA_\alpha(\theta, p) \Psi(\theta, p) \right) d\Pi(\theta) + \int_{\alpha(\theta, p) = n_1(\theta, p)} \alpha(\theta, p) \frac{dz(\theta, p)}{dp} [qV - k + 2\gamma \Psi(\theta, p) qV (1 - q)] + (1 - \theta) 2\gamma \Psi(\theta, p) (k - q^2 V) d\Pi(\theta)$$

$$= \int_{\alpha(\theta, p) = n_1(\theta, p)} \left[ n_1(\theta, p) \frac{dz(\theta, p)}{dp} - z(\theta, p) (1 - \theta) \right] [qV - k + 2\gamma \Psi(\theta, p) qV (1 - q)] + (1 - \theta) 2\gamma \Psi(\theta, p) (k - q^2 V) d\Pi(\theta)$$

$$\geq 0$$

This implies that

$$\frac{dE_\theta [w(\theta, p, \Psi)]}{dp} \geq \frac{dE_\theta [w(\theta, p, 0)]}{dp}$$

When fiscal policy is available, welfare is at least as increasing in disclosure as when fiscal policy is not available. This reveals a (weak) preference for disclosure under the availability of fiscal policy. \(\square\)

Proof of Proposition 15

Proof. Consider first the case in which welfare is strictly concave. This implies that

$$\frac{d^2 E_\theta [w(\theta, p, \Psi)]}{dp^2} < 0$$

and, furthermore, the first-order condition with respect to \(p\) is necessary and sufficient. The FOC satisfies

$$\frac{dE_\theta [w(\theta, p, \Psi)]}{dp} = 0 \iff \Phi(p, \gamma; X) = 0$$
From the implicit function theorem, we have that

$$\frac{\partial p}{\partial \gamma} = -\left(\frac{\partial \Phi}{\partial p}\right)^{-1} \left(\frac{\partial \Phi}{\partial \gamma}\right)$$

By assumption, the objective function is concave, and thus the optimum $p$ is interior. Note that

$$\frac{\partial \Phi}{\partial p} = \frac{d^2 E_{\theta}[w(\theta, p, \Psi)]}{dp^2} < 0$$

and the second term satisfies,

$$\frac{\partial \Phi}{\partial \gamma} = \frac{\partial}{\partial \gamma} \left(\frac{dE_{\theta}[w(\theta, p, \Psi)]}{dp}\right)$$

$$= E_{\theta} \left\{ \frac{\partial^2 \beta(\theta, p)}{\partial p \partial \gamma} \left[ MB_{\beta} - 2\gamma MC_{\beta} \Psi(\theta, p) \right] + \frac{\partial^2 \alpha(\theta, p)}{\partial \gamma} \left[ 1 \left[ z(\theta, p) < z^* \right] MB_{\alpha}(\theta, p) - 2\gamma MC_{\alpha}(\theta, p) \Psi(\theta, p) \right] \right\}$$

$$+ E_{\theta} \left\{ \frac{\partial \alpha(\theta, p)}{\partial \gamma} \left( 1 \left[ z(\theta, p) < z^* \right] \frac{dMB_{\alpha}(\theta, p)}{dp} - 2\gamma \Psi(\theta, p) \frac{dMC_{\alpha}(\theta, p)}{dp} \right) \right\} - 2E_{\theta} \left[ \Psi(\theta, p) \frac{d\Psi(\theta, p)}{dp} \right]$$

$$= E_{\theta} \left\{ \frac{\partial \alpha(\theta, p)}{\partial \gamma} \left( 1 \left[ z(\theta, p) < z^* \right] \frac{dMB_{\alpha}(\theta, p)}{dp} - 2\gamma \Psi(\theta, p) \frac{dMC_{\alpha}(\theta, p)}{dp} \right) \right\} - 2E_{\theta} \left[ \Psi(\theta, p) \frac{d\Psi(\theta, p)}{dp} \right]$$

Notice that the first two terms are equal to zero: the first-order conditions are only positive whenever the polices are maxed out, in which case they do not depend on $\gamma$. This condition is negative or zero for $\alpha(\theta, p) = 0$ or $\alpha(\theta, p) = n_0(\theta, p)$. The only interesting case is then when $\alpha(\theta, p)$ is interior. Consider first the case in which $\beta(\theta, p) = 0$. Then, this term is equal to

$$\frac{\partial \Phi}{\partial \gamma} = E_{\theta} \left\{ \frac{\alpha(\theta, p)}{\gamma} \frac{dz(\theta, p)}{dp} \left( 1 \left[ z(\theta, p) < z^* \right] (qV - k) + \frac{z(\theta, p)}{2\gamma MC_{\alpha}} qV (1 - q) \right) - \frac{z(\theta, p)}{2\gamma MC_{\alpha}} \frac{dz(\theta, p)}{dp} (qV - k) \right\},$$

$$= -E_{\theta} \left\{ \frac{dz(\theta, p)}{dp} (qV - k) \frac{1}{MC_{\alpha}} \left( \alpha(\theta, p) \left( 1 \left[ z(\theta, p) < z^* \right] MC_{\alpha} + z(\theta, p) qV (1 - q) \right) + \frac{z(\theta, p)}{2\gamma} \frac{dz(\theta, p)}{dp} (k - q^2V) \right) \right\} < 0$$

