THE BANKING INDUSTRY AND THE SAFETY NET SUBSIDY*

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Abstract

Governments use monetary policies to counteract the effects of financial crises. In this paper we examine the subsidy that such "safety net" policies provide to the banking industry. Using a model of uncertainty-driven financial crises, we show that any monetary policy designed to maintain risky investment in the face of investor uncertainty (and thus promote economic growth and stability) will subsidize the banking industry. In addition, we show that the *mere presence* of a monetary authority willing to support a failing banking system in bad times subsidizes the banking industry, even if those bad times do not occur. A conditional bailout policy that does not extend equally to all financial institutions creates a greater subsidy for those institutions perceived as being "close" to the central bank, possibly giving these institutions a competitive advantage. Economic profits, in this model, are required to cover fixed costs of entry into the banking system. *Journal of Economic Literature* classification numbers: G2, E5, E44, D8.

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1 Introduction

In a companion paper [Lehnert and Passmore (1999)], we argued that *Knightian uncertainty*–that is, an imprecise estimate of the true probability distribution of events (especially of extreme events)–can cause a financial crisis with many of the hallmarks of the market turmoil of the fall of 1998. We showed that an expansionary monetary policy in the face of uncertainty improved social welfare, but that a combination of fiscal and monetary policies was required to recapture the first-best allocations. In this paper, we augment our model by relaxing the assumption of a competitive, zero-cost financial intermediary. In its place, we consider a banking industry made up of many firms, each of which must pay some fixed costs associated with intermediation. We model such a banking industry with a single firm. This "representative firm" realizes profits sufficient to cover the average fixed cost of entry. We then use this model to analyze the subsidy provided to the banking industry by the government's monetary policy, and how that subsidy is distributed across intermediaries and savers.

The typical analysis of the safety-net subsidy concentrates narrowly on the explicit government guarantee of insured deposits. Thus certain financial institutions are seen as privileged because they can raise funds from depositors at the riskless rate of return. Broader definitions of the safety-net includes access to payments systems and the discount window [see Whalen (1997)]. Beyond that, however, is the subsidy provided by the government's desire to avoid financial crises [see Kwast and Passmore (1999)]. Financial institutions generally suffer during financial crises (for example, during the fall 1998 market turmoil, the equity values of the New York money center banks fell precipitously), and governments generally implement monetary policies to assuage financial crises. Thus a monetary policy designed to undo the ill effects of a financial crisis has the additional effect of increasing profits at financial intermediaries.

This broader definition of a subsidy encompasses the use and distribution of public goods–where, in this paper, the public good is financial stability supported with a monetary policy. By analogy, consider the example of the government's purchase of streetlights for a dark street. Because such lights lower the odds of a car crash–and car crashes create costs that are potentially borne by everyone–everyone benefits. But those who drive cars benefit the most, whereas those who walk benefit least. Because tax payments are not tied to the benefit the taxpayer receives from the streetlights, those taxpayers who walk subsidize those taxpayers who drive. Similarly, here we argue that monetary policy, when used to offset the effects of a financial crisis, potentially benefits everyone but some–such as the banking industry–benefit more than others.

As in our companion paper, if the government must respond to an uncertainty led financial crisis with only a monetary policy (perhaps because fiscal policies are too difficult to adjust quickly), its best policy is to decrease the risk-free rate. This policy provides a direct subsidy to the banking industry, although it may or may not make up for the loss in profits caused by the financial crisis. We further show that such an *unconditional* policy may be interpreted as a *conditional* policy in which the government undertakes a monetary expansion only if a bad state is realized. The *mere presence* of a monetary authority thought to be following such a conditional policy provides a safety-net subsidy.

The paper is organized as follows. In section 2 we briefly analyze the investor's problem and in section 3 we analyze the bank's problem (see the companion paper for a more detailed analysis). We characterize the government's optimal unconditional monetary policy in section 4. In section 5 we consider how conditional monetary policies can subsidize intermediaries, and in section 6 we show how an explicit or implicit government guarantee policy—e.g. a “too big to fail” policy—can complement monetary policy. Section 7 concludes the paper.

2 A Model of Investors

Investors live for two periods, $t = 0, 1$ and are born with a single unit of the consumption good that they may either consume immediately or invest. They have preferences over consumption today and consumption tomorrow of:

$$U(C_0, C_1) = \phi(C_0) + C_1, \text{ where } \phi' > 0 \text{ and } \phi'' < 0. \tag{1}$$

For simplicity, assume that there are two states of nature Ω which will be realized in period $t = 1$: A good state $\overline{\omega}$, and bad state $\underline{\omega}$. The true probability of the good state is p. If we imagine this model to represent a single period in a dynamic setting (as we do in the companion paper) then the bad state is expected to occur only once every $1/(1-p)$ periods. If $p = 0.99$, for example, and a period is taken to be a year, then the bad state represents a once-per-century outcome.

There are two assets: A government bond, b, that pays a gross return r, and an uninsured deposit at the monopolist bank (which we take to represent the banking industry) x, that pays a gross return $R(\omega)$ in each state ω. The second asset represents the return to intermediated loans to risky borrowers, and hence we refer to it as the "risky" asset.

