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Dmitri V. Vinogradov

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Abstract

Banking regulators often practice forbearance and ambiguity in insolvency resolutions. The paper examines the effects of regulatory forbearance and ambiguity in a context of allocational efficiency. Bailouts, liquidations and their stochastic policy mix lead to suboptimal allocations if banks do not internalize insolvency costs. The policy of forbearance may make banks internalizing such costs and improves the efficiency of intermediation.

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Adress for Correspondence: AWI, University of Heidelberg, Grabengasse 14, 69117, Germany. Email: Dmitri.Vinogradov@awi.uni-heidelberg.de

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Bagehot (1873) insisted that there should exist a precise rule, which determines, under which conditions illiquid banks should be closed or not. Nonetheless, regulators do not pursue a strategy of commitment to either the liquidation or the bailout of failing banks. Bennett (2001) writes that an insolvent bank is more likely to continue to operate in developing economies or economies in transition: one half of local banking regulators in this group have allowed insolvent banks to operate, whereas 3 of the 14 deposit insurers in advanced economies have done so. In general, 35% of respondents (10 out of 28) did not deny the practice of allowing equity-insolvent depository institutions to operate for extended periods. Just one example in this connection is that during a 4 year period (1988-92) the FDIC allowed the insolvent First City Bancorporation (with 59 branches in USA) to operate through open bank assistance, and only in 1992 did the recurring losses of the bank led to its closure. Santomero and Hoffman (1998) also note that regulators often delay resolution actions in the hope of a turnaround.

A commitment to a prompt corrective action (PCA), which requires an immediate closure of an insolvent institution, creates limited liability of banks. Although the literature on limited liability in economics is relatively large (see, for example, the review by Noe and Smith, 1997), its applications to banking are scarce. The research focuses mostly on the ideas that limited liability can give the bankers incentives to take on too much risk (e.g. Gollier, Koehl and Rochet, 1996) and/or lead to the excessive interest rates if intermediation is competitive (e.g. Matutes and Vives, 2000). Other effects of limited liability as well as the question to what extent the principle of limited liability holds in practice, suffer a certain lack of attention.

Sinn (2003) defines unlimited liability as the case, in which "banks will always keep their promises", but adds that "unlimited liability is far from being realistic, given that no one can lose more than he has." In a static context, this is obvious. Indeed, consider for an instance a standard two-period setting. In the first period, a depositor decides whether to deposit with the bank or not, while the bank decides upon its investment portfolio. In the second period, two states of nature are possible: either the bank is solvent or not. If the bank is solvent, the depositor is repaid in full. If the bank is insolvent, the depositor can be repaid with no more than the value of the bank's portfolio. In this world, there is no place for unlimited liability, which supports the above idea of Sinn (2003).

Consider now a world with overlapping generations, where the bank can exist for many periods. In each period, a new generation of depositors decides upon depositing with the bank. Over a period, two states of nature are possible: either the bank is solvent or not. If the bank is solvent, old depositors are repaid in full. However, if the bank is insolvent, it can still be liquid due to the deposits acquired from the new generation of depositors. Old depositors can be repaid from these newly acquired funds. This would be the case of unlimited liability. The question is whether the insolvent bank is *allowed* to repay to the old depositors.

These two examples show that a PCA may have disatvantages compared to the forbearance, since the latter eliminates limited liability and some problems related to it. At the same time, it is unclear, whether a broader ambiguity in the regulator's policy may be advantageous. The term "constructive ambiguity" was made popular by Gerald Corrigan (1990) while he was the President of the New York Federal Reserve Bank. Enoch, Stella and Khamis (1997) summarize the key arguments for and against the ambiguity and formally define that constructive ambiguity is maintained with regards to how, when and whether the regulators will employ their safety nets. Applied to banks, this concerns the methods of the failure resolutions, the timing of the resolution, and the commitment to a certain rule. In this sense, regulatory forbearance may be seen as a part of the constructive ambiguity policy, which relates to the delays in insolvency resolutions. The current paper presents a simplified general equilibrium framework to analyze the equilibrium effects of ambiguity and forbearance in bank insolvency resolutions.

There are three major strands of the literature, to which the current paper relates. First, the paper addresses the issue of the efficiency of financial intermediation in linking creditors and borrowers and thus contributes to the research comparing financial systems. Benston and Smith (1976) show that in presence of transaction costs, which prevent the access of agents to financial markets, financial intermediaries can re-establish the link between creditors and borrowers. Diamond (1984) introduces the monitoring function of banks to demonstrate how the intermediated economy may achieve an optimal allocation of ressources. Dewatripont and Maskin (1995) examine the comparative allocational efficiencies of bank-based versus market based economies. Boot and Thakor (1997) study the question of financial system architecture and show that banking systems replace markets if the latter are informationally underdevelopped. Most of the studies imlicitly or explicitly assume proper banking regulation to assist the allocational efficiency of financial intermediation. The current paper uses the allocational efficiency approach to develop arguments for a better design of insolvency regulation in banking sector.

Second, the paper studies the effects of bailouts-liquidation policy of the banking regulator. On the one hand, it is argued that bailing out banks, like flat-rate deposit insurance, may lead to excessive risk taking by them (see e.g. Davies and McManus, 1991). On the other hand, fire sells may lead to a decrease in the bank's liquidation value (see e.g. James, 1991, and Schleifer and Vishny, 1992), which makes prompt liquidations suboptimal. Freixas (2000) employs a cost-benefit analysis to demonstrate that the optimal regulation should combine bailouts and liquidation in a stochastic way. Freixas, Parigi and Rochet (2000) and Rochet and Vives (2004) show that bailouts might be optimal since coordination failures may prevent illiquid but solvent banks from borrowing liquid funds in the market. However, this argument fails, if one considers closures of insolvent but liquid institutions, like those reported by Bennett (2001) as examples of delays in insolvency resolutions. The current paper considers the limited liability aspect of the bailout-liquidation policy and shows that the closure of such banks is not always optimal. Moreover, the stochastic liquidation rule à la Freixas (2000) only provides for an efficient allocation of funds in an intermediated economy, if banks internalize insolvency costs.

