Deposit Insurance without Commitment: Wall St. vs. Main St. *

Russell Cooper[†] and Hubert Kempf[‡]

September 19, 2010

Abstract

This paper studies the provision of deposit insurance **without** commitment. We ask whether a government has an *ex post* incentive to provide deposit insurance in the face of a bank-run. We find that deposit insurance will not be provided if it requires a (socially) undesirable redistribution of consumption or its financing through taxes is too costly. Else, the insurance gains to deposit insurance will be realized even without a government commitment to its provision.

1 Introduction

Within the framework of Diamond and Dybvig (1983), the implications of deposit insurance are well understood. If agents believe that deposit insurance will be provided, then bank runs, driven by beliefs, will not occur. In equilibrium, the government need not act: deposit insurance is never provided. Instead, deposit insurance works through its effects on beliefs, supported by the commitment of a government to its provision.

Yet, recent events during the financial crisis leads one to question this commitment of the government. In many countries, such as the US, the parameters of deposit insurance were adjusted during the crisis period. In other countries, such as UK, ambiguities about the deposit insurance program contributed to banking instability. In yet other countries, such as China, the exact nature of deposit insurance is not explicit. And, in Europe, the combination of a common currency, the commitment of the ECB not to bailout member governments and fiscal restrictions, casts some doubt upon the ability of individual countries to provide deposit insurance if needed.

Finally, in all of these instances, there is also the question of how broadly to define a bank and thus the financial arrangements deposit insurance (in some cases interpretable as an *ex post* bailout) might cover.

*Russell Cooper is grateful to the NSF for financial support. Comments from Todd Keister, Jonathan Willis and seminar participants at the Banque de France and the Federal Reserve Bank of Kansas City are appreciated.

†Economics Department, European University Institute, Florence, Italy and Department of Economics, University of Texas, Austin, russellcoop@gmail.com

‡Banque de France and Paris School of Economics, kempf@univ-paris1.fr

The bailout of AIG, for example, along with the choice not to bailout Lehman Brothers, makes clear that some form of deposit insurance is possible *ex post* for some, but not all, financial intermediaries.

These events highlight ambiguities about the provision and extent of deposit insurance. This motivates a study of deposit insurance without commitment to identify conditions under which this insurance will be provided. A finding that deposit insurance will be provided *ex post* provides a firmer basis for the benefits of this insurance. A finding that deposit insurance will not be provided *ex post* provides guidelines for policy design *ex ante* to change these *ex post* incentives.

There are two central building blocks for our analysis. First there is the standard argument about gains to deposit insurance, as in Diamond and Dybvig (1983). These are present in the *ex post* choice of providing deposit insurance since agents face the risk of obtaining a zero return on deposits in the event of a run.

Second, there are potential costs of redistribution across heterogeneous households that may not be desired. This depends on the social objective function. These costs of redistribution play a key role in the Cooper, Kempf, and Peled (2008) study of bailout of one region by others in a fiscal federation. That analysis highlights two motives for a bailout, the smoothing of consumption and the smoothing of distortionary taxes across regions.

Here, instead of regions, we have heterogeneous households. The central tradeoff we study is between the insurance gains of deposit insurance and the costs of the redistribution that may be entailed in the conduct of this policy. The redistribution arises both from the distribution of deposits across heterogeneous households and the tax obligations needed to finance deposit insurance. As long as the insurance gains dominate, deposit insurance will be provided *ex post* and there is no commitment problem. But, if the deposit insurance entails a redistribution from relatively poor households to richer households and the social welfare function places sufficient weight on poor households, then deposit insurance will not be provided.

In the bank runs literature following Diamond and Dybvig (1983), **?** studies the tradeoff between the incentive effects to take risky actions by banks relative to the stabilizing influence of a bailout for current depositors. Ennis and Keister (2009) also look at the *ex post* incentive for a bailout. Neither of those papers focus on the heterogeneity across households and thus the redistributive aspects of deposit insurance that is highlighted here.

Our presentation explores the trade-off between deposit insurance and redistribution. We begin with a planner's problem in which the central authority has a sufficiently rich set of tools to redistribute across agents independently of the provision of deposit insurance. In the event of a bank run, the central authority insurance provides a form of deposit *ex post.* We then turn to decentralized environments where the powers of redistribution are progressively limited so that a tradeoff emerges between redistribution and insurance. Put differently, the insurance gains from deposit insurance for Main Street must be weighted against the redistribution costs of supporting Wall St.

2 Planner's Problem

The model is a version of Diamond and Dybvig (1983) with heterogeneity across agents. We first study the optimal allocation as the solution of a planner's problem and then turn to a decentralized version of the model.

2.1 Environment

There are three periods, with $t = 0, 1, 2$. In periods 0 and 1, each household receives an endowment of the single good denoted $\alpha = (\alpha^0, \bar{\alpha})$. We index households by their period 0 endowment and refer to them as type α^0. Let $f(\alpha^0)$ be the pdf and $F(\alpha^0)$ the cdf of the period 0 endowment distribution.

Households consume in either period 1, an early consumer, or in period 2, a late consumer. The fraction of early consumers for **each** type of household is π.[1] The preferences of households are determined at the start of period 1, after any saving decision. The utility from period 0 consumption is represented by $u(c^0)$. Utility in periods 1 and 2 is given by $v(c^E)$ if the household is an early consumer and by $v(c^L)$ if the household is a late consumer. Both $u(\cdot)$ and $v(\cdot)$ are assumed to be strictly increasing and strictly concave.