The portfolio choice of investors will be affected by *Knightian uncertainty*: investors will have an imprecise estimate of the probability distribution over states. In a series of axiomatic derivations, Gilboa (1987), Schmeidler (1989), and Gilboa and Schmeidler (1989) show that uncertainty-averse agents with imprecise probability estimates behave like pessimists, acting to maximize their minimum payoff in the "maxmin" form of the utility function. We follow the ϵ-contamination form of Liu (1999) and Epstein and Wang (1994), by describing investors as having a *non-unique set* of prior distributions over states $\mathcal{P}_\epsilon$:

$$\mathcal{P}_\epsilon \equiv \left\{ (1-\epsilon) \begin{pmatrix} p \\ 1-p \end{pmatrix} + \epsilon \begin{pmatrix} m \\ 1-m \end{pmatrix} : 0 \leq m \leq 1 \right\}. \tag{2}$$

This set of subjective probability distributions implies a set of estimates for the probability of the good state:

$$q(\overline{\omega}) = (1-\epsilon)p + \epsilon m,\ 0 \leq m \leq 1.$$

Thus the representative investor has many different subjective prior distributions over the two states, ranging from optimistic, when $m = 1$, to pessimistic, when $m = 0$. However, these distributions are centered on the true distribution $\{p, 1-p\}$. If ϵ is small, uncertainty is low and the distributions are tightly clustered around the true distribution. If ϵ is large, uncertainty is high and distributions are spread out.

Assume for now that the government bond pays a return of r in all states, so that it is truly riskless. Note that we can characterize the investor as choosing a level of total savings, S, and an amount of that savings to invest in the risky asset, $X \leq S$. The remaining $S - X$ is placed in government bonds. With this in mind, and using the "maxmin" form of expected utility, we can then write the representative investor's problem, contaminated by Knightian uncertainty, as:

$$\max_{S,X} \phi(1-S) + r(S-X) + \min_{\{q(\overline{\omega}),1-q(\overline{\omega})\}\in\mathcal{P}_\epsilon} \left\{ q(\overline{\omega})R(\overline{\omega})X + [1-q(\overline{\omega})]R(\underline{\omega})X \right\}.$$

The minimization embedded in the preferences arises from the axiom of uncertainty-aversion. Investors are pessimistic: they act to maximize their payoff assuming that the distribution is the worst one from their set of priors, $\mathcal{P}_\epsilon$. However, because the set of priors $\mathcal{P}_\epsilon$ is centered on the true distribution $\{p, 1-p\}$, it is not the case that investors believe that the bad state will occur with certainty. Pessimistic investors will assume that the bad state occurs with probability $(1-\epsilon)(1-p)+\epsilon$, which, for small values of ϵ, is not much larger than $1-p$.

Although we will defer a complete discussion of the banking industry we assume for now that banks will not pay a higher return in the bad state than in the good state, so $R(\overline{\omega}) \geq R(\underline{\omega})$. With this assumption in mind, the solution to the minimization problem in the investor's problem above is then the probability distribution in $\mathcal{P}_\epsilon$ that weights the bad state with highest probability. Thus we can write the representative investor's problem as:

$$\max_{S,X}\ \phi\,(1-S)+r(S-X)+(1-\epsilon)[pR(\overline{\omega})+(1-p)R(\underline{\omega})]X+\epsilon R(\underline{\omega})X.$$

Because investors are risk-neutral with respect to consumption in period $t = 1$, they hold both assets in positive quantities only if an uncertainty-adjusted rate of return equality condition holds:

$$(1-\epsilon)\overline{R}+\epsilon R(\underline{\omega})=r. \tag{3}$$

Here $\overline{R}$ denotes the *true* expected rate of return on risky assets, which is simply $pR(\overline{\omega})+(1-p)R(\underline{\omega})$. So the investor behaves as though he believes the true probability model, expecting $\overline{R}$ from the risky asset, holds with only $1-\epsilon$ probability. With the remaining ϵ probability, the investor believes that the bad outcome is assured. If the Knightian uncertainty contaminated rate of return equality relation (3) holds, the investor's problem may be written:

$$\max_{S}\ \phi(1-S)+rS.$$

The investor is indifferent to any division of total savings, $S(r)$, between the government bond and the risky asset when (3) holds. This implies a policy for total savings $S(r)$ that satisfies:

$$\phi'(1-S) = r. \tag{4}$$

Now relax the assumption that the government bond pays a return of r in all states, and assume instead that it pays state-contingent returns $r(\omega)$. The representative investor now chooses a level of total savings S, bank deposits X, and bond holdings $S-X$ to solve:

$$\begin{aligned}(5)\quad \max_{S,X}\ & \phi\,(1-S) \\ & + \min_{\{q(\overline{\omega}),1-q(\overline{\omega})\}\in\mathcal{P}_\epsilon} \Big\{ q(\overline{\omega})[r(\overline{\omega})(S-X) + R(\overline{\omega})X] \\ & \qquad + [1-q(\overline{\omega})][r(\underline{\omega})(S-X) + R(\underline{\omega})X] \Big\}.\end{aligned}$$

3 The Banking Industry's Problem

The total investment X made by the representative investor in the banking industry is completely intermediated to borrowers, who pay an aggregate gross return of $\rho(\omega, X)$ in each state ω. Define $\rho(X)$ to be the *true* expected aggregate gross repayment amount when total investment is X:

$$\rho(X) = p\cdot\rho(\overline{\omega}, X) + (1-p)\cdot\rho(\underline{\omega}, X).$$