Finally, this paper contributes to the literature in political ambiguity and forbearance. Cukierman and Meltzer (1986) suggested one of the first models to encompass the ambiguity in monetary policy. Alesina and Cukierman (1990) study the role of ambiguity in electoral processes. The literature on constructive ambiguity in financial sector is scarce. Freixas (2000) and Shim (2005) argue in favor of a stochastic bailout rule. Kocherlakota and Shim (2006) find that the choice between forbearance and PCA depends crucially on the properties of the stochastic process governing the value of the collateral behind the defaulting credit. Kahl (2002) discusses forbearance with regards to firms in financial distress and shows that forbearance may be justified through the need of the firm's creditors to obtain better information about the firm's viability. All these papers study the optimality of closure policy from the point of view of the party, which is responsible for the closure. The decision-making of the institution in financial distress is seen as though the latter is aware of the probability of closure. Even if the distressed institution is not well informed, its decision-making is governed by a subjective probability distribution or beliefs with regards to the closure policy. In contrast to these studies, the current paper offers a framework, in which two groups of agents (depositors and bankers) face ambiguity. In this case, their beliefs must not be identical. The asymmetry in beliefs may drastically change the equilibrium outcome, making the equilibrium allocation of funds in the intermediated economy significantly different from that in the market economy. This supports the idea that the "constructive ambiguity" and forbearance should rather take a stochastic form with the regulator informing the public on the properties of the probability distribution chosen, than bias towards unpredictability and intransparency.

The paper proceeds as follows. Section I describes the macroeconomic environment, which is common for both market and intermediated economies. Section II presents the macroeconomic equilibrium in the market economy, which serves as the reference point for further analysis. Section III introduces financial intermediation into the model and discusses the stochastic bailout policy of the regulator. In Section IV the policy of forbearance is studied, and Section V presents an analysis of ambiguos closure policy. The paper concludes with a summary of results.

I. Macroeconomic Environment

Consider an economy with overlapping generations consisting of a continuum of agents who live for two periods. Generation t is born in the beginning of period t and is endowed with a unit amount of the consumption-investment good. This generation is young in period t, becomes old in the beginning of period $t+1$ and dies in the end of period $t+1$. In each period, one generation is born.

Each generation consists of potential entrepreneurs and of consumers. It is convenient to normalize the mass of each group of agents to unity. Entrepreneurs differ from consumers in that the former have access to a production technology Ψ, and the latter do not. The production technology is risky and has a constant state-contingent return to scale. In each period $t+1$, one of two states of nature $\mathbf{s}_{t+1}$, "H" or "L", is possible, and if k_t units of good are invested in period t, the production technology delivers $r^H k_t$ units of good in "H"-state of nature and $r^L k_t$ units of good in "L"-state of nature in period $t+1$:

$$\Psi\left(k_t, \mathbf{s}_{t+1}\right) = \begin{cases} r^H k_t & \text{if} \quad \mathbf{s}_{t+1} = H \\ r^L k_t & \text{if} \quad \mathbf{s}_{t+1} = L \end{cases} \tag{1}$$

The probability of "H"-state of nature is p and is constant over time. The state-contingent gross rates of return r^F and r^L, induced by the production technology are also constant over time.

The assumption of a constant return to scale is equivalent to a standard assumption of a risky asset yielding two different rates of return in two different states of nature. The introduction of entrepreneurs is only needed to provide more intuition on the funds channelling from creditors to borrowers.

Furthermore, there exists also a storage technology, which allows one to transfer funds from period t into period $t+1$, and yields a risk-free rate of return r^F, which is also constant over time. The risk-free storage technology is available to both entrepreneurs and consumers. It is assumed that

$$r^H > r^F > r^L \tag{2}$$

and

$$pr^H + (1-p)r^L > r^F \tag{3}$$

The first assumption guarantees that neither technology dominates another one *a priori*. The second assumption states that the production technology dominates the storage technology *in terms of expected values*. The existence of the storage (risk-free asset) combined with the risky rechnology ensures that the market is complete, as soon as both assets are available for trade. In a complete market, the equilibrium allocation of funds is Pareto-optimal and may serve as a reference point for a further comparison.

Finally, assume that all agents are risk-neutral and only care about their consumption when old. This reduces their decision-making to maximization of investment gains. The assumption of risk-neutrality is not crucial for the study of allocational efficiency. It is important that if consumers wish to compose a portfolio of risky and risk-free assets in the market economy, they should be able to have a portfolio with the same properties in the intermediated economy. So if the intermediated system is able to provide for an optimal allocation of funds, it should be able to do it for risk-neutral agents as well.

II. Market Economy

Assume there exists a market place in which potential entrepreneurs and consumers can negotiate at no costs. Entrepreneurs offer consumers an opportunity to share the usage of the production technology. Entrepreneurs charge consumers with a proportional fee $\gamma_t \geq 0$ for the access to the production technology. As a result, if a consumer delivers x_t units of the good to an entrepreneur, only $(1-\gamma_t)\,x_t$ units are invested on behalf of the consumer, while the rest of $\gamma_t x_t$ belongs to the entrepreneur.

Hence, each entrepreneur possesses a total of $m_t = 1 + \gamma_t x_t$ units of good for investment and has an opportunity to invest a share y_t of it into the risky production technology, and the share $(1-y_t)$ into the storage technology with no risk. The entrepreneurs maximize the profit they expect to obtain in period $t+1$:

$$\begin{aligned} E_{t+1} &= pr^H y_t\,(1+\gamma_t x_t) + (1-p)r^L y_t\,(1+\gamma_t x_t) \\ &\quad + r^F (1-y_t)\,(1+\gamma_t x_t) \end{aligned}$$

The decision-making of the entrepreneur depends on x_t as well as on y_t:

$$\begin{aligned} E_{t+1} \quad &\rightarrow \quad \max_{x_t, y_t} \\ \text{s.t.} \quad & \quad x_t \geq 0 \\ & \quad 0 \leq y_t \leq 1 \end{aligned} \tag{4}$$

The expected profit function is linear in both x_t and y_t. The solution of optimization problem

(4) is:

$$y_t^* = 1 \quad (5)$$

$$x_t^d \in \left\{ \begin{array}{ll} \{\infty\} & \text{if} \quad \gamma_t > 0 \\ [0;\infty) & \text{if} \quad \gamma_t = 0 \end{array} \right. \quad (6)$$

Here x_t^d denotes the demand of entrepreneurs for external funds, which depends on the fee γ_t. The aggregate demand for the external funds $X_t^d(\gamma_t) = \int_0^1 x_t^d(\gamma_t)\,di = x_t^d(\gamma_t)$ is also indefinite under any positive fee γ_t.[1]