Note then that this term is always negative. Consider now the case in which $\alpha(\theta, p)$ is interior, and $\beta(\theta, p) = n_0(\theta, p)$. Then, the derivative is

$$\frac{\partial \Phi}{\partial \gamma} = E_{\theta} \left\{ -\frac{MB_{\alpha}}{2\gamma MC_{\alpha}} \frac{dz(\theta, p)}{dp} \left( 1 \left[ z(\theta, p) < z^* \right] (qV - k) + \frac{z(\theta, p)}{2\gamma MC_{\alpha}} qV (1 - q) \right) \right\} - E_{\theta} \left[ \frac{z(\theta, p)}{\gamma MC_{\alpha}} \frac{dz(\theta, p)}{dp} \right]$$

$$= -E_{\theta} \left\{ \frac{z(\theta, p)}{MC_{\alpha}} \frac{dz(\theta, p)}{dp} \left( \frac{qV - k}{2\gamma MC_{\alpha}} \frac{dz(\theta, p)}{dp} \left( 1 \left[ z(\theta, p) < z^* \right] MC_{\alpha} + z(\theta, p) qV (1 - q) \right) \right) + \frac{dz(\theta, p)}{dp} \right\}$$

$$= -E_{\theta} \left\{ \frac{z(\theta, p)}{MC_{\alpha}} \frac{dz(\theta, p)}{dp} \left( \frac{qV - k}{2\gamma MC_{\alpha}} \frac{dz(\theta, p)}{dp} \left( 1 \left[ z(\theta, p) < z^* \right] MC_{\alpha} + z(\theta, p) qV (1 - q) \right) + \frac{dz(\theta, p)}{dp} \right) \right\}.$$
Also negative. This implies that, if welfare is concave, then

\[ \frac{\partial p}{\partial \gamma} < 0 \]

Note that the sign derivation of \( \frac{\partial \Psi}{\partial \gamma} \leq 0 \) does not depend on any specific properties of the welfare function or the distribution \( \pi(\theta) \). These are relevant only to the extent that assumptions are required to ensure that \( \frac{\partial \Psi}{\partial \gamma} \leq 0 \) as well. Even if we are not able to establish strict concavity of the welfare function, the above result holds for any welfare function that is locally concave at the optimal disclosure point.

Assume now that welfare is convex. Then, the solution is at a corner, either at \( p = 0 \) or \( p = p^m \). If \( p = 0 \), there is no disclosure, and so there are no runs. This means that \( \beta(\theta, 0) = 0 \), and \( \alpha(\theta, 0) = \min \left\{ 1, \frac{MB_x(\theta, 0)}{2\gamma MC_\alpha(\theta, 0)} \right\} \).

Expected welfare is

\[
\mathbb{E}_\theta \left[ w(\theta, 0, \Psi) \right] = \mathbb{E}_\theta \left[ w(\theta, 0, 0) + \mathbb{E}_\theta \left[ MB_x(\theta, 0) \alpha(\theta, 0) \right] - \gamma \mathbb{E}_\theta \left[ (MC_\alpha(\theta, 0) \alpha(\theta, 0))^2 \right] \right]
\]

\[
= \mathbb{E}_\theta \left[ \theta^* A^* + \mathbb{E}_\theta \left[ 1 - \theta \right] \left( A^* + qV - k \right) + \int_{z^*_R}^{\theta^*} \frac{MB_x(\theta, 0)^2}{4\gamma MC_\alpha(\theta, 0)} d\Pi(\theta) + \int_{\theta^*}^{\theta^m} \left\{ MB_x(\theta, 0) - \gamma [MC_\alpha(\theta, 0)]^2 \right\} d\Pi(\theta) \right]
\]

where \( \theta^* (0) \) is the smaller root of

\[
\frac{MB_x(\theta, 0)^2}{2\gamma MC_\alpha(\theta, 0)} = 1
\]

\[
\theta^* = z^* + \frac{1}{4\gamma (qV - k)} \left[ \frac{1}{4\gamma (qV - k)} + 2z^* \right]
\]

If \( p = p^m \), there is no adverse selection. This means that \( \alpha(\theta, p^m) = 0 \), and \( \beta(\theta, p^m) = \min \left\{ p^m \left( 1 - \theta \right), \frac{MB_x(\theta, 0)}{2\gamma MC_\alpha(\theta, 0)} \right\} \).

Let \( \theta^m = 1 - \frac{1}{p^m} \frac{MB_x}{2\gamma MC_\alpha} \), the level of \( \theta \) beyond which all bad banks whose types are disclosed are supported. Then, welfare is

\[
\mathbb{E}_\theta \left[ w(\theta, p^m, \Psi) \right] = \mathbb{E}_\theta \left[ w(\theta, p^m, 0) + \mathbb{E}_\theta \left[ MB_x(\theta, p^m) \beta(\theta, p^m) \right] - \gamma \mathbb{E}_\theta \left[ (MC_\alpha(\theta, 0) \beta(\theta, p^m))^2 \right] \right]
\]

\[
= \mathbb{E}_\theta \left[ \theta^* \left( A^* + qV - k \right) + \mathbb{E}_\theta \left[ 1 - \theta \right] \left( (1 - p^m) \left( A^* + qV - k \right) + p^m \delta A^* \right) + \frac{MB_x^2}{4\gamma MC_\alpha^2} \Pi(\theta^m) + \int_{\theta^*}^{\theta^m} p^m \left( 1 - \theta \right) MB_x d\Pi(\theta) \right]
\]