These returns, which are paid back to the representative bank, satisfy:

$$\rho(\overline{\omega}, X) \geq \rho_0, \text{ all } X \geq 0, \text{ and}$$
$$\rho(\underline{\omega}, X) = \rho_0, \text{ all } X \geq 0.$$

Thus returns in the good state always (weakly) exceed returns in the bad state. Further, ρ represents an underlying technology that exhibits decreasing returns to investment and finite returns, so:

$$\frac{\partial \rho(\overline{\omega}, X)}{\partial X} < 0, \text{ and:}$$
$$\rho(\overline{\omega}, 0) = M, \ M < \infty.$$

Finally, to simplify the analysis, we will often assume that $\rho_0 = 0$, although no results of importance depend on this assumption. We take the good state to stand for normal times, including relatively bad times like recessions. The bad state stands for aggregate realizations that are well outside the range experienced even in conventionally bad times–in other words, a severe financial crisis or economic depression.

The representative bank pays a fixed cost to enter the intermediation industry, but has zero marginal costs of intermediation. If investors have deposited an amount X and the bank pays gross returns of $R(\overline{\omega})$ and $R(\underline{\omega})$, it has expected profits of:

$$X \left\{ p[\rho(\overline{\omega}, X) - R(\overline{\omega})] + (1-p)[\rho_0 - R(\underline{\omega})] \right\}. \tag{6}$$

Note that investment X depends on the returns paid by the bank, $R(\overline{\omega})$ and $R(\underline{\omega})$, because investors base their portfolio allocation decisions on these returns.

The banking industry's optimization problem is that of maximizing its expected profits (6), by choice of state-dependent returns $R(\omega)$, where investment X solves the general investor's problem (5). However, the solution to this problem is intimately tied up with the government's choice of bond returns, $r(\omega)$.

Because the banking industry and the representative investor work with different subjective probability distributions over states of nature (the investor acts like a pessimist because of uncertainty aversion), the banking industry finds it profitable to provide a completely riskless asset; that is, to set the returns in both states the same, $R(\overline{\omega}) = R(\underline{\omega}) = R_c$. The banking industry takes the government's choice of monetary policy, the risk-free interest rate r, as given. It can raise any amount of deposits X less than $S(r)$ so long as there is rate-of-return equality between (uninsured) bank deposits and the government bond: $R_c = r$. The banking industry's problem is thus:

$$\max_{X}\; pX\rho(\overline{\omega}, X) + (1-p)X\rho_0 - R_c X, \tag{7}$$

$$\text{subject to: } X \leq S(r) \text{ and } R_c = r.$$

Notice that in the bad state of the world the banking industry will make ex post profits of $X(\rho_0 - R_c)$ or $X(\rho_0 - r)$, which, for low values of ρ_0, will be negative.

Assuming that there is positive demand for government bonds in equilibrium, so $X \leq S(r)$, the solution to the banking industry's problem (7) is to raise deposits of $X^0(r)$:

$$X^0(r): \qquad \rho(\overline{\omega}, X^0) + X^0 \frac{\partial \rho(\overline{\omega}, X^0)}{\partial X} = \frac{r}{p} \tag{8}$$

(where we have assumed that $\rho_0 = 0$). The representative investor holds a portfolio with $X^0(r)$ held in bank deposits and the remainder $S(r) - X^0(r)$ held in the government bond, where the function $X^0(r)$ is implicitly defined by equation (8). From this analysis, a decrease in the risk-free rate r increases both the amount of investment, $X^0(r)$, and the banking industry's profits. The banking industry's problem is shown graphically in figure 1. The line marked MR(X) is the bank's marginal revenue from raising an extra unit of deposits and loaning them out. Because the bank can offer a deposit contract that pays a certain rate of return of $R_c = r$, investors' decisions are not affected by their uncertainty. Notice the importance of the assumption that $S(r) > X^0(r)$: the banking industry faces a perfectly elastic supply curve for funds.

We now relax the assumption that banks can earn negative profits in the bad state. Instead, we assume that output in the bad state is so low as to preclude any organization, even the government, from smoothing across aggregate realizations. As a result, banks will be unable to pay a return on deposits that is constant across all states. In the bad state, banks will be able to pay at most a return of ρ_0. Because the pessimistic investor puts undue weight on the bad state, the banking industry will find it optimal to pay as high a return as possible in that state, $R(\underline{\omega}) = \rho_0$, and thus realize zero profits in that state. As a result, Knightian uncertainty adjusted rate of return equality between the risky and the riskless asset [equation (3)] requires that, for investors to hold both deposits at the bank and government bonds, the return on deposits in the good state, $R(\overline{\omega})$, must satisfy:

(9) $$R(\overline{\omega}) = \frac{1}{1-\epsilon}\frac{r}{p}.$$

The banking industry must therefore pay a markup over the risk-free rate to attract investors. Here, because we are assuming that $R(\underline{\omega}) = \rho_0 = 0$, the markup is exactly $1/(1-\epsilon)$. Because the banking industry only realizes positive profits in the good state of the world, its problem (7) now becomes:

$$\max_X \; pX[\rho(\overline{\omega}, X) - R(\overline{\omega})], \text{ subject to: } X < S(r). \tag{10}$$