There are two storage technologies available in the economy. There is a one period technology which generates a unit of the good in period $t+1$ from each unit stored in period t. Late households can store their period 1 endowment using this technology.

There is a two period technology which yields a return of $R > 1$ in period 2 for each unit stored in period 0. This technology is illiquid though and has a return of 0 if it is interrupted in period 1.[2]

2.2 Optimal Allocation

For the planner's problem, we assume that the household type is observable so that the contract is contingent on the household's endowment α^0. In contrast, the household's preferences are not assumed to be observed by the planner. So, though the contract is dependent upon realized household preferences, the allocation must be incentive compatible.

The planner chooses the type dependent functions $(d(\alpha^0), x^E(\alpha^0), x^L(\alpha^0))$ and the fraction of deposits to invest in the one period technology, ϕ, to maximize:

$$\int \omega(\alpha^0)[u(\alpha^0 - d(\alpha^0)) + \pi v(\bar{\alpha} + x^E(\alpha^0)) + (1-\pi)v(\bar{\alpha} + x^L(\alpha^0)]f(\alpha^0)d\alpha^0. \tag{1}$$

Here the period 0 consumption of the household is its endowment less a deposit, $\alpha^0 - d(\alpha^0)$. The period 1 consumption for an early consumer is the household's endowment plus its transfer under the contract,

[1] Here there are two important assumptions. First, π is independent of α^0 and second there is no aggregate uncertainty in π.

[2] As in Cooper and Ross (1998), there could be some period 1 liquidation value for this technology as well. If $\tau > 0$, then in the event of a run any investment in the illiquid technology will be liquidated in period 1. We assume that τ is sufficiently close to zero that we work with the analytically easier case of $\tau = 0$.

$\bar{\alpha} + x^E(\alpha^0)$. Likewise the period 2 consumption if the household is a late consumer is $\bar{\alpha} + x^L(\alpha^0)$. For late consumers, the endowment in period 1 is saved to period 2 using the one period technology.

The resource constraints for the planner are:

$$\phi D = \pi \int x^E(\alpha^0) f(\alpha^0) d\alpha^0 \tag{2}$$

and

$$(1-\phi)DR = (1-\pi) \int x^L(\alpha^0) f(\alpha^0) d\alpha^0. \tag{3}$$

Here ϕ is the fraction of the overall deposits put into the one-period technology and $d(\alpha^0)$ is the "deposit" of agent of type α^0. Total deposits are denoted $D = \int d(\alpha^0) f(\alpha^0) d\alpha^0$. In (1) the welfare weight of a type α^0 agent is $\omega(\alpha^0)$.

The first order condition with respect to $d(\alpha^0)$ for this problem is:

$$\omega(\alpha^0) u'(\alpha^0 - d(\alpha^0)) = \lambda \tag{4}$$

for all α^0 where λ is the multiplier on (2). This condition implies that the marginal utility of period 0 consumption, weighted by $\omega(\alpha^0)$, is equal across households. Difference between the consumption allocation and endowment distribution in period 0 reflects redistribution through the tax system across heterogeneous agents.

The other first order conditions are:

$$v'(\bar{\alpha} + x^E(\alpha^0)) = Rv'(\bar{\alpha} + x^L(\alpha^0)) \tag{5}$$

and

$$v'(\bar{\alpha} + x^E(\alpha^0)) = u'(\alpha^0 - d(\alpha^0)). \tag{6}$$

Condition (5) stipulates optimal insurance across being an early and a late consumer. The final condition ties down the intertemporal dimension of the consumption profile. Further, from (5), $x^E(\alpha^0) < x^L(\alpha^0)$ and thus $c^E(\alpha^0) < c^L(\alpha^0)$ as $R > 1$.

As a special case, suppose the weights are independent of the household endowment, i.e. $\omega(\alpha^0) = \bar{\omega}$. Then these conditions imply that the consumption levels of all agents were independent of α^0: there would be complete redistribution along with optimal risk sharing.

2.3 Runs and Deposit Insurance

Though this is the planner's problem, there is still the possibility of "runs". Since we do not assume that planner observes the tastes of each household, we implement this allocation through a direct mechanism in which households announce their taste types to the planner.

One equilibrium is truth-telling which implements the above allocations. Since $c^L(\alpha^0) > c^E(\alpha^0)$, late households have no incentive to claim to be early households as long as all others tell the truth.

But there is the possibility that each household would announce their taste to be "early" consumer, given that others are doing the same. If so, this is akin to a bank run. In the spirit of sequential service, households would line up to obtain their promised allocation of $x^E(\alpha^0)$. Those near the front of the line would be served, others would not.

In fact, with $\pi < 1$ and $\tau = 0$, there is always a bank run equilibrium. To see this, note that (2) implies $\phi D < \int x^E(\alpha^0) f(\alpha^0) d\alpha^0$. The left side is the total amount of resources available to the economy while the right side, which is larger, is the total demands for consumption in period 1 if all agents announce they are early consumers. Since there are not enough resources to meet the demands of the households, each would strictly prefer to announce they are early consumers rather than late consumers in order to have a positive probability of obtaining positive consumption.

Let ζ be the probability that a household is able to withdraw $x^E(\alpha^0)$ from the intermediation process. We assume ζ is not dependent on the household type. Since the total resources in the event of a run are ϕD, then $\zeta = \frac{\phi D}{\int x^E(\alpha^0) f(\alpha^0) d\alpha^0}$. The expected utility of a type α^0 household during a bank run is

$$\zeta v(c^E(\alpha^0)) + (1 - \zeta) v(\bar{\alpha}). \tag{7}$$

Thus sequential service implies that agents face consumption risk in a bank run with promised consumption of $c^E(\alpha^0)$ going to those served while the others consume their endowment.