The planner prefers no disclosure if and only if the following parametric restriction is satisfied,

\[
MB_x p^m \mathbb{E}_\theta \left[ 1 - \theta \right] + \int_{z^*_R}^{\theta^m} \frac{MB_x(\theta, 0)^2}{4\gamma MC_\alpha(\theta, 0)} d\Pi(\theta) + \int_{\theta^*}^{\theta^m} \left\{ MB_x(\theta, 0) - \gamma [MC_\alpha(\theta, 0)]^2 \right\} d\Pi(\theta) \geq \mathbb{E}_\theta \left[ (qV - k) + \frac{MB_x^2}{4\gamma MC_\alpha} \Pi(\theta^m) \right]
\]

or

\[
MB_x p^m \int_{z^*_R}^{\theta^m} (1 - \theta) d\Pi(\theta) - (qV - k) \int_{z^*_R}^{\theta^m} \theta d\Pi(\theta) + \frac{1}{4\gamma} \left[ \int_{z^*_R}^{\theta^m} MB_x^2 d\Pi(\theta) - \int_{z^*_R}^{\theta^m} MB_x^2 d\Pi(\theta) \right] - \gamma \left[ \int_{\theta^*}^{\theta^m} MC_\alpha^2 d\Pi(\theta) - \int_{\theta^*}^{\theta^m} [MB_x^2] d\Pi(\theta) \right]
\]
It is enough to show that this restriction is less likely to be binding as $\gamma \uparrow$. That is, as fiscal capacity decreases, the planner is more likely to choose $p = 0$ than $p = p^m$. For this, define the above inequality as $\Lambda (\gamma) \geq 0$, and it is enough to show that

$$\frac{\partial \Lambda (\gamma)}{\partial \gamma} \geq 0$$

To show this, take the derivative, noting that the only parameters that implicitly depend on $\gamma$ are $\theta^m$ and $\theta^a$,

$$\frac{\partial \Lambda (\gamma)}{\partial \gamma} = \pi (\theta^m) \frac{\partial \theta^m}{\partial \gamma} \left\{ p^m (1 - \theta^m) MB_\beta - \frac{MB_\alpha}{\gamma MC_\alpha} - \gamma [p^m (1 - \theta^m) MC_\alpha] \right\} - \pi (\theta^a) \frac{\partial \theta^a}{\partial \gamma} \left\{ MB_\alpha (\theta^a) - \frac{MB_\alpha (\theta^a)^2}{4 \gamma MC_\alpha (\theta^a)^2} - \gamma \right\}$$

$$\geq \frac{1}{4 \gamma^2} \left[ \int_{z^R}^{\gamma} MB_\beta \frac{d\Pi (\theta)}{MC_\beta} - \int_{z^R}^{\gamma} MB_\beta \frac{d\Pi (\theta)}{MC_\beta} \right] - \left[ \int_{z^R}^{\gamma} MC_\alpha \frac{d\Pi (\theta)}{MCA_\alpha} - \int_{z^R}^{\gamma} MC_\alpha \frac{d\Pi (\theta)}{MCA_\alpha} \right]$$

$$\geq \frac{1}{4 \gamma^2} \left[ \left( \frac{MB_\beta}{MC_\beta} \right)^2 - 4 \gamma^2 \Pi (\theta^a) \left( \frac{MB_\alpha (\theta^a)^2}{4 \gamma^2 MC_\alpha (\theta^a)^2} - MC_\alpha (\theta^a)^2 \right) \right]$$

$$\geq \frac{1}{4 \gamma^2} \left( MB_\beta \frac{d\Pi (\theta)}{MC_\beta} \right)^2 \geq 0$$

We then conclude that the inequality is indeed less likely to bind as $\gamma \uparrow$, so that the planner will (weakly) prefer to disclose less.

\[ \square \]

C **General Model for** $[\theta, \bar{\theta}] \supset \{ z^R, z^I \}$

Since the case $\theta \in [z^R, z^I]$ is treated extensively in the main text, we focus on $\theta \in [\hat{\theta}, \bar{\theta}]$ where $[z^R, z^I] \subset [\hat{\theta}, \bar{\theta}]$.

The analysis of the cases in which the support of $\theta$ is a strict subset follow from specializations of the analysis in this section.

Recall, from section XXX that the thresholds $\theta^R (p)$ and $\theta^I (p)$ are given by

$$\theta^R (p) = \frac{1 - p}{1/z^R - p}$$

$$\theta^I (p) = \frac{1 - p}{1/z^I - p}$$

The main analysis disregards $\theta^R (p)$, since $\theta \geq z^R$, but it now becomes relevant for the general case. Expected
welfare for the private equilibrium can be written as

\[ E_\theta [w(\theta, p, \Psi)] = \bar{y}_1 - \gamma (\Psi)^2 + pE[1 - \theta] \delta A^b \]
\[ + \delta \int_{\theta}^{\max[\theta^a(p), \bar{\theta}]} [\theta A^g + (1 - \theta)(1 - p) A^b] d\Pi(\theta) \]
\[ + \int_{\theta}^{\bar{\theta}} [\theta A^g + (1 - \theta)(1 - p)(A^b + qV - k)] d\Pi(\theta) \]
\[ + \int_{\max[\theta^a(p), \bar{\theta}]}^{\bar{\theta}} \theta(qV - k) d\Pi(\theta) \]

The first line is as before, and contains the endowment, the fiscal costs and the costs from disclosing banks that are bad with certainty. The second line is the new component: by letting \( \theta \leq \bar{z} \), we are allowing for the possibility of system-wide runs, in which even banks with the good signal suffer a run. This happens if the aggregate state, the average quality of the banks, is low enough, and the level of disclosure is also low enough. Thus the general case contains an additional benefit of disclosure that was not present in the main analysis: by disclosing more, the planner is reducing the likelihood that the good pool suffers a run (or even eliminating it altogether).