Here $R(\overline{\omega})$ is as defined in equation (9) above. The solution to this problem is a level of investment $X^\star$ that satisfies:

$$\begin{aligned} \rho(\overline{\omega}, X^\star) + X^\star \frac{\partial \rho(\overline{\omega}, X^\star)}{\partial X} &= R(\overline{\omega}), \text{ or, from (9):} \\ &= \frac{1}{1-\epsilon}\frac{r}{p}. \end{aligned} \tag{11}$$

This equation implicitly defines the amount invested as a function of the risk-free rate, $X^\star(r)$. The effect of uncertainty on the banking industry is displayed in figure 2. Notice immediately that when investors are uncertain, so that $\epsilon > 0$, the amount invested falls below the optimum: $X^\star(r) < X^0(r)$ for the same level of r. Also, notice that profits (the shaded area in each diagram) fall as uncertainty rises. In essence, uncertainty increases the cost of funds of banks. By lowering the risk-free rate, the government can force investors to reshuffle their portfolios to contain more of the risky asset. Such a policy will lower the cost of funds and result in increased profits to the banking industry.

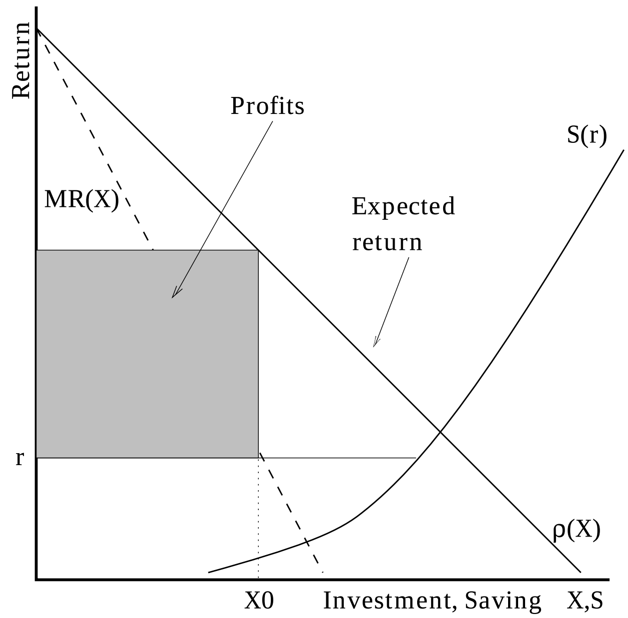

Figure 1: Banking industry's problem when there is no uncertainty.

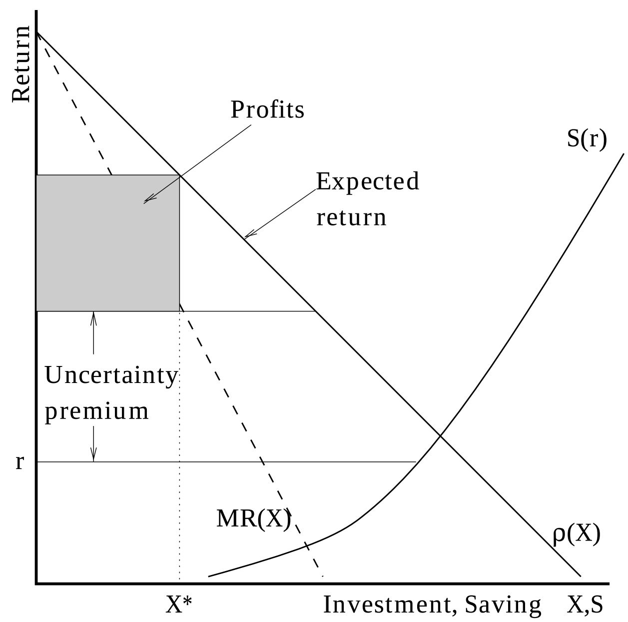

Figure 2: Banking industry's problem with an uncertainty premium.

4 Unconditional Government Monetary Policy

We assume that the government will act to maximize a social welfare function that sums the banking industry's profits and the investor's utility with equal weights, netting out the surplus-shifting effects of monetary policy. Changes in r change the surplus claimed by banks relative to that held by the investor, as well as changing the investor's optimal portfolio. It is this latter effect that affects total economy-wide surplus.

The government sells $S - X$ bonds in the first period and pays out a total of $r(S - X)$ in the second period. The government has a riskless storage technology that pays a unit return in all states. The government can then pay a greater or lower return than this “natural” rate on its bonds. If it pays a higher return, it must levy taxes to pay for the return on its bonds above the technologically-determined rate. If it pays a lower return, it realizes revenue, which we assume is refunded lump-sum. We refer to a policy of depressing the risk-free rate below the natural rate as an expansionary monetary policy.

The government can make lump-sum transfers (taxes if negative) of $H^1(\omega)$ in the second period. Thus the government's budget constraint is:

(12) $$(1 - r)(S - X) - H^1 \geq 0.$$

If the gross return on government bonds is less than unity, $r < 1$, then government realizes seigniorage revenue. By setting $H^1 = (1 - r)(S - X)$ it can lump-sum refund any such revenue.

Proposition 1 (Optimal Monetary Policy)

When there is no uncertainty, so $\epsilon = 0$, the optimal monetary policy will be to set the risk-free rate to unity: $r = 1$. When there is uncertainty, so $\epsilon > 0$, the optimal monetary policy will be to decrease the risk-free rate, so that $r < 1$. The optimal risk-free rate will be greater than $1 - \epsilon$. Such a policy will increase the total surplus divided between the investor and the bank industry, and will also directly increase the banking industry's profits.