Consumers decide upon the allocation of their unit endowment of funds in the following parts: x_t for the production technology, which is accessible thank to entrepreneurs, and $(1 - x_t)$ for the safe storage technology. Given the fee, γ_t, charged by entrepeneurs, the expected gains of consumers are

$$G_{t+1} = pr^H(1-\gamma_t)\,x_t + (1-p)r^L(1-\gamma_t)\,x_t + r^F(1-x_t)$$

and the corresponding opitmization problem is

$$G_{t+1} \rightarrow \max_{x_t} \quad (7)$$

$$\text{s.t.} \qquad 0 \leq x_t \leq 1$$

Obviously, the solution of the optimization problem is

$$x_t^s \in \left\{ \begin{array}{lll} \{0\} & \text{if} & \gamma_t > \frac{pr^H+(1-p)r^L-r^F}{pr^H+(1-p)r^L} \\ [0;1] & \text{if} & \gamma_t = \frac{pr^H+(1-p)r^L-r^F}{pr^H+(1-p)r^L} \\ \{1\} & \text{if} & \gamma_t < \frac{pr^H+(1-p)r^L-r^F}{pr^H+(1-p)r^L} \end{array} \right.$$

The total amount of funds supplied by all consumers to entrepreneurs is

$$X_t^s(\gamma_t) = \int_0^1 x_t^s(\gamma_t)\,di = x_t^s(\gamma_t)$$

Now we can find the temporary equilibrium in the market economy for any period t.

Definition 1 *Temporary equilibrium in period t is an allocation of funds X_t^* and the fee γ_t^* such that $X_t^* = X_t^d(\gamma_t^*) = X_t^s(\gamma_t^*)$*

It is easy to see that under a strictly positive fee γ_t the demand for external funds from

[1] Since all entrepreneurs are equal, I omit index i related to an individual entrepreneur everywhere in the text. The appearance of i in the integration only aims to show that we sum individial demands over all entrepreneurs.

entrepreneurs is infinitely high, but the supply of funds from consumers is limited to unity. The only possibility for the equilibrium is $\gamma_t^* = 0$, which means that entrepreneurs provide consumers with a free of charge access to the production technology. At the same time, the equilibrium allocation of funds is $X_t^* = 1$, which means that consumers invest their whole initial endowment in the risky technology. This equilibrium constellation does not depend on the index of period t, and persists over time.

In the following, I will introduce financial intermediation into the economy and concentrate on the deposit market equilibrium and the resulting allocation of funds in the risky technology. I will use the result above and assume henceforth that the access to the risky technology is free of charge. Since the demand for funds on the side of entrepreneurs is absolutely price-elastic, we will only need to study the supply of funds, or equilvalently the demand for the risky asset, to obtain the equilibrium allocation X_t^* of funds in the risky investment project.

III. Intermediated economy

Assume the market place described above does not exist, or the access to it induces high transaction costs for the agents.[2] This justifies the existence of financial intermediaries. Assume, financial intermediation is present in the model in the form of banks, which belong to producers in equal shares, and the property rights are transferred from generation to generation through bequests. Banks are operated by managers who constitute a negligeably small part of the population. The banking sector is assumed to be competitive and consisting of a continuum of banks distributed at the interval $[0, 1]$.

Assume there exists a regulatory authority which is responsible for bailouts or liquidation of banks. A bailout is performed through subsidization, and presumes paying out the debts of the bank to its depositors. If a bank is bailed out, its charter is continued for the next period. Liquidation means closure of an insolvent bank and transferring its liquidation value to the depositors

[2] A special example for such costs would be an asymmetry of information, such that an agent i does not know whether another agent j is entrepreneur or consumer, but can obtain this information at some costs. This would make finding a counterpart for a loan contract costly.

indemnifying the banks' debts.

If in period $t+1$ a bank is insolvent, the regulator may opt to bail it out. To do this, the regulator collects taxes from generation $t+1$ and subsidizes the bank so that the bank obtains enough funds to repay the depositors of generation t. Under this scheme, depositors of generation t do not internalize the costs of the bailout. In general, the regulator does not promise to save the banks unambiguously, but rather announces some probability of bailouts z.

A. *Sequence of Events*

Consider two subsequent periods $t-1$ and t. In period $t-1$, consumers of generation $t-1$ decide upon the composition of their investment portfolio: part a_{t-1} of their unit initial endowment is deposited with a bank, and part $(1-a_{t-1})$ is invested in the risk-free asset. Simultaneously, the bank decides upon the amount of deposits D_{t-1} it wishes to collect at interest rate r_t^D (this is the interest rate, which determines the repayment to the depositors in period t, this explains the time-index), and upon the optimal composition of its financial portfolio: share x_{t-1} of the collected deposits is invested in the risky production technology, and share $(1-x_{t-1})$ is invested in the risk-free asset.

The production takes place between periods $t-1$ and t according to (1). In the beginning of period t, the state of nature for this period is known to all agents.

If portfolio gains of the bank in period t are not below the total amount due to depositors of period $t-1$, the bank is solvent. The bank repays on deposits of period $t-1$ and pays any accruing dividends to its shareholders of generation $t-1$. The property rights are transferred from the generation $t-1$ to the generation t. Consumers of generation t make their decisions similarly to their predecessors in period $t-1$ as described above and deposit with the bank. Finally, the bank invests in the production technology, and the economy proceeds to period $t+1$.

If the portfolio gains of the bank in the period t are below the total amount to be repaid to the depositors of generation $t-1$, the bank is insolvent. An insolvency resolution takes place. If the bank is liquidated, the value of its portfolio is transferred to the depositors of generation $t-1$ in equal shares. In case of the liquidation of a bank, a new bank is immediately created to