First-best welfare is as before, and corresponds to the situation in which there are no runs and all banks invest

\[ W^{FB} = A^b E[1 - \theta] + A^g E[\theta] + qV - k \]

C.1 Economy without Runs

As before, it is useful to understand the impact of disclosure on each source of inefficiency separately, before moving to the analysis of the full problem. In this case, we can write welfare as

\[ E_\theta [w(\theta, p, 0)] = \bar{y}_1 + \int_{\theta}^{\max[\theta^f(p), \bar{\theta}]} [\theta A^g + (1 - \theta)(A^b + qV - k)] d\Pi(\theta) \]
\[ + \int_{\theta}^{\bar{\theta}} [\theta (A^g + qV - k) + (1 - \theta)(A^b + qV - k)] d\Pi(\theta) \]
\[ = \bar{y}_1 + E[1 - \theta] (A^b + qV - k) + A^g E[\theta] + (qV - k) \int_{\max[\theta^f(p), \bar{\theta}]}^{\bar{\theta}} \theta d\Pi(\theta) \]

As before, welfare is weakly increasing in disclosure in the absence of runs, since \( \frac{d\theta^f(p)}{dp} < 0 \): by disclosing more, the planner unfreezes markets at no cost. This is true up to \( p \) such that \( \theta^f(p) = \bar{\theta} \), beyond which disclosure has no effect on welfare. We can then define

\[ p^f: \theta^f(p^f) = \bar{\theta} \Leftrightarrow p^f = \frac{z^f - \bar{\theta}}{z^f(1 - \bar{\theta})} \]

as the maximum \( p \) for which welfare is increasing in disclosure.
C.2 Economy without Lemons

Assume now that there is no adverse selection problem in credit markets. This allows us to write expected welfare as

\[ E_\theta [w(\theta, p, 0)] = y_1 + pE [1 - \theta] \delta A^b + \delta \int_{\max[\theta^R(p), 0]}^\theta \left[ \theta A^b + (1 - \theta) (1 - p) A^b \right] d\Pi(\theta) \]

\[ + \int_{\max[\theta^R(p), 0]}^\theta \left[ \theta (A^p + qV - k) + (1 - \theta) (1 - p) (A^b + qV - k) \right] d\Pi(\theta) \]

\[ = \delta \int_{\max[\theta^R(p), 0]}^\theta \left[ \theta A^b + (1 - \theta) A^b \right] d\Pi(\theta) + \int_{\max[\theta^R(p), 0]}^\theta \left[ \theta (A^p + qV - k) + (1 - \theta) (1 - p) (A^b + qV - k) \right] d\Pi(\theta) \]

Contrary to the baseline analysis, in which no trade-off exists and welfare is strictly decreasing in disclosure, disclosure now has a benefit when it comes to runs: by disclosing, the planner will be reducing the likelihood that the economy finds itself in the midst of a system-wide run, when \( \theta < z^R \). This means that optimal disclosure, without adverse selection, can potentially be different from \( p = 0 \). The derivative of expected welfare with respect to \( p \) is

\[ \frac{dE_\theta [w(\theta, p, 0)]}{dp} = 1 \left[ \theta^R(p) \geq \theta \right] \pi \left[ \theta^R(p) \right] \left( - \frac{d\theta^R(p)}{dp} \right) \left\{ \theta^R(p) \left[ (1 - \delta) A^p + qV - k \right] + (1 - p) \left[ 1 - \theta^R(p) \right] \left[ (1 - \delta) A^b + qV - k \right] \right\} d\Pi(\theta) \]

\[ - \int_{\max[\theta^R(p), 0]}^\theta \left[ (1 - \theta) A^b + qV - k \right] d\Pi(\theta) \]

Note that the first component of the derivative only depends on \( p \) for \( \theta^R(p) \geq \theta \): as with adverse selection, beyond a certain point, disclosure is so high that a system-wide run becomes impossible. We can let that point be denoted as

\[ p^R: \theta^R(p^R) = \theta \Leftrightarrow p^R = \frac{z^R - \theta}{z^R(1 - \delta)} \]

For \( p \geq p^R \), the derivative of welfare is equal to the term on the second line only, and thus strictly negative. Expected welfare is strictly decreasing on disclosure for \( p \geq p^R \), since disclosing anything beyond this point has no impact on the probability of a system-wide run (which is averted with certainty) and only causes inefficient runs on bad banks. This logic is similar to the one in the baseline model, and to the logic behind Proposition XXX.

Focusing on \( p \leq p^R \), there are benefits and costs to disclosure. The second derivative of the welfare function is-

\[ \frac{d^2E_\theta [w(\theta, p, 0)]}{dp^2} = - \left\{ \pi \left[ \theta^R(p) \right] \left( \frac{d\theta^R(p)}{dp} \right)^2 + \pi \left[ \theta^R(p) \right] \frac{d^2\theta^R(p)}{dp^2} \right\} \left\{ \theta^R(p) \left[ (1 - \delta) A^p + qV - k \right] + (1 - p) \left[ 1 - \theta^R(p) \right] \left[ (1 - \delta) A^b + qV - k \right] \right\} \]

\[ - \pi \left[ \theta^R(p) \right] \left( \frac{d\theta^R(p)}{dp} \right)^2 \left[ (1 - \delta) \left[ A^p - (1 - p) A^b \right] + p \left[ qV - k \right] \right] + 2\pi \left[ \theta^R(p) \right] \frac{d\theta^R(p)}{dp} \left[ 1 - \theta^R(p) \right] \left[ (1 - \delta) \right] \]

Note that both terms in the second line are negative. For the first line, it is enough to show that the first factor is
positive to establish the entire term as negative. We can sign it as
\[
\pi \left[ \theta^R (p) \right] \left\{ -2 \frac{1/ \bar{z}^R - 1}{(1/ \bar{z}^R - p)^2} + \frac{\tau^R(\theta^R(p)) \left( 1/ \bar{z}^R - 1 \right)^2}{\pi[\theta^R(p)] \left( 1/ \bar{z}^R - p \right)^2} \right\}
\]
\[= \pi \left[ \theta^R (p) \right] \frac{1/ \bar{z}^R - 1}{(1/ \bar{z}^R - p)^2} \frac{1}{1-p} \left\{ -2 + 2p + \left( 1/ \bar{z}^R - 1 \right) \theta^R (p) \frac{\tau^R(\theta^R(p)) \left( 1/ \bar{z}^R - 1 \right)}{\pi[\theta^R(p)]} \right\}
\]
\[= \pi \left[ \theta^R (p) \right] \frac{1/ \bar{z}^R - 1}{(1/ \bar{z}^R - p)^2} \frac{1}{1-p} \left\{ \pi \left[ \theta^R (p) \right] \left( 1/ \bar{z}^R - 1 \right) - 2 + 2p \right\}
\]

It is then enough that the term in brackets be positive. This happens when
\[
\min_p \left[ \theta^R (p) \right] \geq \max_p \frac{2 (1-p)}{1/ \bar{z}^R - 1} = \frac{2 \bar{z}^R}{1 - \bar{z}^R}
\]

This then becomes a sufficient condition for concavity of the welfare function. This means that the optimum is interior and solves the first-order condition.