In the event of a run, the planner redistributes the available resources, ϕD, to households. Let $\tilde{x}(\alpha^0)$ denote the resources transferred to household of type α^0.

Proposition 1 *Given a bank run, the planner has an incentive to reallocation consumption relative to the outcome under sequential service.*

Proof. The planner chooses the transfers, $\tilde{x}(\alpha^0)$, to maximize:

$$\int \omega(\alpha^0)[v(\bar{\alpha} + \tilde{x}(\alpha^0))] f(\alpha^0) d\alpha^0. \tag{8}$$

The resource constraint is:

$$\int \tilde{x}(\alpha^0) f(\alpha^0) d\alpha^0 = \phi D. \tag{9}$$

The first-order condition implies that

$$\omega(\alpha^0) v'(\bar{\alpha} + \tilde{x}(\alpha^0)) = \kappa \tag{10}$$

for all α^0.

Under sequential service, agents would face a probability of not being served. Some agents would receive their promised $x^E(\alpha^0)$ while others would receive nothing. Clearly this allocation, summarized by (7) is feasible for the planner *ex post* but does not satisfy (10). ■

The key here is not this allocation *per se* but rather that the planner will intervene to reallocate resources in the event of a run. Under this policy, the planner is able to intervene during a bank run, taking all of the resources available and redistribute them. This is similar to a type of intervention termed a "haircut" since all of the shareholders take a reduction in their claim on the intermediary. This is a way to spread the risk of sequential service.

As in the arguments of Wallace (1988), the government is not constrained by the same sequential service structure as is present in the underlying relationship between households and the intermediaries. That is, in (9), the planner had access to all the resources of the bank to allocate among all agents.

Instead of looking at a complete reallocation of banking resources after a run, we can ask if the planner would have an incentive to provide deposit insurance so that each agent received the promised allocation of $x^E(\alpha^0)$. Deposit insurance is less general than the redistribution in (8) as it entails full restoration of deposits, financed by some tax system. To do so, the planner would have to tax the period 1 endowment of the agents to generate enough resources to provide $x^E(\alpha^0)$ to all agents. Note that since the run is not anticipated at the time the allocation is chosen, the tax system used to finance deposit insurance is not part of the *ex ante* optimal arrangement.[3] Letting $T(\alpha^0)$ be the tax on a type α^0 household, the constraint that taxes must cover the difference between the promised allocation and the available resources is

$$\int T(\alpha^0)f(\alpha^0)d\alpha^0 = \int x^E(\alpha^0)f(\alpha^0)d\alpha^0 - \phi D. \tag{11}$$

The difference between expected utility with deposit insurance, Δ, and one with runs is given by

$$\Delta \equiv \int \omega(\alpha^0)v(c^E(\alpha^0) - T(\alpha^0))f(\alpha^0)d\alpha^0 - \int \omega(\alpha^0)[\zeta v(c^E(\alpha^0)) + (1-\zeta)v(\bar{\alpha})]f(\alpha^0)d\alpha^0. \tag{12}$$

With this structure, there are conditions under which the planner will provide deposit insurance *ex post*. These propositions are useful in understanding why deposit insurance may not be provided in the decentralized banking case that follows.

Proposition 2 *If $\omega(\alpha^0) = \bar{\omega}$ and $T(\alpha^0) = \bar{T}$ for all α^0, then deposit insurance will be provided ex post.*

Proof. When welfare weights are equal across households, the first-order conditions for the planner imply that consumption allocations are equal as well: $(c^0(\alpha^0), c^E(\alpha^0), c^L(\alpha^0)) = (c^0, c^E, c^L)$ for all α^0. Using this equalization of consumptions along with the lump-sum tax, $\Delta \geq 0$ if and only if

$$v(c^E - \bar{T}) \geq \zeta v(c^E) + (1-\zeta)v(\bar{\alpha}). \tag{13}$$

From (11), $\bar{T} = x^E - \phi D = x^E(1-\zeta)$, using the definition of ζ. If c^E is independent of α^0, so is x^E. The comparison of utility becomes

$$v(c^E - x^E(1-\zeta)) = v(\zeta x^E + \bar{\alpha}) \geq \zeta v(c^E) + (1-\zeta)v(\bar{\alpha}). \tag{14}$$

[3] See Cooper and Ross (1998) for a model in which the prospect of bank runs are understood *ex ante*.

The inequality is implied by the strict concavity of $v(\cdot)$. Hence deposit insurance is welfare enhancing *ex post.* ■

In this case, the equality of the welfare weight implies equality of consumption across households. The lump sum taxes used to finance the DI maintain the distribution of claims net of taxes. Thus deposit insurance provides an insurance gain without any redistribution *ex post.*

Proposition 3 *If deposit insurance can be designed for each household type separately, then deposit insurance will be provided ex post.*

Proof. In this case, we show that $\Delta > 0$ by arguing that there are gains to deposit insurance for each type. There are, by assumption, no interactions across the groups so no costs to redistribution. Thus we show

$$v(c^E(\alpha^0) - T(\alpha^0)) > \zeta_{\alpha^0} v(c^E(\alpha^0)) + (1 - \zeta_{\alpha^0}) v(\bar{\alpha})$$

for each α^0. If there are no interactions across groups, the deposit insurance for each type of household must be financed by a tax on those households alone, $T(\alpha^0) = x^E(\alpha^0)(1 - \zeta_{\alpha^0})$. Inserting this tax, we have

$$v(c^E(\alpha^0) - x^E(\alpha^0)(1 - \zeta_{\alpha^0})) = v(\zeta_{\alpha^0} x^E(\alpha^0) + \bar{\alpha}) > \zeta_{\alpha^0} v(c^E(\alpha^0)) + (1 - \zeta_{\alpha^0}) v(\bar{\alpha})$$

The inequality comes from the strict concavity of $v(\cdot)$. Since this holds for all α^0 types, $\Delta > 0$. ■

Once again, with these policies, the planner is able to provide insurance without any redistribution. Here that is possible because of the type specific insurance scheme.