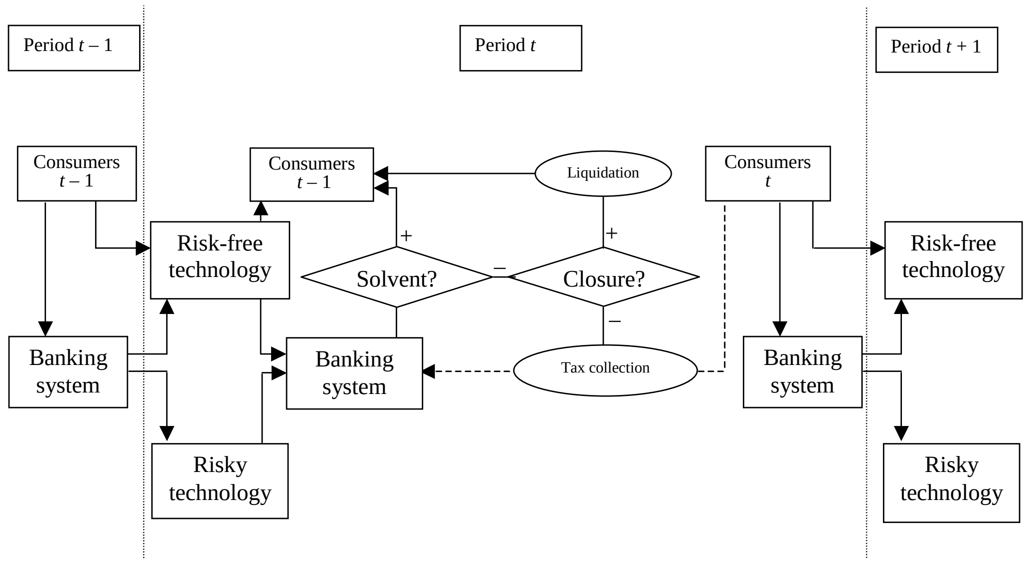

Figure 1. Sequence of events in intermediated economy

replace the liquidated one. The new bank belongs to the producers of generation t. Consumers of generation t repeat the decision-making of the preceeding generation. The bank invests and the economy proceeds to period $t + 1$.

If the insolvent bank is not liquidated, it is bailed out through a subsidy. The regulator collects taxes from generation t to subsidize the bank in period t. The bank repays to depositors of generation $t - 1$. Property rights are transferred to generation t, the decision-making takes place as above, the bank invests and the economy proceeds to period $t + 1$.

The sequence of events is presented in Figure 1. The rhombi in denote the nodes, in which the development of events can follow different scenarios. The first rhombus determines the first scenario (a solvent bank repays its depositors) and the way to the second and third scenarios (if the bank is insolvent). The second rhombus distinguishes between the second scenario (an insolvent bank is bailed out through a subsidy financed via taxes collected from the consumers of the new generation) and the third scenario (an insolvent bank is liquidated). If the bank is subsidized, the arrow leads back to the solvency-check rhombus. After the bank has obtained the subsidy, it is able to repay its depositors of generation $t - 1$, and, hence, is solvent. Further events develop as in the case of solvency: the property rights are transferred from the generation $t - 1$ to the generation t. If the bank is liquidated, its value is paid to the depositors of generation $t - 1$, and no property rights can be transferred to generation $t+1$. However, in the latter case, generation t establishes a new banking system so that in all three scenarios, there is again a banking system which belongs to generation t. The consumers of generation t deposit and invest in the risk-free technology. The banking system invests and the events repeat.

In Figure 1, the banking system in period t is split into two parts: first, into the banking system, which still belongs to the old generation (generation $t-1$), and secondly, into the banking system, which belongs to the new generation t. If the banking system is solvent, the rhombus "Solvent?" switches to "+", the deposits of generation $t-1$ are repaid, and members of generation $t-1$ transfer their property rights to generation t. As a result, the banking system now belongs to the generation t. If the banking system is insolvent, the rhombus "Solvent?" switches to "-", and the decision regarding closure is made. If the regulator decides to liquidate the banks, the rhombus "Closure?" switches to "+", and the consumers of generation $t-1$ obtain the portfolio value of the banks. Liquidation cancels the property rights so that generation $t-1$ cannot transfer any property rights to generation t. Generation t has to create a new banking system with which it deposits. Finally, if the regulator decides to bail the banks out, the rhombus "Closure?" switches to "-", and taxes are collected from generation t, which is shown with the respective dashed arrow. Note that this flow of funds is only possible if the rhombus "Closure?" is switched to "-". Otherwise, the oval "Tax collection" is not switched on, and the dashed arrow corresponding to the taxation and subsidization is interrupted. If the banks obtain the subsidy, the rhombus "Solvent?" is switched to "+" so that the flow of funds to the consumers of generation $t-1$ is now possible, and they obtain their deposits repaid in full. They can now transfer the property rights to generation t so that the same banking system belongs now to generation t.

We can define the state-contingent rate of return $\widetilde{r}_{t+1}^{\mathbf{s}_{t+1}}$ ($\mathbf{s}_{t+1} \in \{H, L\}$) as the rate of return, which the bank obtains in period $t+1$ on the investment made in period t in a financial portfolio with the share x_t invested into the risky technology and $(1-x_t)$ invested into the risk-free one:

$$\widetilde{r}_{t+1}^{\mathbf{s}_{t+1}} = \begin{cases} x_t r^H + (1-x_t)\, r^F & \text{if} \quad \mathbf{s}_{t+1} = H \\ x_t r^L + (1-x_t)\, r^F & \text{if} \quad \mathbf{s}_{t+1} = L \end{cases} \tag{8}$$

Remember, r^H and r^L are parameters and do not change over time.

A bank is solvent if $\widetilde{r}^{\mathbf{s}_{t+1}}_{t+1} > r^D$. If the banks in period $t+1$ are insolvent, the regulator can intervene and bail out the banks. If the bailout is performed (which probability is z), depositors receive their deposits in full with interest accrued. If, however, the bailout is not performed, the banks are liquidated and the repayments to depositors are determined by the value of banks' assets in period $t+1$. Depositors are informed about the values of p, z and the share of the risky asset in banks' portfolios x_t so that they can form expectations about future repayments on deposits, given the announced deposit rate r^D_{t+1}.

B. Supply of Deposits

Consumers of generation t maximize their expected gains from investing into the risk-free technology and into a deposit contract at the interest rate r^D_{t+1}. Their optimization problem is as follows

$$\begin{aligned} G_{t+1} \quad &\rightarrow \quad \max_{a_t} \\ \text{s.t.} \quad &\quad 0 \leq a_t \leq 1 \end{aligned} \tag{9}$$

with

$$\begin{aligned} G_{t+1} \;=\; & z a_t \left(1 + r^D_{t+1}\right) + p\,(1-z) \min\left\{a_t \left(1 + r^D_{t+1}\right); a_t \left(1 + \widetilde{r}^H_{t+1}\right)\right\} + \\ & (1-p)(1-z) \min\left\{a_t \left(1 + r^D_{t+1}\right); a_t \left(1 + \widetilde{r}^L_{t+1}\right)\right\} + (1-a_t)\left(1 + r^F\right) \end{aligned} \tag{10}$$

The first term in this function is the expected payoff to depositors if the regulator bails out the bank. The second and the third terms correspond to the case without bailouts.