C.3 Full Economy

We now proceed the disclosure problem in the full economy. As before, the general problem without fiscal policy is
\[
\max_{\theta \in [0,1]} E_{\theta} \left[ w(\theta, p, 0) \right]
\]

where the objective function can be written as
\[
E_{\theta} \left[ w(\theta, p, 0) \right] = \bar{g}_1 + \delta A^b
\]
\[+ 1 \left[ p \leq p^R \right] \left\{ \int_{\theta}^\phi \theta \left( A^q - A^b \right) d\Pi (\theta) + \int_{\theta^R(p)}^{\phi} \theta \left( A^q - \delta A^b - (1-p) \left[ (1-\delta) A^b + qV - k \right] \right) + (1-p) \left( 1 - \theta \left( A^q - \delta A^b + qV - k \right) \right) \right\} d\Pi (\theta) -
\]
\[+ 1 \left[ p^R \leq p \leq p^I \right] \left\{ \int_{\theta}^{\phi} \theta \left( A^q - \delta A^b + qV - k - (1-p) \left[ (1-\delta) A^b + qV - k \right] \right) + (1-p) \left( (1-\delta) A^b + qV - k \right) \right\} d\Pi (\theta) -
\]
\[+ 1 \left[ p \geq p^I \right] \left\{ \int_{\theta}^{\phi} \theta \left( A^q - \delta A^b + qV - k - (1-p) \left[ (1-\delta) A^b + qV - k \right] \right) + (1-p) \left( (1-\delta) A^b + qV - k \right) \right\} d\Pi (\theta)
\]

We can recover the previous result that the planner will never set \( p \geq p^I \): given that \( z^I > \bar{z}^R \) implies that \( p^R < p^I \), we know that the benefits of disclosure are zero beyond this point: not only has the planner averted a system-wide run with certainty, but it has also unfreezed the market. Disclosing beyond this point only causes costly runs, and is therefore not optimal. We look at the optimal choice in the \([0, p^R]\) and \([p^R, p^I]\) separately, and compare the results to find the global optimum.
1. For \( p \in [0, p^R] \), the derivative of expected welfare with respect to \( p \) is

\[
\frac{\text{d} \mathbb{E}_\theta[w(\theta, p, 0)]}{\text{d} p} = \pi [\theta^I(p)] \left( \frac{\text{d} \theta^I(p)}{\text{d} p} \right) \theta^I(p) (qV - k)
+ \pi [\theta^R(p)] \left( \frac{\text{d} \theta^R(p)}{\text{d} p} \right) \{ \theta^R(p) (1 - \delta) A^b + (1 - \delta) A^b + qV - k \}
- \int_{\theta^R(p)}^{\delta} (1 - \theta) [(1 - \delta) A^b + qV - k] \text{d}\Pi(\theta)
\]

The second derivative is

\[
\frac{\text{d}^2 \mathbb{E}_\theta[w(\theta, p, 0)]}{\text{d} p^2} = -\left\{ \pi' [\theta^I(p)] \theta^I(p) \left( \frac{\text{d} \theta^I(p)}{\text{d} p} \right)^2 + \pi [\theta^I(p)] \theta^I(p) \frac{\text{d}^2 \theta^I(p)}{\text{d} p^2}
+ \pi [\theta^R(p)] \left( \frac{\text{d} \theta^R(p)}{\text{d} p} \right)^2 \{ \theta^R(p) (1 - \delta) A^b + (1 - \delta) A^b + qV - k \}
- \pi [\theta^R(p)] \left( \frac{\text{d} \theta^R(p)}{\text{d} p} \right)^2 \{ (1 - \delta) A^b - (1 - p) [(1 - \delta) A^b + qV - k] \}
+ 2 (1 - \theta^R(p)) \pi [\theta^R(p)] \frac{\text{d} \theta^R(p)}{\text{d} p} [(1 - \delta) A^b + qV - k] \right\}
\]

Sufficient conditions for concavity are

\[
\min_p \chi [\theta^I(p)] \geq \max_p \frac{3 - 1/z^I - 2p}{1/z^I - 1} = \frac{3z^I - 1}{1 - z^I}
\]

and

\[
\min_p \chi [\theta^R(p)] \geq \max_p \frac{2(1 - p)}{1/z^R - 1} = \frac{2z^R}{1 - z^R}
\]

So the function is concave for \( \chi(\theta) \geq \max \left[ \frac{3z^I - 1}{1 - z^I}, \frac{2z^R}{1 - z^R} \right] \). This means that the optimum is interior, and solves the first-order condition.

2. For \( p \in [p^R, p^I] \), the derivative is

\[
\frac{\text{d} \mathbb{E}_\theta[w(\theta, p, 0)]}{\text{d} p} = \pi [\theta^I(p)] \left( \frac{\text{d} \theta^I(p)}{\text{d} p} \right) \theta^I(p) (qV - k) - \int_{\theta^R(p)}^{\delta} (1 - \theta) [(1 - \delta) A^b + qV - k] \text{d}\Pi(\theta)
\]

And all results that we derived for the baseline model also apply. Thus, depending on whether the function is concave or convex, the optimum can be interior and solve the above first-order condition, or be at the boundaries of the choice set, in this case either \( p^R \) or \( p^I \).