3 Decentralization

Instead of the optimal allocation from the planner's perspective, we can also study the decentralized allocation through bank contracts. This approach has a couple of advantages. First it allows us to focus on government provision of deposit insurance and the related taxation of period 1 endowments independent of period 0 redistribution. This allows us to gain some insights into the tradeoff between redistribution and insurance. Second, we are able to use this structure to look at runs at a subset of banks.

Suppose there are competitive banks offering contracts to households. Through this competition, the equilibrium outcome will maximize household utility subject to a zero expected profit constraint. Since household types are observable, the contracts will be dependent on α^0.[4]

For now, as in Diamond and Dybvig (1983), assume that neither the bank nor its customers places positive probability on a bank run. We study the possibility of runs given this optimal contract.

[4]Later we explore a case with restricted contracts in which private information makes this dependence infeasible.

3.1 Household Optimization

Given a contract stipulating a return on deposits in the two periods, $(r^1(\alpha^0), r^2(\alpha^0))$, the type α^0 household solves:

$$max_d u(\alpha^0 - d) + \pi v(\bar{\alpha} + r^1(\alpha^0)d) + (1-\pi)v(\bar{\alpha} + r^2(\alpha^0)d) \tag{15}$$

The first-order condition for the household is

$$u'(\alpha^0 - d) = \pi r^1(\alpha^0)v'(\bar{\alpha} + r^1(\alpha^0)d) + (1-\pi)r^2(\alpha^0)v'(\bar{\alpha} + r^2(\alpha^0)d) \tag{16}$$

Denote the solution as $d(\alpha^0)$ and the value of this problem as $U_{\alpha^0}(r^1(\alpha^0), r^2(\alpha^0))$.

3.2 Banks

The bank will choose a contract and an investment plan, $(r^1(\alpha^0), r^2(\alpha^0), \phi(\alpha^0))$ to maximize household utility, $U_{\alpha^0}(\cdot)$, subject to a zero expected profit constraint for each type α^0. The bank will place a fraction of deposits, $\phi(\alpha^0)$ into the liquid storage technology which yields a unit in either period 1 per unit deposited in period 0. The remainder is deposited into the illiquid technology.

The zero expected profit condition for a type α^0 contract is:

$$r^1(\alpha^0)\pi d(\alpha^0) + r^2(\alpha^0)(1-\pi)d(\alpha^0) = \phi(\alpha^0)d(\alpha^0) + (1-\phi(\alpha^0))d(\alpha^0)R. \tag{17}$$

To be sure the bank can meet the needs of customers, the following constraints must hold as well:

$$\phi(\alpha^0)d(\alpha^0) \geq r^1(\alpha^0)d(\alpha^0)\pi \qquad \text{and} \qquad (1-\phi(\alpha^0))d(\alpha^0)R \geq r^2(\alpha^0)(1-\pi)d(\alpha^0). \tag{18}$$

Clearly if the two constraints in (18) hold with equality, then the zero expected profit condition is met. Note that these conditions hold for any level of deposits.

3.3 Decentralized Allocation

The decentralized allocation maximizes $U_{\alpha^0}(r^1(\alpha^0), r^2(\alpha^0))$ subject to (17) and (18). The first-order condition implies

$$v'(\bar{\alpha} + r^1(\alpha^0)d(\alpha^0)) = Rv'(\bar{\alpha} + r^2(\alpha^0)d(\alpha^0)). \tag{19}$$

In addition, the constraints in (18) are binding so that (17) holds.

Condition (19) is similar to condition (5) from the planner's problem. Both conditions characterize optimal insurance across the two preference states for a household of type α^0. Of course, the levels of consumption need not be the same in the two solutions since the planner's allocation allowed for redistribution through the choice of $d(\alpha^0)$. Importantly, the welfare weights, $\omega(\alpha^0)$ are not present in the decentralized allocation.

4 Systemic Runs and Deposit Insurance

Given the optimal contract written without any consideration of bank runs. We ask two questions.[5] First, can there be a run without Deposit Insurance (DI)? Second, if so, will the government have an incentive to provide DI *ex post*?

In this section, we assume there are runs on all banks in the system. Later we study the case where there are runs on only a subset of the banks.

4.1 Are there runs?

For the decentralization given above, the answer to the first question is simple: as long as $\phi(\alpha^0) < r^1(\alpha^0)$, the bank does not have enough resources to allow all agents to withdraw $r^1(\alpha^0)d(\alpha^0)$. Since (18) is binding, $\pi < 1$ implies $\phi(\alpha^0) < r^1(\alpha^0)$. In contrast to Diamond and Dybvig (1983) and Cooper and Ross (1998), the condition for runs is simple due to our assumption that the two period technology has essentially no liquidation value.