Optimization problem (7) determines the optimal share a^*_t of deposits in the portfolio of consumers. Remember, the group of consumers has a unit mass and may be thought as being distributed on the interval $[0;1]$. Each consumer possesses a unit initial endowment. Total (aggregate) supply of deposits in the economy in the period t is then

$$D^s_t = \int_0^1 a^*_t di = a^*_t \tag{11}$$

Proposition 1 *If the regulator bails out banks with probability z, the aggregate deposit supply in* *the economy is given by the function*

$$D_t^s\left(r_{t+1}^D, x_t\right) = \begin{cases} 1 & \textit{if} \quad r_{t+1}^D \geq r^F + \frac{(1-p)(1-z)}{p+z(1-p)} x_t \left(r^F - r^L\right) \\ 0 & \textit{if} \quad r_{t+1}^D < r^F + \frac{(1-p)(1-z)}{p+z(1-p)} x_t \left(r^F - r^L\right) \end{cases} \tag{12}$$

To prove the proposition it suffices to substitue in (10) for $\widetilde{r}_{t+1}^{\mathbf{s}_{t+1}}$ from (8) and to solve optimzation problem (9). Doe to linearity of the objective function of depositors in a_t, the solution is straightforward. Equation (11) guarantees that the solution is the aggregate deposit supply function. The interest rate expression in (12) follows from the equality of the expected deposit rate of return to the risk-free one. For simplicity, it is assumed that if the two rates are equal, consumers still deposit the whole their endowment with the bank.[3]

C. Demand for deposits

Banks do not internalize the costs of bailouts, since it is the next generation, who is charged with taxes to subsidize the banks. This results in the limited liability of banks in each state of the nature. It should be noted that if a bank is insolvent and subsidized, its profit is zero. The objective function of each bank is:

$$\begin{aligned} \Pi_{t+1} &= p \max\left[\left(x_t r^H + (1-x_t) r^F - r_{t+1}^D\right) D_t; 0\right] + \\ &\quad + (1-p) \max\left[\left(x_t r^L + (1-x_t) r^F - r_{t+1}^D\right) D_t; 0\right] \end{aligned} \tag{13}$$

If the banking system is competitive, each individual bank is a price-taker and solves the following optimization problem:

$$\begin{aligned} \Pi_{t+1} &\rightarrow \max_{x_t, D_t} \\ \text{s.t.} \quad & 0 \leq x_t \leq 1 \\ & 0 \leq D_t \end{aligned} \tag{14}$$

The solution to this optimization problem determines the each competitive bank's demand for deposits and its portfolio composition. The optimal choice $\left(x_t^*, D_t^d\right)$ of each competitive bank

[3] This assumption may be justified through infinitesimal costs of access to the risk-free investment project.

in period t is given by:

$$D_t^*\left(r_{t+1}^D\right) \in \begin{cases} [0,\infty) & \text{if } r_{t+1}^D \geq r^H \\ \{\infty\} & \text{if } r_{t+1}^D < r^H \end{cases} \quad (15)$$

$$x_t^*\left(r_{t+1}^D\right) \in \begin{cases} [0;1] & \text{if } r_{t+1}^D \geq r^H \\ \{1\} & \text{if } r_{t+1}^D < r^H \end{cases} \quad (16)$$

As soon as deposit interest rate is below r^H, banks expect strictly positive profit from each unit invested in the risky asset. The reason for that is that under limited liability, the worst outcome for banks is zero, but the best one is given by the rate of return r^H, which appears with strictly positive probability p. The linearity of the objective function implies that the demand of banks for deposits is unlimited, and the share invested in the risky asset is 1. If, however, $r_{t+1}^D \geq r^H$ holds, then expected profit of banks is zero independetly of the decision of banks. Therefore, banks are indifferent with regards to the amount of deposits accumulated and to the composition of their portfolios.

D. Equilibrium

One can define temporary competitive equilibrium in a following way:

Definition 2 *Temporary competitive equilibrium in period t under parameters $\left(p; r^F;\ r^H; r^L\right)$ is the allocation-price tuple $\left(X_t^*, D_t^*, r_{c,t+1}^D\right)$, which provides*

1. $X_t^* = x_t^* D_t^d\left(r_{c,t+1}^D\right)$ *with* $(x_t^*; D_t^d) \in \arg\max \Pi_t^e$
2. $D_t^s(r_{c,t+1}^D; x_t^*) = a_t^* \in \arg\max G_t^e$
3. $D_t^* = D_t^d\left(r_{c,t+1}^D\right) = D_t^s\left(r_{c,t+1}^D; x_t^*\right)$

In the equilibrium in period t, the competitive interest rate on deposits $r_{c,t+1}^D$ is settled at the level, which equates demand $D_t^d\left(r_{c,t+1}^D\right)$ and supply $D_t^s\left(r_{c,t+1}^D; x_t^*\right)$ of deposits given the optimal decision of the banks with regard to their portfolio composition x_t^*. This determines the equilibrium investment in the risky technology X_t^*.

Proposition 2 *If the regulator commits to bail out banks with probability z, there exist multiple* *competitive equilibria in each period t given by:*

$$\begin{cases} X_t^* \in [0;1] \\ D_t^* = 1 \\ r_{c,t+1}^D \geq r^H \end{cases} \quad (17)$$

Under competition, limited liability of banks leads to excessive equilibrium interest rate. This justifies the general critique of the bailout policy as propagating moral hazard in banking. Though there is no explicit moral hazard in my model, it still demonstrates that competitive banks set the deposit interest rate higher than the expected rate of return from investment in the risky technology. A stochastic bailout rule fails to solve the problem of excessive interest rates, if there is no internalization of bailout costs by banks. Moreover, since banks have no incentives to invest all collected deposits into risky technology, the link between creditors (consumers) and borrowers (entrepreneurs) may be partially or completely broken in all equilibria with $X_t^* \in [0;1)$. The following section shows that regulatory forbearance may ensure internalization of bailout costs by banks and thus improve the allocational efficiency of the intermediated economy.

IV. Regulatory Forbearance

Regulatory forbearance is a delay in the liquidation of an insolvent bank. In contrast to bailouts, forbearance does not require the action of the regulator to be financed through the taxes or in some other way, as it is in the case of subsidization. If the regulator does not liquidate an insolvent bank, it is still possible that the bank obtains enough deposits from the new generation to repay the depositors of the previous one. One can see it as workout incentives of the future generations. This may require some guarantees from the regulator which would allow to avoid bank runs. Since banks would start the next period with losses, the total amount of funds in the economy will be lower than in the current period. The dynamics of equilibria may then be non-trivial. For the analysis of intertemporal effects in such a case see Allen and Gale (1997), Mavrotas and Vinogradov (2005) and Gersbach and Wenzelburger (2006). This paper, in contrast, focuses on the decision-making of current bankers and current depositors within current period, abstracting from intertemporal effects.