C.3.1 Specialization, \( \pi(\theta) = \beta \theta^X \)

We adopt the same specialization as in the main text, and parametrize the distribution of the aggregate state to be of the form \( \pi(\theta) = \beta \theta^X \), where \( \beta \) is a normalizing constant that depends on \( \chi, \theta, \bar{\theta} \).
For $\chi = -3$, the FOC for $p \in [0,p^R]$ can be written as

$$(1/z^I - 1) (qV - k) + (1/z^R - 1) [(1 - \delta) A^g + (1/z^R - 1) \{(1 - \delta) A^b + qV - k\}] - (1 - \delta) A^b + qV - k \right\} \frac{(1/z^R - p)^2}{6 (1 - p)} (3 - 2/z^R)$$

Note that if the term in curly brackets is negative, the entire FOC is positive, and no optimum can exist in this interval. This happens when $z^R \leq \tilde{z} \leq \tilde{\theta}$. Both of these assumptions are satisfied for our baseline calibration. The optimum must then be in the $[p^R, p^I]$ interval. In this case, the FOC reads

$$\beta (1 - p)^{-2} (1/z^I - 1) (qV - k) - E (1 - \theta) [(1 - \delta) A^b + qV - k]$$

### C.4 Fiscal Policy

The analysis of fiscal policy is undertaken taking $(p, \theta)$ as given. We first look at fiscal policy separately, and then jointly.

#### C.4.1 Credit Guarantees

Credit guarantees are now offered only to the good pool, since the bad pool consists only of bad banks. This means that depositors/lenders know that if a bank in the good pool survives, then it invests with certainty (it can only survive with deposit guarantees - more coming next). As before, the government chooses to support a mass equally toox banks in the good pool. As before, the cost per bank supported in the good pool is given by

$$MC_\alpha = k - qV [z + q (1 - z)]$$

We look at fiscal policy in three different situations

1. $\theta \leq \theta^R (p)$, in which case the good pool suffers a run, and no credit guarantees are ever offered. Thus $\alpha = 0$.

2. $\theta \in [\theta^R (p), \theta^I (p)]$. In this case, the good pool suffers from adverse selection. Welfare is given by

$$g_0 \delta A^b + (g_1 - \alpha) [z A^g + (1 - z) \{(A^b + qV - k)\}] + \alpha [z A^g + (1 - z) A^b + qV - k] - \gamma \Psi^2$$

where

$$\Psi = \alpha MC_\alpha$$

Define

$$MB_\alpha = z (qV - k)$$

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and the FOC simply implies

\[ \alpha = \max \left\{ 0, \min \left\{ g_1, \frac{MB_0}{2\gamma MC_0} \right\} \right\} \]

note that both marginal benefit and marginal cost are functions of \((p, \theta)\) through \(z\).

3. \(\theta \geq \theta^l(p)\), in which case the bad pool suffers a run and the good pool is free from adverse selection, so \(\alpha = 0\).

### C.4.2 Deposit Guarantees

Deposit guarantees can be offered to either pool, since the bad pool always suffers a run, and the good pool may or may not suffer one. As before, let \(\beta_i\) denote the mass of banks supported in pool \(i = 0, 1\). We have that

\[
MC_0 \equiv (1 - q) (D - A^b) \\
MC_1 \equiv (1 - q) (D - A^b) (1 - z)
\]

So that it is cheaper to provide deposit guarantees to the good pool (since there are less bad banks in that pool).

1. If \(\theta < \theta^R(p)\), both pools suffer a run, and the government may activate deposit guarantees for both of them. Welfare is then

\[
(g_0 - \beta_0) \delta A^b + \beta_0 (A^b + qV - k) + (g_1 - \beta_1) \delta [zA^g + (1 - z) A^b] + \beta_1 [zA^g + (1 - z) (A^b + qV - k)] - \gamma \Psi^2
\]

where

\[ \Psi = \beta_0 MC_0 + \beta_1 MC_1 \]

Let

\[
MB_0 \equiv (1 - \delta) A^b + qV - k \\
MB_1 \equiv (1 - z) [(1 - \delta) A^b + qV - k] + z (1 - \delta) A^g
\]

then, the FOC are

\[
\beta_0 : MB_0 - 2\gamma \Psi MC_0 \leq 0 \\
\beta_1 : MB_1 - 2\gamma \Psi MC_1 \leq 0
\]

Note that we have that

\[
\frac{MB_0}{MC_0} = \frac{MB_1}{MC_1} \iff 0 \leq z (1 - \delta) A^g
\]

meaning that the government always chooses to exhaust support to the good pool before supporting the bad
pool. The optimal policy is then as follows: set

$$\beta_1 = \max \left\{ 0, \min \left\{ g_1, \frac{MB_1}{2\gamma MC_0^2} \right\} \right\}$$

If $\beta_1 < g_1$, set $\beta_0 = 0$. Otherwise, set

$$\beta_0 = \max \left\{ 0, \min \left\{ g_0, \frac{MB_0}{2\gamma MC_0^2} \left( MC_0 - g_1 \right) \right\} \right\}$$

2. If $\theta \geq \theta^R(p)$, support is extended to the bad pool only. In this case, welfare is

$$(g_0 - \beta_0) \delta A^b + \beta_0 (A^b + qV - k) + g_1 \left[ zA^g + (1 - z) (A^b + qV - k) + 1 \{ \theta \geq \theta^f(p) \} z (qV - k) \right] - \gamma \Psi^2$$

where

$$\Psi = \beta_0 MC_0$$

Implying that the optimal policy follows

$$\beta_0 = \max \left\{ 0, \min \left\{ g_0, \frac{MB_0}{2\gamma MC_0^2} \right\} \right\}$$