Notice that proposition 1 merely states that an expansionary monetary policy increases aggregate social welfare. However, not all parties benefit equally, and some might even be made worse off (although the other parties then would all be made so much better off that they would be willing to transfer resources to those who were made worse off). Now we consider the question directly of whether or not savers are made directly better off by a monetary expansion.

Proposition 2 (Distribution of Benefits to Monetary Policy)

Savers will be made directly better off (that is, without requiring a lump-sum transfer of the banking industry's profits) by a monetary expansion, beginning from a neutral policy stance of $r = 1$, if and only if the elasticity of investment

$X^\star(r)$ *exceeds* $1/\epsilon$*:*

$$- \left. \frac{\partial X^\star(r)}{\partial r} \frac{r}{X^\star(r)} \right|_{r=1} \geq \frac{1}{\epsilon}.$$

Notice that monetary expansions are thus more likely to directly benefits savers at larger values of the uncertainty parameter ϵ*.*

Finally, we consider directly the expected profits of the banking industry as a whole *before* the uncertainty parameter has been realized.

Proposition 3 (Banking Industry Profits)

Consider two economies with identical distributions of the uncertainty parameter, $a(\epsilon)$*. In the first economy the government sets the risk-free rate to the technological rate of return to storage,* $r = 1$*, under all realizations of the uncertainty parameter. In the second economy, the government sets the risk-free rate only after observing the uncertainty parameter, following an interest-rate policy of* $r(\epsilon)$*. The policy satisfies* $1 - \epsilon \leq r(\epsilon) \leq 1$ *and also* $S(r(\epsilon)) \geq X^\star(r(\epsilon))$*, all* ϵ*. The banking industry will make greater expected profits in the second economy than in the first. Total expected social surplus will be greater in the second economy than in the first, although without lump-sum transfers between banks and savers, savers may be worse off.*

5 Conditional Monetary Policies

In proposition 1 above we established that an expansionary monetary policy increases the total surplus divided between the investor and the banking industry (modeled as a representative monopolist); furthermore, a monetary expansion directly increases the bank's profits. In this section we expand the range of possible monetary policies to include state contingent values for the return on bonds. Thus the government may, for example, commit to an expansion only in the bad state of the world. We show that this class of policies, if chosen correctly, will also be Pareto-improving. Therefore, the *mere presence* of a monetary authority with the right kind of state-contingent monetary policy will have all of the beneficial effects discussed in the previous section. However, unless the bad state is realized, the monetary authority will not move the risk-free rate away from unity. If the bad state is very unlikely, the monetary authority will almost certainly be, ex post, passive.

A contingent monetary policy is a choice of rates-of-return on the government bond in each state, $r(\omega)$. We consider only the class of policies in which the government sets the return on the government bond equal to unity in the good state, and to some lower rate in the bad state. That is, the government does nothing in the good state (since a return of unity is the technologically determined return on the storage technology), and engineers a monetary expansion in the bad state. We show that such a policy is equivalent (with an appropriate change of variables) to an unconditional policy of the type studied in the previous section.

Monetary policy (in the restricted class that we are studying here) boils down to a choice of rate of return on the government bond in the bad state: $r(\underline{\omega})$. The return in the good state is assumed to be unity: $r(\overline{\omega}) = 1$. Thus the investor's problem (5) becomes:

$$\text{(13)} \quad \max_{S,X} \ \phi\,(1-S) + \min_{\{q(\overline{\omega}),1-q(\overline{\omega})\}\in\mathcal{P}_\epsilon} \Big\{ q(\overline{\omega})[(S-X)+R(\overline{\omega})X] + [1-q(\overline{\omega})][r(\underline{\omega})(S-X)+H^1(\underline{\omega})] \Big\}.$$

Here, as before, we are assuming that $\rho_0 = 0$ and so $R(\underline{\omega}) = 0$, for simplicity. In the bad state the government will realize some seigniorage revenue, which is then refunded lump-sum to the investor via $H^1(\underline{\omega})$, determined by the government's budget constraint (12). In the good state, the government does not manipulate the return on bonds, so realizes no seigniorage revenue.

For both assets to be held in positive amounts, the banking industry must pay a return in the good state, $R(\overline{\omega})$, that satisfies a rate of return equation:

$$q^\star(\overline{\omega})R(\overline{\omega}) = q^\star(\overline{\omega}) + [1 - q^\star(\overline{\omega})]r(\underline{\omega}). \tag{14}$$