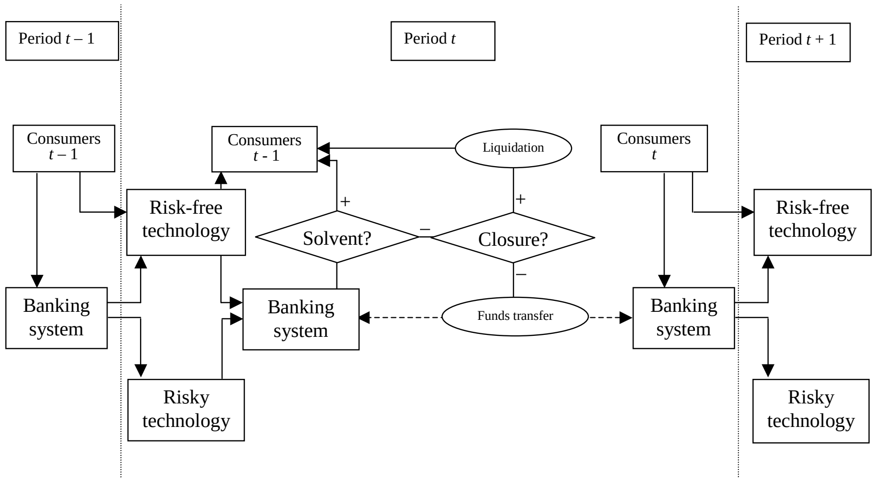

Figure 2. Sequence of events in the intermediated economy: regulatory forbearance

A. Sequence of Events

The sequence of events in case of forbearance is shown in Figure 2. The main difference between figures 1 and 2 is that the regulator does not decide whether to baioult or to liquidate, but rather decides whether to delay the liquidation in a hope for a turnaround. If the regulator forbears, a transfer of funds between the new generation and the old generation is possible through the banking system. Previously, such a transfer was only possible in the form of a subsidy financed through taxes from the young generation and paid to the banking system in order to enable it to repay the deposits to the old generation. Now these are the deposits of the young generation, which may be used by the banking system to repay the old depositors. In the timing of events, first, the new deposits are collected, and only then are the old depositors repaid. The intergenerational transfer of funds is shown by the dashed arrow between the banking system belonging to the new generation and the banking system belonging to the old generation in Figure 2. Note that if the rhombus "Closure?" is switched to "+", this transfer of funds is interrupted, since the oval "Funds transfer" is switched off. In this case, the banking system which belonged to generation $t-1$ is liquidated, no property rights are transferred to generation t, and the new banking system is created.

B. Supply of Deposits

The consumers of each generation are informed that the regulator can delay the bankruptcy procedure with probability z. For depositors this means that their bank continues its operations, and would repay deposits in full at the expense of the future generation. This results in the same deposit supply function as previously:

$$D_t^s\left(r_{t+1}^D, x_t\right) = \begin{cases} 1 & \text{if} \quad r_{t+1}^D \geq r^F + \frac{(1-p)(1-z)}{p+z(1-p)} x_t \left(r^F - r^L\right) \\ 0 & \text{if} \quad r_{t+1}^D < r^F + \frac{(1-p)(1-z)}{p+z(1-p)} x_t \left(r^F - r^L\right) \end{cases} \tag{18}$$

Note that now z denotes the probability of the regulatory forbearance.

C. *Demand for Deposits*

If an insolvent bank is not liquidated, the bank starts the next period with losses. This stresses the difference between insolvency and illiquidity: in the setting here, an insolvent bank may still be liquid due to workout incentives of the future generations. If, however, the bank is liquidated, then the limited liability holds. An important issue is whether the bank takes the future losses into account in its objective function. Formally, since the shareholders of the bank transfer the property rights after their deposits are repaid, they do not face losses. If the bank only maximized the profit of its current shareholders, it should again count on the limited liability and no internalization of bailout-liquidation costs occurs. However, the bank continues with the new generation of shareholders, which is worse off if the losses occur. If the management of the bank (which I refer to as "bankers") is concerned with the wealth of both generations of the shareholders, it should take the future losses into consideration when determining the optimal strategy of the bank.[4]

To summarize, in each period, the bank maximizes it's expected profit of the next period and internalizes the costs of bailout. The bailout is seen as a workout by the next generation of depositors, who provide the bank with the funds needed to cover the bank's obligations before the previous generation of depositors. The internalization implies that the principle of the limited liability is not valid for the bank, if the regulator forbears and lets the bank to continue its operations.

[4] This effect could become more clear if one considers long lived agents, who make myopic decisions. Then the "new generation" of shareholders is effectively the same group of shareholders as before. The usage of the term "generation" is then justified only with the necessity to distinguish between the decisions made by the same agents in different periods. In such a case, it would be obvious that the bank does not count on the limited liability in case of forbearance, since its losses obviously make its shareholders worse off. An alternative way could also be an inroduction of agents, who live over three periods. Then there always exists a part of the bank's shareholders, who suffer from losses, so that the bank has to internalize the losses. I prefer to stay within a single framework throughout the entire paper, and do not alter the model.

Therefore, if the bank is not closed, it may experience losses, which is a consequence of unlimited liability.