C.4.3 Both Policies

We now combine the two policies, and allow the government to offer credit and deposit guarantees at the same time. We consider the three different cases

1. If $\theta \geq \theta^f(p)$, the government sets $\alpha = \beta_1 = 0$, and $\beta_0$ is set as before.

2. If $\theta \in (\theta^R(p), \theta^f(p))$, the government sets $\beta_1 = 0$. The government now has to jointly set $\alpha, \beta_0$. Welfare is given by

$$(g_0 - \beta_0) \delta A^b + \beta_0 (A^b + qV - k) + (g_1 - \alpha) \left[ zA^g + (1 - z) (A^b + qV - k) \right] + \alpha \left[ zA^g + (1 - z) A^b + qV - k \right] - \gamma \Psi^2$$

where

$$\Psi = \beta_0 MC_0 + \alpha MC_0$$

The FOC, as before, is of the form

$$\beta_0 : \frac{MB_0}{MC_0} - 2\gamma \Psi \leq 0$$

$$\alpha : \frac{MB_0}{MC_0} - 2\gamma \Psi \leq 0$$

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So that the government fully exhausts the policy with the greatest marginal benefit-to-cost ratio before setting the other. The planner chooses to set the credit guarantee first if and only if

$$z \geq \frac{\left(1 - \delta \right) A^b + qV - k}{(1 - q) [(qV - k) (D - A^b) + qV ((1 - \delta) A^b + qV - k)]} \frac{z^f}{1 + \frac{MC_0 \cdot qV - k}{MC_0 \cdot q(1 - q)V}}$$

Or, if $z$ is high enough; note that $MB_0, MC_0$ are independent of $z$, and hence of $(p, \theta)$, thus this restriction is purely parametric. In this case, we have that the optimal policy follows

$$\alpha = \max \left\{ 0, \min \left\{ g_1, \frac{MB_0}{2MC_0^2} \right\} \right\}$$

and $\beta_0 = 0$ if $\alpha < g_1$. Otherwise,

$$\beta_0 = \max \left\{ 0, \min \left\{ g_0, \frac{MB_0}{2MC_0^2} - \frac{MC_0}{MC_0^2} g_1 \right\} \right\}$$

If the condition is not satisfied, $\beta_0$ is set first.

3. If $\theta \leq \theta^R(p)$, the analysis is more complex as then the government has to compare the cost-benefit ratios of setting $\beta_0, \beta_1, \alpha$ as all three policies are potentially active. Welfare is then

$$(g_0 - \beta_0) \delta A^k + \beta_0 (A^k + qV - k) + (g_1 - \beta_1) \delta \left[ z A^k + (1 - z) A^k \right] + \left( \beta_1 - \alpha \right) \left[ z A^k + (1 - z) \left( A^k + qV - k \right) \right] + \alpha \left[ z A^k + (1 - z) \right]$$

where

$$\psi = \alpha MC_1 + \beta_0 MC_0 + \beta_1 MC_1$$

Note that the problem is slightly more complex: while the planner still chooses the policy such that $\frac{MB_1}{MC_1^2} \geq \max_{j \in \mathbb{P}} \left\{ \frac{MB_1}{MC_1^2} \right\}$, it faces the constraint that $\alpha \leq \beta_1$. That is, credit guarantees can only be offered to the good pool if deposit guarantees are offered to prevent a run in the first place. We must therefore consider all possible cases separately. Note that $\beta_1$ always dominates $\beta_0$, as we have showed above.

(a) Consider first the case in which $\beta_1$ is the preferred policy. Then

$$\beta_1 = \max \left\{ 0, \min \left\{ g_1, \frac{MB_1}{2MC_1^2} \right\} \right\}$$

and the other policies are only set if $\beta_1 = g_1$. In that case, the planner proceeds to compare $\alpha, \beta_0$, following the previous decision rule. The sufficient condition for $\beta_1$ to be preferred over $\alpha$ is a quadratic on $z$.

(b) Consider now the case in which $\alpha$ is the preferred policy. Then, the planner will set $\beta_1 = \alpha$, since we
must have that \( \alpha \leq \beta_1 \). In this case, the optimal policy satisfies

\[
\alpha = \max \left\{ 0, \min \left\{ g_1, \frac{MB_\alpha}{2\gamma MC_\alpha (MC_\alpha + MC_1)} \right\} \right\}
\]

and \( \beta_1 = \alpha \). If \( \alpha < g_1 \), then \( \beta_0 = 0 \). Otherwise,

\[
\beta_0 = \max \left\{ 0, \min \left\{ g_0, \frac{MC_\beta}{2\gamma MC_\beta (MC_\alpha + MC_1)} \frac{(MC_\alpha + MC_1)}{MC_1} g_1 \right\} \right\}
\]

D Crisis Scenarios

We now analyze how the optimal disclosure policy changes in response to changes in the lower bound of the distribution of the aggregate state \( \psi (\theta) \), which we interpret as capturing the severity of a financial crisis. Recall from Figures 5 and 6 that \( \theta = z^R \) eliminates the outcome in which both categories suffer a run. We focus on downside risk by studying how the optimal disclosure policy changes when \( \theta < z^R \), and a system-wide run, outcome \((\mathcal{R}, \mathcal{R})\) becomes a possibility. Recall from the aforementioned diagrams that the likelihood of this crisis state (as measured by the size of the region for a fixed choice of \( p \), since the distribution of risk is uniform) decreases as signal precision \( p \) increases. The government can then eliminate the possibility of a systemic run by setting a high enough precision for the signal.