Here $q^\star(\overline{\omega})$ is the solution to the minimization problem in (13) above; it is the most pessimistic distribution in $\mathcal{P}_\epsilon$, given the agent's choices. As we saw above, the most pessimistic distribution in $\mathcal{P}_\epsilon$ is the one that weights that bad state the most, and the good state the least:

$$q^\star(\overline{\omega}) = (1 - \epsilon)p.$$

Compare condition (14) to (3), the rate-of-return equality condition when the government pursues an unconditional monetary policy. We will show that, within a feasible range, a conditional policy $r(\underline{\omega})$ is equivalent to an unconditional policy r. Let r_u denote an unconditional return on bonds that produces a desired equilibrium. The allocations associated with this desired equilibrium, $\{S(r_u), X^\star(r_u)\}$, may be mimicked by a conditional policy $r(\underline{\omega})$ that, in turn, leads banks to pay the same returns $\{R(\overline{\omega}), R(\underline{\omega})\}$. If we continue to assume, for simplicity, that $\rho_0 = 0$, and so $R(\underline{\omega}) = 0$, then, from equation (3):

$$R(\overline{\omega}) = \frac{r_u}{(1 - \epsilon)p}.$$

Given the conditional policy $r(\underline{\omega})$, from equation (14), we can calculate that:

$$R(\overline{\omega}) = 1 + \left(\frac{1}{q^\star(\overline{\omega})} - 1\right) r(\underline{\omega}).$$

The return on the risky asset (that is, uninsured deposits at the bank) in the good state, $R(\overline{\omega})$, is the same if the conditional monetary policy satisfies:

$$r(\underline{\omega}) = \frac{r_u - p(1-\epsilon)}{1 - p(1-\epsilon)}. \tag{15}$$

Because negative gross interest rates are not allowed, the smallest unconditional interest rate that may be mimicked is:

$$r_u = (1-\epsilon)p.$$

This is below the lowest possible optimal choice of the unconditional risk-free rate, $1-\epsilon$. (See proposition 1 above.) Thus the allocation associated with the optimal choice of unconditional monetary policy is always available with a conditional monetary policy of the kind we have outlined here.

Thus, in reacting to a level of uncertainty $\epsilon > 0$, the government may use either an unconditional monetary policy or a conditional monetary policy. From equation (15), it is clear that if the government chooses to use a conditional monetary policy, and the bad state is realized, the monetary expansion will be greater than if the government had chosen an unconditional monetary policy.

6 Implicit Government Guarantees of the Banking Industry

Governments often, either explicitly or implicitly, guarantee the safety and soundness of their national banking industries. Investors feel confident that certain classes of assets (e.g. deposits at banks) are backed by the government. Investors may also believe that certain ostensibly risky assets are also, in reality, backed by the government, e.g. equity in an institution considered to be "too big to fail" or "too embarrassing to fail." The degree to which any particular institution is thought to be protected, expressed as a probability of being bailed out in the bad state, will also affect its profitability. Institutions that are perceived as being more likely to be bailed out will pay a lower cost of funds than those perceived to be less likely to be bailed out. Finally, investors may believe that the government will undertake a wholesale support of many different types of risky assets if they are threatened by "systemic risk" or "contagion." Investors, in short, may trust that many classes of risky assets are implicitly protected by the government from aggregate shocks.

We can model such an implicit guarantee here by allowing the government to fund the banking industry directly if the bad state of nature is realized. The banking industry as a whole will continue to make zero profits in the bad state, but investors will realize more than the pure liquidation value of the institutions. The government raises seigniorage revenue with a monetary expansion in the bad state, and then instead of refunding this revenue lump-sum, it differentially rewards holders of the risky asset.

We shall, it turns out, be able to restrict our attention to a slight generalization of the class of conditional monetary policies considered in the previous section. As before, the government does not distort the rate-of-return to bonds away from unity in the good state, and engineers a monetary expansion only if the bad state is realized. Now however, the government will no longer refund the resulting seigniorage revenue lump-sum, but will use it to fund the banking industry's claimants directly.

Recall from the government's budget constraint (12), that its *total* seigniorage revenue from a monetary expansion, that is, setting a state-contingent rate of return on government bonds less than unity, in state ω is:

$$F(\omega) = [1 - r(\omega)](S - X).$$

Here S and X represent the representative household's choices of total savings and holdings of the risky asset. These choices will be affected by the conditional monetary policy that the government chooses. Assume that seigniorage revenue F is completely distributed, pro rata, to holders of the risky asset. Thus, in the bad state, the risky asset no longer earns zero, but rather:

$$
\begin{aligned}
R(\underline{\omega}) &= \frac{F(\underline{\omega})}{X}, \text{ or:} \\
&= \frac{[1 - r(\underline{\omega})](S - X)}{X}, \text{ if } S > X. \qquad (16)
\end{aligned}
$$

Assume that, as always, returns in the good state exceed returns in the bad state, so that $R(\overline{\omega}) = R(\underline{\omega})$, despite the government's implicit guarantee.

A monetary policy that combines monetary expansions with direct funding of the risky asset in bad times will act like a stronger monetary expansion without direct funding (that is, without an implicit guarantee). If the government chooses a policy of setting the return on bonds to $r^\star < 1$ in the bad state without a guarantee policy, it would be able to achieve the same results with a policy of setting the return on bonds to $r^{\star\star} > r^\star$ with a guarantee policy. To see this, note that the banking industry must pay a return in the good state of:

$$
q^\star R(\overline{\omega}) + (1 - q^\star)R(\underline{\omega}) = q^\star \cdot 1 + (1 - q^\star)r(\underline{\omega}), \qquad (17)
$$

$$
\text{where: } q^\star = (1 - \epsilon)p, \text{ and:}
$$

$$
R(\underline{\omega}) = \frac{[1 - r(\underline{\omega})](S - X)}{X}, \text{ if } S > X.
$$

As the guarantee amount $R(\underline{\omega})$ increases, the uncertainty premium that the banking industry has to pay falls. Compare the rate-of-return equation with the guarantee to the one without it, that is, equation (17) to equation (14). By providing a guarantee the government gets some extra portfolio bang for its monetary expansion buck.