Now, the objective function of the bank in each period t takes into account the possibility of forbearance in the period $t+1$:

$$\begin{aligned} \Pi_{t+1} &= z\left[x_t\left(pr^H+(1-p)\,r^L\right)+(1-x_t)\,r^F-r^D_{t+1}\right]D_t+ \\ & (1-z)\,p\max\left[x_t r^H+(1-x_t)\,r^F-r^D_{t+1};0\right]D_t+ \\ & (1-z)\,(1-p)\max\left[\left(x_t r^L+(1-x_t)\,r^F-r^D_{t+1}\right);0\right]D_t \end{aligned} \tag{19}$$

Each competitive bank maximizes its objective function (19):

$$\begin{aligned} \Pi_{t+1} &\rightarrow \max_{x_t,D_t} \\ \text{s.t.} \quad & 0\leq x_t\leq 1 \\ & 0\leq D_t \end{aligned} \tag{20}$$

The solution of this optimization problem is given by:

$$x_t^* \in \begin{cases} [0;1] & \text{if} \quad r^D_{t+1}\geq \frac{1}{p+z(1-p)}\left(pr^H+z\,(1-p)\,r^L\right) \\ \{1\} & \text{if} \quad r^D_{t+1}< \frac{1}{p+z(1-p)}\left(pr^H+z\,(1-p)\,r^L\right) \end{cases} \tag{21}$$

$$D_t^d \in \begin{cases} \{0\} & \text{if} \quad r^D_{t+1}> \frac{1}{p+z(1-p)}\left(pr^H+z\,(1-p)\,r^L\right) \\ [0,\infty) & \text{if} \quad r^D_{t+1}= \frac{1}{p+z(1-p)}\left(pr^H+z\,(1-p)\,r^L\right) \\ \{\infty\} & \text{if} \quad r^D_{t+1}< \frac{1}{p+z(1-p)}\left(pr^H+z\,(1-p)\,r^L\right) \end{cases} \tag{22}$$

Comparing the bank's choice (21-22) with its choice under stochastic bailouts (16-15), one obtains that the internalization of costs induced by the forbearance policy of the regulator reflects in a more cautionary behavior of banks: banks only wish to acquire deposits at a lower interest rate than before.

D. Equilibrium

To determine the competitive equilibrium in period t in line with definition 2, we again need to satisfy the condition $D^d=D^s$. Since banks internalize now bailout costs, they operate under the assumption of unlimited liability, which eliminates excessively high interest rates and ensures the link between creditors and borrowers. The following proposition establishes this fact:

Proposition 3 *If the regulator pursues forbearance in period* $t+1$ *with probability* $z\in(0,1]$, *which is known to both bankers and depositors, the temporary competitive equilibrium in period t is:*

$$\begin{cases} X_t^* = 1 \\ D_t^* = 1 \\ r_{c,t+1}^D = \frac{1}{p+z(1-p)}\left(pr^H + z\left(1-p\right)r^L\right) \end{cases} \tag{23}$$

Note that as z approaches 0, this equilibrium is very similar to the competitive equilibrium under stochastic bailouts with no internalization of bailout costs by banks (limited liability). With $z \to 0$, the competitive equilibrium is unique and is characterized by the interest rate $r_c^D \to r^H$. The intuition behind this is that with even a very small probability of the bailout, the banks still (partially) internalize the costs of insolvency, and this prevents deposit interest rate from being excessively high. If $z = 0$, banks operate under limited liability, and the result (17) holds.

If $z = 1$, the competitive banking sector offers deposit interest rate exactly at the level of the expected rate of return of the risky asset. In the bailout case above this was impossible.

To summarize, regulatory forbearance may have a positive effect if the current generation of depositors believes in workout incentives of future generations, which ensure full repayment on the deposits. This positive effect has two dimensions: first, it is the allocational efficiency, and second, it is the prevention of excessively high interest rates in the competitive banking sector. It is important that under forbearance banks internalize insolvency costs, otherwise the effect disappears.

V. Constructive Ambiguity

Tha analysis above assumed that both depositors and banks are informed about the probability of liquidation $(1 - z)$. What would happen if this does not hold? If the regulator pursues an ambiguous policy, the true information about such probability distribution is not known to the agents. The decision-making under ambiguity is then based upon beliefs of the agents, which must not be symmetric even if they exhibit the same degree of pessimism/optimism. If we assume that both depositors and bankers are pessimistic, they should count for the worst possible outcome (see. e.g. Chateauneuf et al., 2006). The worst possible outcome for depositors takes place if the insolvent bank is liquidated immediately, which corresponds to the case $z = 0$. In this case depositors obtain only the liquidation value of the bank, i.e. the value of its portfolio. Substituting for $z = 0$ in (18) we obtain

$$D_t^s\left(r_{t+1}^D, x_t\right) = \begin{cases} 1 & \text{if} \quad r_{t+1}^D \geq r^F + \frac{(1-p)}{p} x_t \left(r^F - r^L\right) \\ 0 & \text{if} \quad r_{t+1}^D < r^F + \frac{(1-p)}{p} x_t \left(r^F - r^L\right) \end{cases} \tag{24}$$

The worst possible outcome for bankers is, however, the policy of forbearance, since in this case banks work under unlimited liability and may experience losses. If bankers count for $z = 1$, their otimal choice (21-22) turns to

$$x_t^* \in \begin{cases} [0;1] & \text{if} \quad r_{t+1}^D \geq pr^H + (1-p)\, r^L \\ \{1\} & \text{if} \quad r_{t+1}^D < pr^H + (1-p)\, r^L \end{cases} \tag{25}$$

$$D_t^d \in \begin{cases} \{0\} & \text{if} \quad r_{t+1}^D > pr^H + (1-p)\, r^L \\ [0,\infty) & \text{if} \quad r_{t+1}^D = pr^H + (1-p)\, r^L \\ \{\infty\} & \text{if} \quad r_{t+1}^D < pr^H + (1-p)\, r^L \end{cases} \tag{26}$$

The resulting equilbrium is straightforward:

Proposition 4 *If the regulator follows ambiguous bailout policy, and the beliefs of depositors and bankers with regards to forbearance are extremely asymmetric, the temporary competitive equilibrium in period t is:*

$$X_t^* = D_t^* = \begin{cases} 1 & \textit{if} \quad p^2 \geq \frac{r^F - r^L}{r^H - r^L} \\ 0 & \textit{if} \quad p^2 < \frac{r^F - r^L}{r^H - r^L} \end{cases} \tag{27}$$

$$r_{c,t+1}^D \in \begin{cases} \left\{pr^H + (1-p)\, r^L\right\} & \textit{if} \quad p^2 \geq \frac{r^F - r^L}{r^H - r^L} \\ \left[pr^H + (1-p)\, r^L; r^F + \frac{1-p}{p}\left(r^F - r^L\right)\right] & \textit{if} \quad p^2 < \frac{r^F - r^L}{r^H - r^L} \end{cases} \tag{28}$$

This proposition demonstrates that if the investment risk (as measured by $1 - p$) is high enough, the intermediated economy fails to link creditors and borrowers and experiences desintermediation. The reason for that is that both bankers and depositors are pessimistic and exhibit cautionary behavior. Depositors expect an insolvent bank to be liquidated and a higher deposit interest rate is needed to make the deposit supply positive. Bankers expect not to be closed, and face unlimited liability. Their desire to avoid losses leads to a lower deposit interest rate than the one acceptable for depositors. As a result, ambiguity in the regulatory policy may lead to an equilibrium allocation, which does not replicate the one attainable in the market economy. The proposition is illustrated in Figure **??**, which depicts demand and supply of deposits under both low and high investment risks.