This change in the structure of the problem has the potential to considerably alter the government’s incentives: previously, no disclosure \( p = \frac{1}{2} \) was the “safe” option that ensured the predictable outcome of both classes simultaneously facing adverse selection but being saved from runs. Full disclosure, on the other hand, involved a risky bet: while the government was certain that banks with the good signal would be spared from runs and adverse selection, those with the bad signal faced a run, and the size of this run was variable and dependent on the realization of \( \theta \). This gamble now becomes more attractive: the formerly safe option of no disclosure is now very risky, since it maximizes the likelihood of the disaster outcome \((\mathcal{R}, \mathcal{R})\).

Figure 17 plots the optimal disclosure policy as a function of \( \theta \), for different levels of fiscal capacity. The blue solid line corresponds to the case where no fiscal policy is available (or \( \gamma \rightarrow \infty \)), while the red dashed line corresponds to high fiscal capacity, \( \gamma = 10 \), and the green dotted line to \( \gamma = 30 \). For the baseline parametrization, our results are robust to the possibility of disaster risk: the level of disclosure is monotonically increasing in fiscal capacity (decreasing in \( \gamma \)). Note, however, that the presence of disaster risk does create some incentives for disclosure: the planner with no fiscal capacity opts for a positive, albeit small, amount of disclosure. This is related to the fact described in the previous paragraph: no disclosure is no longer risk-free and may result in a system-wide run. By disclosing a small amount of information, the planner can reduce the probability of a full run taking place. This incentive is exacerbated when some fiscal capacity is available, as evidenced by the behavior of the green line. No disclosure is exactly optimal at \( \theta = z^R \) when fiscal capacity is limited, as this now ensures that no run will take
Figure 17: Optimal disclosure choice as a function of $\theta$, Baseline

This figure plots the optimal disclosure policy as a function of the lower bound of the distribution of $\theta$, $p(\theta)$. The blue solid line corresponds to the case with no fiscal policy, or low fiscal capacity $\gamma \to \infty$. The red dashed line corresponds to $\gamma = 10$, and the green dotted line to $\gamma = 30$.

As $\theta$ increases beyond $z^R$, the disclosure function for low fiscal capacity becomes increasing. In fact, the function becomes exactly linear with a slope equal to one: for this region, the only possible outcome for $p = 0.5$ is still $(L, L)$, but the planner can increase $p$ in order to put positive probability on the $(L, L)$ outcome without putting any positive probability on $(R, L)$. So no disclosure becomes strictly dominated by some disclosure.

When fiscal policy is available, the structure of the optimal policy can change considerably. The red dashed line corresponds to $\gamma = 10$, or ample fiscal capacity. In this case, the planner finds it optimal to disclose almost fully. Due to ample fiscal capacity, the government is always able to deal with any adverse scenario through fiscal interventions. As fiscal capacity becomes more limited, this is no longer the case: the green dotted line plots the optimal policy for $\gamma = 30$. While the government decides to disclose less, the level of information that is revealed still dominates that of a fiscally incapable government. For $\theta \geq z^R$, the behavior of the optimal policy obeys a logic that is similar to the one that prevails in the absence of policy: for this region: a full run becomes impossible, while less and less mass is placed on the $(R, L)$ outcome. By fully disclosing, the government needs only to activate one policy instrument: deposit guarantees for banks that receive the bad signal (and whose set coincides with that of bad banks, since the signal is perfect). This turns out to be cheaper than revealing less information and having to activate credit guarantee policies.

We now show that changes in our parametrization can, in some cases, reverse our main result in the case of disaster risk. Figure 18 plots the optimal choice of disclosure for different levels of $\theta$ for an alternative parameterization where we increase $A^g$, thus making runs on good banks costlier. Once again, the blue solid line corresponds
Figure 18: Optimal disclosure choice as a function of $\theta$, High $A^o$.

This figure plots the optimal disclosure policy as a function of the lower bound of the distribution of $\theta$, $p(\theta)$, for a higher value of $A^o$. The blue solid line corresponds to the case with no fiscal policy, or low fiscal capacity $\gamma \to \infty$. The red dashed line corresponds to $\gamma = 10$, and the green dotted line to $\gamma = 30$.

to the case where no fiscal policy is available (or $\gamma \to \infty$), while the dashed red line corresponds to $\gamma = 10$, and the dotted green line to $\gamma = 30$. For a certain level of $\theta$ onwards, the previous analysis applies. It is, however, interesting to note what happens when the probability of a disaster is very high (i.e., when $\theta$ is very low). With no fiscal policy, the government opts for full disclosure if the lower bound on the support of $\theta$ is low enough: for a very low value of $\theta$, the $(R, R)$ region is large and decreasing in $p$. Thus maximizing welfare is equivalent to minimizing the likelihood of this outcome, and setting $p = 1$, full disclosure, is optimal. As $\theta$ increases, however, the importance of this region becomes smaller, and the planner once again finds it optimal to choose lower disclosure.

The cost of gambling over the size of a certain run becomes greater than the cost of gambling between no run and a full run. In the case of ample fiscal capacity (red dashed line), the planner finds it optimal to disclose almost fully. In this case, the government is always able to deal with any adverse scenario through fiscal interventions. Yet, the fiscally able government discloses less than the government with no fiscal capacity at all, and the level of disclosure becomes non-monotonic in $\gamma$, as the green dotted line ($\gamma = 30$) illustrates. With some fiscal capacity, the government can have incentives not to fully disclose even if a disaster is very likely. For sufficiently low values of $\theta$, more fiscal capacity can then result in less disclosure: in the absence of any fiscal capacity, the government chooses to fully disclose to save all the (few) good banks in the economy. With limited fiscal capacity, the government can save some banks from runs, and this gives room for some bad banks to be saved from runs and receiving the good signal alongside good banks. Thus the fiscally able government can actually disclose less.
References