4.2 Deposit Insurance

The run can be avoided if the government will provide deposit insurance, but will it have an incentive to do so *ex post*? Deposit insurance provides to each household its promised return of $r^1(\alpha^0)d(\alpha^0)$ under its deposit contract. This insurance is funded by the levy of a tax, $T(\alpha^0)$, on households.

4.2.1 Household Period 1 Utility under Deposit Insurance

If, *ex post* the government provides deposit insurance, then welfare is:

$$W^{DI} = \int \omega(\alpha^0)v(\bar{\alpha} + \chi(\alpha^0) - T(\alpha^0))f(\alpha^0)d\alpha^0 \tag{20}$$

where $\chi(\alpha^0) \equiv r^1(\alpha^0)d(\alpha^0)$ is the total promised by the bank to the household. If $\omega(\alpha^0)$ is a constant, then the objective of the government is just a population weighted average of household expected utility. In general, the structure of $\omega(\alpha^0)$ will be relevant for gauging the costs and benefits of the redistribution associated with DI.

Another key element in the redistribution is the tax system used to pay for DI. In (20), $T(\alpha^0)$ is the tax paid by an agent of type α^0. Government budget balance requires $\int [T(\alpha^0) + \phi(\alpha^0)d(\alpha^0)]f(\alpha^0)d\alpha^0 = \int \chi(\alpha^0)f(\alpha^0)d\alpha^0$. The left side of this expression is the total tax revenues collected by the government plus the liquidated invested and the right side is the total paid to each depositor $\chi(\alpha^0)$.

[5] As in Cooper and Ross (1998), we could also study the choice of a deposit contract given that runs are possible. This is of interest if the government does not have an incentive to provide deposit insurance.

If, *ex post*, there is no deposit insurance, then welfare is given by:

$$W^{NI} = \int \omega(\alpha^0)[\zeta v(\bar{\alpha} + \chi(\alpha^0)) + (1-\zeta)v(\bar{\alpha})]f(\alpha^0)d\alpha^0. \tag{21}$$

Here ζ is again the probability a household obtains the full return on its deposit.

The values of DI and not providing DI are both calculated at the start of period 1. This is because the government lacks the ability to commit to DI before agents make their deposit decisions. The government can only react to a bank run in period 1.

4.2.2 Welfare Effects of DI

The government has an incentive to provide deposit insurance iff $\Delta \equiv W^{DI} - W^{NI} \geq 0$. We can write this difference as

$$\begin{aligned}\Delta = \int \omega(\alpha^0)[v(\chi(\alpha^0) + \bar{\alpha} - T(\alpha^0)) - v(\chi(\alpha^0) + \bar{\alpha} - \bar{T})]f(\alpha^0)d\alpha^0 + \\ \int \omega(\alpha^0)[v(\chi(\alpha^0) + \bar{\alpha} - \bar{T}) - v(\zeta\chi(\alpha^0) + \bar{\alpha})]f(\alpha^0)d(\alpha^0) + \\ \int \omega(\alpha^0)[v(\zeta\chi(\alpha^0) + \bar{\alpha}) - \zeta v(\chi(\alpha^0) + \bar{\alpha}) - (1-\zeta)v(\bar{\alpha})]f(\alpha^0)d\alpha^0\end{aligned} \tag{22}$$

where $\bar{T} = \int T(\alpha^0)f(\alpha^0)d\alpha^0$.

Here there are three terms. The first two terms capture the two types of redistribution through deposit insurance. One effect is through differences in tax obligations and the other effect comes from differences in deposit levels across types. The third term is the insurance effect of deposit insurance.

Specifically, the first term captures the redistribution from taxes. It is the utility difference between consumption with deposit insurance and type dependent taxes and consumption with deposit insurance and type independent taxes, $\bar{T}$.

The second term captures the effects of **redistribution** through deposit insurance. The term $v(\chi(\alpha^0) + \bar{\alpha} - \bar{T}) - v(\zeta\chi(\alpha^0) + \bar{\alpha})$ is the difference in utility between the consumption allocation if type α^0 gets his promised allocation and bears a tax of $\bar{T}$ and the allocation obtained if all households received a fraction ζ of their promised allocation. This second part is the utility of the expected consumption if there are runs without deposit insurance.

The third term captures the **insurance** gains from DI. This is clearly positive if $v(c)$ is strictly concave. These gains are independent of the shape of $\omega(\alpha^0)$.

Thus the key tradeoff to the provision of DI *ex post* is whether the insurance gains dominate the redistribution effects. Importantly, this tradeoff was not present in the discussion of the planner's solution. In that case, the ability of the planner to redistribute across the heterogenous households implied that the insurance gains from DI where independent of the redistribution. But, in this decentralized economy they are coupled.

Assume there is no heterogeneity across households, so $F(\alpha^0)$ is degenerate. In this case, deposit insurance is valued as it provides risk sharing across households of the uncertainty coming from sequential service.

Proposition 4 *If $F(\alpha^0)$ is degenerate, $v(c)$ is strictly concave, then the government **will** have an incentive to provide deposit insurance.*

Proof. In this case, the first two terms of (22) are zero. The third term is strictly positive since $v(\cdot)$ is strictly concave. Hence $\Delta > 0$. ■

This is a standard result in the Diamond and Dybvig (1983) model. It highlights the insurance gain from DI when there are no costs of redistribution. Here we see that the insurance benefit is enough to motivate the provision of deposit insurance without commitment.