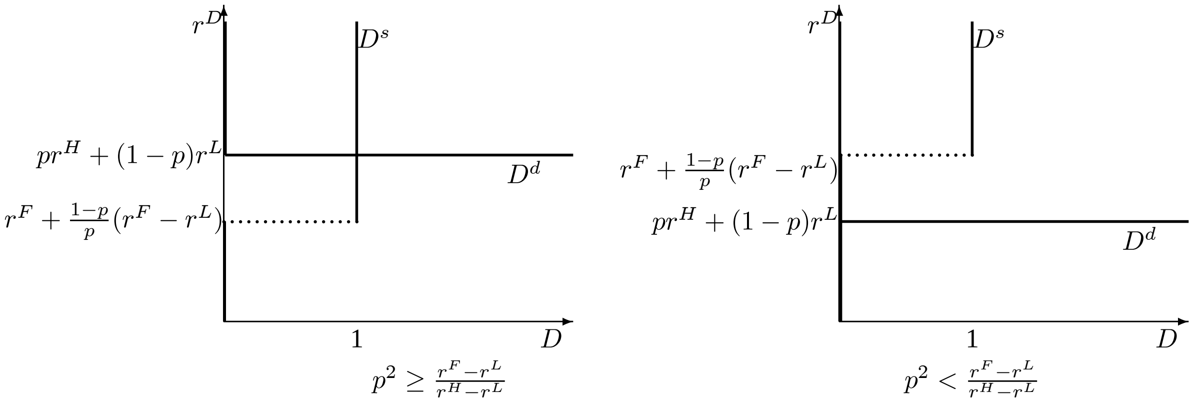

Figure 3. Equilibrium under ambiguity

In a dynamic setting, beliefs may be updated from period to period. One can expect that the updating process converges to some probabilistic rule, even if the regulator does not follow any. In this case, the asymmetry in beliefs can disappear, and both depositors and bankers would believe that liquidation will be performed with some probability $(1-z)$, which can be understood as the ratio of average number of liquidations to the average number of insolvencies per period over a sufficiently large number of periods.

However, if the probability of liquidation $(1-z)$ is known, it is not clear, what happens in "no liquidation" case. The analysis above shows that there is a difference between the case in which an insolvent bank is bailed out at the expense of future generations, or when it is allowed to continue in a hope of a turnaround (regulatory forbearance). In both cases, depositors are repaid in full, but the decision-making by banks is different, and it may again lead to allocational inefficiency if banks do not internalize the insolvency costs. This argument stresses that the policy of "constructive ambiguity" cannot be completely ambiguos and some signal to the public regarding the insolvency resolution procedure is desired.

Another issue is whether beliefs of bankers and depositors converge to the same probabilistic rule? If they follow the same updating process then the answer is "yes". However it is unclear whether the beliefs of depositors and bankers follow the same updating process. This is especially unclear if the signal from the regulator is observed by depositors and bankers differently. In such a case, we obtain asymmetry in beliefs combined with the asymmetry in information, and it is hard to imagine that there exists some updating rule which would help depositors to reveal the true information from the past observations.

So was Bagehot right after all, when he argued that banking regulators should follow a precise bailout-liquidation rule?[5] The answer to this question depends on the way one understands the "preciseness" of the bailout rule. Not only commitment to liquidation and commitment to bailouts, but also their stochastic combination may be harmful for the economy, if banks do not internalize the costs of insolvency. This could be an argument in favor of constructive ambiguity. At the same time, excessive ambiguity can also be harmful for the economy, since asymmetry in beliefs of the public can lead to disintermediation. Stochastic forbearance, instead, offers a possibility to create internalization of insolvency costs by banks, but does not lead to a cautionary behavior of depositors, so that disintermediation does not occur, and the system of financial intermediaries performs its role of channelling funds from creditors to borrowers.

VI. Summary

A stochastic (probabilistic) bailout rule does not necessarily lead to the internalization of insolvency costs by banks. An example of this is the case in which the bailouts are financed by future generations. In this case, intermediation may be inefficient. On the one hand, this stresses the need for a design of the bailout policy which would provide for the internalization of insolvency costs by banks. On the other hand, it is desirable that depositors do not internalize the costs of bailouts, otherwise they exhibit cautionary behaviour, which can again lead to inefficient intermediation or to disintermediation. Forbearance provides a convenient tool to make depositors less cautionary in their choice.

Uncertainty with respect to insolvency resolutions is one of the pillars of the constructive ambiguity. Another pillar is uncertainty in the timing of bailouts, which leads to the regulatory forbearance. Regulatory forbearance may help to achieve the efficiency of financial intermediation,

[5] "Was Bagehot right after all?" is the second title of the paper by Rochet and Vives (2004) and refers to Bagehot's (1873) suggestion that a bailout-liquidation policy of the regulator should follow a precise rule.

but only if depositors believe in intergenerational workout incentives, which ensure the inflow of deposits into the banking system in each period. Forbearance induces internalization of losses by banks, and intergenerational workout incentives eliminate internalization of bailout costs by current depositors. Under such conditions, uncertainty with regard to the timing of bailout may promote the allocational efficiency of financial intermediation.

If the regulator follows an ambiguous policy of insolvency resolutions, an asymmetry in beliefs of depositors and bankers may arise with respect to whether insolvent banks are liquidated or bailed out. If depositors believe insolvent banks to be liquidated, and the bankers believe them to be allowed to operate further, a situation may appear, in which the banking system provides a different allocation of resources in risky and riskless projects than the one in the market-based economy. An extreme case is disintermediation, when households do not deposit with banks but rather invest their whole endowment in the risk-free asset.

An important policy implication of the analysis in this paper is that the policy of "constructive ambiguity" should not be too ambiguous. It is important that both bankers and depositors receive an identical signal from the regulator, which would ensure their identical beliefs with regards to future insolvency resolutions. This does not imply that the regulator has to commit either to commitment or to liquidation, and still Bagehot (1873) was right: the certain rule, which the regulator should follow, is a stochastic combination of liquidation, bailouts and forbearance. If this rule is known to the public, this contributes to the allocational efficiency of the intermediated economy.

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