Although an (implicit or explicit) guarantee policy will in general increase the expected profits of the banking industry, the banking industry will continue to fare very poorly in the bad state. Banks realize the extra profits only if the good state is realized. Next, note that in our analysis there are no moral hazard considerations to degrade the benefits of a government guarantee policy. Here, by funding the system in bad times at the expense of bond holders, the government causes investors to readjust their portfolios more sharply than with a pure monetary expansion. If investors had some costly monitoring duties, then such implicit guarantees would weaken their incentive to properly monitor financial institutions and, ultimately, borrowers.

Finally, consider an intermediary institution that financial markets expect will be bailed out in the bad state only with probability α. The greater α, the "closer" the institution is to the government. For example, a large money-center bank might be seen as a high-α institution, while a small finance company might be seen as a low-α institution. Consider a single institution, too small to individually affect the equilibrium levels of aggregate savings and investment S and X. This institution is assigned a bailout probability of α^i. Using the augmented rate-of-return equality condition, equation (17) above, we can determine what return the institution would have to promise, in the high state, in order to attract deposits, $R^i(\overline{\omega})$:

$$R^i(\overline{\omega}) = -\frac{1-q^\star}{q^\star} R(\underline{\omega})\alpha^i + \left[1 + \frac{1-q^\star}{q^\star} r(\underline{\omega})\right].$$

As in equation (17) above, $q^\star$ is the Knightian-uncertainty adjusted probability of the good state, and $R(\underline{\omega})$ is the return on the risky asset (uninsured bank deposits), assuming that the institution is bailed out. Otherwise, investors anticipate salvaging nothing from their investment in the bad state. Notice immediately that the return institutions must promise, $R^i(\overline{\omega})$, is decreasing in the probability of a bailout, α^i. However, all institutions, even those for whom markets estimate no probability of a bailout ($\alpha = 0$), benefit from the government's policy of decreasing the risk-free rate in bad times; that is, of specifying $r(\underline{\omega}) < 1$.

7 Conclusion

In this paper we augmented our model of uncertainty-driven financial crises to consider how optimal monetary responses would affect the profits of the banking industry. We concluded that optimal monetary policy responses to uncertainty-led financial crises, which are always expansions, increased expected profits in the banking industry. We further considered monetary policies that took the form of a conditional monetary expansion, in which the government reduces the rate paid on its bonds only in clearly bad economic times. We showed that policies of this kind can always recapture the allocations associated with unconditional monetary policies (although in the companion paper we show that only a fiscal policy can recapture the first-best allocations). Finally, we showed that monetary policies combined with an implicit guarantee were more effective at altering investors' portfolio choice than monetary policies alone (in which the seigniorage revenue was refunded lump sum to investors), and that financial intermediaries that are perceived by investors as "close" to the government–that is, more likely to be bailed out by the government in bad times–benefit more from monetary policy through a lower cost of funds. Such guarantee policies increase banking industry profits *ex ante*, and *ex post* if the good state is realized.

The government, in our paper, acts to maintain economic growth and stability by minimizing the number of worthwhile projects that are starved of capital. A monetary policy that maintains output in the face of uncertainty will, almost as a side-effect, subsidize the banking industry. Such a subsidy results in a lower cost of funds for banks, possibly giving them a competitive advantage over intermediaries that are viewed as less closely tied to government policy.

Appendix

Proof of Proposition 1

The government acts to maximize the social welfare function:

$$\max_{r} \; V(r) + \Pi(r), \text{ subject to: } S(r) \geq X^{\star}(r). \tag{A.1.1}$$

Here $V(r)$ is the investor's value function when the risk-free rate is r:

$$V(r) = \phi[1 - S(r)] + r[S(r) - X^{\star}(r)] + X^{\star}[pR(\overline{\omega}) + (1-p)R(\underline{\omega})] + H^1.$$

$S(r)$ is the investor's optimal savings policy. For the remainder of this section, assume that, in the bad state, there is no output, so that $\rho_0 = 0$. (This assumption merely simplifies the analysis.) Thus the bank's payments must satisfy:

$$R(\underline{\omega}) = 0, \text{ and: } R(\overline{\omega}) = r/[p(1-\epsilon)].$$

Recall from the government's budget constraint (12) that the lump-sum transfer H^1 is $H^1 = (1-r)(S - X)$, because $r = 1$ is the technologically-determined natural rate of return. Thus we can rewrite the investor's value function as:

$$V(r) = \phi[1 - S(r)] + S(r) - X^{\star}(r) + \frac{r}{1-\epsilon} X^{\star}(r). \tag{A.1.2}$$

The investor's optimal savings policy, from equation (4), implies that $\phi' = r$. The derivative of the investor's value function with respect to the monetary policy instrument, the risk-free rate r, is then:

$$\frac{dV(r)}{dr} = S'(\cdot)[1 - r] + \frac{X^{\star}}{1-\epsilon} + \frac{\partial X^{\star}(r)}{\partial r}\left[\frac{r}{1-\epsilon} - 1\right]. \tag{A.1.3}$$