It is comparable to the result in the planner's problem reported in Proposition 2. For that result, any heterogeneity across households was offset by taxes and transfers so that, as noted earlier, consumption allocations were independent of α^0 in the optimal allocation. Hence DI was provided for insurance reasons alone, as in Proposition 4.

When there is heterogeneity across households, these insurance gains may be offset by redistribution. The next two subsections study these redistribution effects with type dependent taxes. In doing so, we consider two situations. In the first, the tax system to fund DI is set at the same time the decision is made to provide DI or not. In this case, there is enough flexibility in the tax system to offset any redistribution effects of DI. In the second scenario, we take the tax system as given and explore the incentives to provide DI.

4.3 Taxation *ex post*: DI Will Be Provided

Here we consider a government which can choose the tax system used to finance DI at the same time it is choosing to provide insurance or not. This can be viewed as the choice of a supplemental tax to fund DI.

Thus we consider W^{DI} as the solution to an optimal tax problem:

$$W^{DI} = max_{T(\alpha)} \int \omega(\alpha)v(\chi(\alpha^0) + \bar{\alpha} - T(\alpha))f(\alpha)d\alpha \tag{23}$$

The first-order condition is $\omega(\alpha)v'(\chi(\alpha^0) + \bar{\alpha} - T(\alpha))$ independent of α. This creates a connection between $\omega(\alpha)$ and $T(\alpha)$ which can be used to evaluate the gains to DI.

Proposition 5 *If $T(\cdot)$ solves the optimization problem (23), then deposit insurance is always provided.*

Proof.

Using the first order condition from (23), we rewrite (22) as:

$$\Delta = \int \frac{[v(\chi(\alpha^0) + \bar{\alpha} - T(\alpha)) - v(\zeta\chi(\alpha^0) + \bar{\alpha})]}{v'(\chi(\alpha^0) + \bar{\alpha} - T(\alpha))} f(\alpha^0)d(\alpha^0) +$$
$$\int \omega(\alpha^0)[v(\zeta\chi(\alpha^0) + \bar{\alpha}) - \zeta v(\chi(\alpha^0) + \bar{\alpha}) - (1-\zeta)v(\bar{\alpha})]f(\alpha^0)d\alpha^0 +$$

The second term is positive as argued previously. The first term can be shown to be positive as well.

To see this, do a second-order approximation of the second part of the first term, $v(\zeta\chi(\alpha^0)+\bar{\alpha})$, around the first part, $v(\chi(\alpha^0)+\bar{\alpha}-T(\alpha))$. Using the fact that $\int T(\alpha)f(\alpha)d\alpha = (1-\zeta)\int \chi(\alpha)f(\alpha)d\alpha$, the first term reduces to

$$\int \frac{-((1-\zeta)\chi(\alpha^0)-T)^2 v''(\chi(\alpha^0)+\bar{\alpha}-T(\alpha))}{v'(\chi(\alpha^0)+\bar{\alpha}-T(\alpha))} f(\alpha^0)d(\alpha^0) \tag{24}$$

which is positive as $v(\cdot)$ is strictly concave. Thus $\Delta > 0$.

■

Why is there always a gain here but not when taxes as type independent? Because with this *ex post* tax scheme, the current government can undo any undesirable redistribution coming from DI. Thus the redistribution costs are not present.

This result is important for the design of policy. As governments strive to make clear the conditions under which deposit insurance and other financial bailouts will be provided *ex post*, they ought to articulate how revenues will be raised to finance those transfers. If a government says it will not rely on existing tax structures but instead will, in effect, solve (23), then private agents will know that the government will have enough flexibility in taxation to overcome any redistributive costs of deposit insurance. This will enhance the credibility of a promise to provide deposit insurance *ex post*.

4.4 Taxation *ex ante*: Will DI Be Provided with Type Independent Taxes?

If the tax system to fund DI is not set *ex post*, costly redistribution may arise. Then the tradeoff between insurance gains and redistribution emerges. As we shall see, these redistribution effects can be large enough to offset insurance gains.

To study these issues, we return to (22) which cleanly distinguishes the redistribution and insurance effects. We start with a case in which taxes are independent of type to gain some understanding of the tradeoff and then return to the more general case where taxes depend on agent types.

To focus on one dimension of the redistributive nature of deposit insurance, assume that taxes are type independent: $T(\alpha) = \bar{T}$ for all α. Under this tax system, (22) simplifies to:

$$\Delta = \int \omega(\alpha^0)[v(\chi(\alpha^0)-\bar{T}+\bar{\alpha}) - v(\zeta\chi(\alpha^0)+\bar{\alpha})]f(\alpha^0)d(\alpha^0) +$$
$$\int \omega(\alpha^0)[v(\zeta\chi(\alpha^0)+\bar{\alpha}) - \zeta v(\chi(\alpha^0)+\bar{\alpha}) - (1-\zeta)v(\bar{\alpha})]f(\alpha^0)d\alpha^0. \tag{25}$$

If taxes are independent of type, then the government budget constraint implies

$$\bar{T} = \int [\chi(\alpha^0) - \phi(\alpha^0)d(\alpha^0)]f(\alpha^0)d\alpha^0. \tag{26}$$

With type independent taxes, redistribution arises solely from differences in deposits across types. In some cases, this redistribution can be costly to society.

Proposition 6 *If $\omega(\alpha^0)$ is weakly decreasing in α^0, then the redistribution effects of deposit insurance reduce social welfare.*

Proof. The effects of redistribution are captured by the first term in (25). Using $\zeta = \frac{\int \phi(\alpha^0)d(\alpha^0)f(\alpha^0)d\alpha^0}{\int \chi(\alpha^0)f(\alpha^0)d\alpha^0}$, $\bar{T} = (1-\zeta)\int \chi(\alpha)f(\alpha)d\alpha$. Letting $\hat{c}(\alpha^0) = \zeta\chi(\alpha^0)+\bar{\alpha}$ and $\bar{c} \equiv \int \hat{c}(\alpha^0)f(\alpha^0)d\alpha^0$, the first term (25) becomes

$$\int \omega(\alpha^0)[v(\frac{1}{\zeta}(\hat{c}(\alpha^0)-\bar{c})+\bar{c}) - v(\hat{c}(\alpha^0))]f(\alpha^0)d\alpha^0. \tag{27}$$

The first consumption allocation, $\frac{1}{\zeta}(\hat{c}(\alpha^0)-\bar{c})+\bar{c}$, is a mean-preserving spread of the second, $\hat{c}(\alpha^0)$. Both have the same mean of $\bar{c}$ and since $1 > \zeta$ the variance of the first consumption allocation is larger. From the results on mean preserving spreads, if $v(c)$ is strictly concave

$$\int [v(\chi(\alpha^0) - \bar{T} + \bar{\alpha}) - v(\zeta\chi(\alpha^0) + \bar{\alpha})]f(\alpha^0)d(\alpha^0) < 0. \tag{28}$$

Using the fact that the welfare weights integrate to one, we can write the first term in (25) as

$$\begin{aligned}&\int [v(\chi(\alpha^0) - \bar{T} + \bar{\alpha}) - v(\zeta\chi(\alpha^0) + \bar{\alpha})]f(\alpha^0)d(\alpha^0) + \\ &\quad \text{cov}(\omega(\alpha_0), v(\chi(\alpha^0) - \bar{T} + \bar{\alpha}) - v(\zeta\chi(\alpha^0) + \bar{\alpha}))).\end{aligned} \tag{29}$$

From the discussion above, the first term is negative.

If $\omega(\alpha^0)$ is independent of α^0, then the covariance term in (29) is zero and so (29) is negative. This is costly redistribution.

If $\omega(\alpha^0)$ is decreasing in α^0, then social welfare put less than the population weight on high α_0 agents.

To show that $\chi(\alpha^0)$ is increasing in α^0, the first-order condition of the household, (16), can be written as

$$u'(\alpha^0 - d) = \pi r^1 v'(\chi(\alpha^0) + \bar{\alpha}) + (1-\pi)r^2 v'(\bar{\alpha} + r^2(\alpha^0)d) \tag{30}$$

The feasibility constraint for the bank, (18), along with the first-order condition for the optimal deposit contract, (19), implies

$$u'(\alpha^0 - d) = v'(\chi(\alpha^0) + \bar{\alpha}) \tag{31}$$

From this expression, an increase in α^0 will lead to an increase in consumption in both period 0 and in period 1, for early consumers. For this to be the case, $\chi(\alpha^0)$ must increase with α^0.

■

Proposition 6 makes clear that the provision of DI may entail distribution effects that are socially undesirable. There are two key pieces of the argument. First, if welfare weights are type independent, then the provision of deposit insurance financed by a lump-sum tax creates a mean preserving spread in consumption. This is welfare reducing. Second, if welfare weights are decreasing so that the rich are valued less than the poor in the social welfare function, then the redistribution from poor to rich from the provision of deposit insurance reduces social welfare further. This second influence is captured by the covariance term in (29).

This results contrasts with Proposition 4 which highlights the gains from the provision of deposit insurance. One important factor in the tradeoff between insurance and redistribution is the underlying distribution of income and thus of deposits. In the following proposition we look at changes in distributions bank deposits, denoted $H(\chi)$.

Proposition 7 *If $v'''(\cdot) < 0$ and $\omega(\alpha_0)$ is constant, then Δ is lower when $H(\cdot)$ is replaced by a mean preserving spread.*

Proof.

We rewrite (25) to express the gains from deposit insurance using the distribution over claims on the bank, χ rather than endowments:

$$\tilde{\Delta} = \int [v(\chi - \bar{T} + \bar{\alpha}) - \zeta v(\chi(\alpha^0) + \bar{\alpha}) - (1 - \zeta)v(\bar{\alpha})]h(\chi)d\chi \tag{32}$$

where $h(\cdot)$ is the pdf over bank claims.

If $v'''(\cdot) < 0$, then by differentiation, $v(\chi - \bar{T} + \bar{\alpha}) - \zeta v(\chi + \bar{\alpha})$ is strictly concave in χ. Thus if we replace $H(\cdot)$ with a mean preserving spread, $\tilde{\Delta}$ will be lower. ■

These propositions highlight the redistributive effects of deposit insurance. Proposition 6 provides sufficient conditions for redistribution to be costly. Proposition 7 makes clear that these losses from redistribution depend on the distribution of deposits.

Of course, deposit insurance also has an insurance gain, as captured by the second term of (25). These gains can outweigh the redistribution costs and thus rationalize the provision of deposit insurance *ex post.* To gauge the magnitude of this tradeoff, we turn to an example.