Now consider the bank's profit function, assuming that $R(\underline{\omega}) = 0$ and $R(\overline{\omega}) = r/[p(1-\epsilon)]$:

$$\Pi(r) = \max_{X} \; p\rho(X)X - \frac{r}{1-\epsilon} X. \tag{A.1.4}$$

By the envelope theorem, this has slope:

$$\frac{d\Pi(r)}{dr} = -\frac{X^\star}{1-\epsilon}. \tag{A.1.5}$$

Summing together the slopes from (A.1.3) and (A.1.5) gives us the net change in total surplus from a change in the risk-free rate, assuming that the constraint in (A.1.1) does not bind:

$$\frac{d[V(r)+\Pi(r)]}{dr} = S'(r)(1-r) + \frac{\partial X^\star(r)}{\partial r}\left[\frac{r}{1-\epsilon} - 1\right]. \tag{A.1.6}$$

Notice first that if there is no uncertainty and if the risk-free rate is equal to unity, $\epsilon = 0$ and $r = 1$, then the derivative in (A.1.6) is zero. Thus the Pareto-optimal risk-free rate when there is no uncertainty is the technologically-determined return on storage, or just unity. In this model, there is no net gain to an activist monetary policy if the uncertainty parameter is zero.

Next, note that if there is uncertainty ($\epsilon > 0$) and the risk-free rate is equal to unity, that the derivative of the social welfare function (A.1.6) is negative. The constraint is not binding at $r = 1$ by assumption. So that a slight decrease in the risk-free rate from its natural level of $r = 1$ is always Pareto-improving. Decreasing the risk-free rate also decreases total savings

Note also that if $r < 1 - \epsilon$ then the unconstrained derivative (A.1.6) is positive. Thus even if the constraint that bond demand be non-negative is not binding, the optimal risk-free rate will lie in the range $[1-\epsilon, 1]$. Because the savings schedule $S(r)$ is upward-sloping, the constraint will require that the optimal constrained interest rate exceed the optimal unconstrained interest rate.

Decreasing the risk-free rate in the face of uncertainty increases the net surplus in the economy because investors will shift their portfolios away from the low-return safe asset (the government bond) and towards the high-expected-return risky asset (an uninsured deposit in the bank). This surplus is shared between the monopolist bank and the investors. The bank's profits increase by an amount:

$$-\frac{d\Pi(r)}{dr} = \frac{X^\star(r)}{1-\epsilon}.$$

The rest of the surplus is allocated to the investor. Thus bank profits increase as the result of an optimal monetary expansion. ■

Proof of Proposition 2

Using the results from the proof of proposition 1 above, notice that the slope of the representative saver's value function is:

$$\frac{dV(r)}{dr} = S'(\cdot)(1-r) + \frac{X^\star}{1-\epsilon} + \frac{\partial X^\star}{\partial r}\left[\frac{r}{1-\epsilon} - 1\right].$$

At $r = 1$ this becomes:

$$\left.\frac{dV(r)}{dr}\right|_{r=1,\epsilon>0} = \frac{X^\star}{1-\epsilon} + \frac{\partial X^\star}{\partial r}\left[\frac{1}{1-\epsilon} - 1\right].$$

This may be rewritten as:

$$\left.\frac{dV(r)}{dr}\right|_{r=1,\epsilon>0} = \frac{X^\star}{1-\epsilon}\left[1 + \epsilon\frac{\partial X^\star}{\partial r}\frac{1}{X^\star}\right].$$

For the saver to benefit directly from a *decrease* in the risk-free rate, this slope must be negative. This is the case if and only if:

$$-\left.\frac{\partial X^\star}{\partial r}\frac{1}{X^\star}\right|_{r=1} > \frac{1}{\epsilon}.$$

This is more likely to hold if ϵ is large. ■

Proof of Proposition 3

From proposition 1 above we know that, along each realization of the uncertainty parameter ϵ, the banking industry will make greater profits and the total social surplus will be greater if the government decreases the risk-free rate in the face of uncertainty. In particular, if the government does not alter the risk-free rate, it risks an uncertainty-led financial crisis. Proposition 2 delivers the distributional components of the proposition. ■

References

Epstein, L. G. and T. Wang (1994). Intertemporal asset pricing under Knightian uncertainty. *Econometrica 62*(2), 283–322.

Gilboa, I. (1987). Expected utility with purely subjective non-additive probabalities. *Journal of Mathematical Economics 16*(1), 65–88.

Gilboa, I. and D. Schmeidler (1989). Maxmin expected utility with non-unique prior. *Journal of Mathematical Economics 18*(2), 141–53.

Kwast, M. and W. Passmore (1999). The subsidy provided by the federal safety net: Theory and evidence. Manuscript, Board of Governors of the Federal Reserve System.

Lehnert, A. and W. Passmore (1999). Pricing systemic crises: Monetary and fiscal policy when savers are uncertain. Forthcoming, Finance and Economics Discussion Series, Board of Governors of the Federal Reserve System, Washington DC.

Liu, W. (1999). Heterogeneous agent economies with Knightian uncertainty. Manuscript, Department of Economics, University of Washington, Seattle.

Schmeidler, D. (1989). Subjective probability and expected utility without additivity. *Econometrica 57*(3), 571–587.

Whalen, G. (1997). The competitive implications of a safety-net subsidy. Economics Working Paper 97-9, Office of the Comptroller of the Currency.