4.4.1 Example

Here we consider a specific example to illustrate conditions for the provision of deposit insurance. Assume there are two types of households, rich and poor. The rich households have an endowment in youth of $\alpha^0 = \alpha^r$ and the poor have an endowment in youth of $\alpha^0 = \alpha^p$. Let the fraction of rich households be given by f. Assume $u(c) = \frac{c^{1-\gamma_0}}{1-\gamma_0}$ and that $v(c) = \beta\frac{c^{1-\gamma_1}}{1-\gamma_1}$. Thus there are two curvature parameters,

To compute an equilibrium, we solve for the optimal contract offered by a bank to a type α^0 household. This involves finding a level of deposits and interest rates for early and late consumers that satisfy (16), (18) and (19). We also check that bank investment in the two technologies is non-negative and that interest rates are non-negative as well.

Given the contract, we can evaluate the social gains from deposit insurance by calculating $\Delta \equiv W^{DI} - W^{NI}$ using some welfare weights. Taxes are type independent.

Figures 1 and 2 provide some results. For these figures, $\bar{\alpha} = 1$, $\beta = 0.9$, $R = 1.10$ and the fraction of rich households was set at 50%. The weight on the poor, $\omega(\alpha^p)$, is shown on the horizontal axis. Since

Figure 1: Effects of Risk Aversion

Figure 2: MPS on Endowment Distribution

the fraction of poor was 50% and there are only two types, any weight above 50% on the horizontal axis is putting more weight on poor households.

The effects of variations in risk version are shown in the first part of the figure. Here the initial endowments were fixed at $\alpha^p = 3$ and $\alpha^r = 5$.

First, note that for large values of the weight on the poor, deposit insurance is not welfare increasing. This reflects the redistribution from poor to rich households through the provision of deposit insurance.

Second, an increase in risk aversion from $\gamma = 2$ to $\gamma = 5$, increases the range of weights on poor households such that $\Delta < 0$. Both the gains to insurance and the costs of redistribution depend on the curvature of household utility. Evidently here as the curvature increases, the costs of redistribution increase faster than the insurance gains.

The second part of the figure shows the effects of a mean preserving spread such that $\alpha^p = 1$ and $\alpha^r = 5$. As is clear from this figure, the MPS of endowments reduces the gains to DI for all levels of welfare weight for the poor.

4.4.2 Restricted Contract

A second way of highlighting the tradeoff between redistribution and insurance is through the outcome of the model with a restricted contract. In particular, assume that the intermediary is restricted to offer the same contract to all agents: type dependent returns are not feasible. Further, suppose that a deposit contract is summarized by a single interest rate, denoted r, which is the annual gross return. So deposits for one period earn r and deposits for two periods earn r^2.

With this simplified contract we continue to explore the tradeoff between redistribution and insurance.

The analysis of the household and banking problems with this restricted contract are similar to the more general case specified above. The appendix provides a detailed analysis of this restricted contract.

The deposit of a type α_0 household is given by $d(r, \alpha_0)$. The deposit is increasing in the endowment α_0 and increasing in the deposit return r. Importantly, even if $v''(c) = 0$, the household will have a well defined deposit level as long as $u''(c) < 0$. Thus we can study the special case of risk neutrality in periods 1 and 2 in this model.[6]

[6] In the previous specification where the returns could differ for early and late consumers, at $v''(\cdot) = 0$, there consumption for early households went to zero. The restricted contract has the benefit of being better behaved when $v(\cdot)$ is linear.

Given the deposit demand functions, a bank will choose a r and a portfolio to maximize expected utility of the households subject to zero profit and feasibility constraints.

Using this model, we return to our discussion of costly redistribution and the risk sharing benefits of deposit insurance. For the restricted contract, if almost risk neutral with respect to variations in early and late consumption DI will not be provided *ex post* if redistribution is costly enough.

Proposition 8 *If households are not too risk averse and $\omega(\alpha^0)$ is strictly decreasing in α^0, then a government **will not** have an incentive to provide deposit insurance.*

Proof.

With the restricted contract, (25) becomes

$$\Delta = \int \omega(\alpha^0)[v(rd(r,\alpha^0) - \bar{T} + \bar{\alpha}) - v(\zeta rd(r,\alpha^0) + \bar{\alpha})]f(\alpha^0)d(\alpha^0) + \int \omega(\alpha^0)[v(\zeta rd(r,\alpha^0) + \bar{\alpha}) - \zeta v(rd(r,\alpha^0) + \bar{\alpha}) - (1-\zeta)v(\bar{\alpha})]f(\alpha^0)d\alpha^0. \tag{33}$$

Suppose $v(\cdot)$ is linear. Then there are no insurance gains and the second term in (33) is zero leaving

$$\Delta = \int \omega(\alpha^0)[(1-\zeta)rd(r,\alpha^0) - \bar{T}]f(\alpha^0)d(\alpha^0) \tag{34}$$

Using $\zeta = \frac{\int \phi(\alpha^0)d(r,\alpha^0)f(\alpha^0)d\alpha^0}{\int rd(r,\alpha^0)f(\alpha^0)d\alpha^0}$, $\bar{T} = (1-\zeta)r\int d(r,\alpha)f(\alpha)d\alpha$. Let $\bar{d}(r) \equiv \int d(r,\alpha)f(\alpha)d\alpha$, (35) becomes

$$(1-\zeta)r\int \omega(\alpha^0)[(d(r,\alpha^0) - \bar{d}(r))]f(\alpha^0)d(\alpha^0) = (1-\zeta)r \times \operatorname{cov}(\omega(\alpha^0), d(r,\alpha^0) - \bar{d}(r)) \tag{35}$$

Since $d(r,\alpha^0)$ is increasing in α^0 , the provision of deposit insurance redistributes from low to high α^0 households. This redistribution reduces social welfare if $\omega(\alpha^0)$ is strictly decreasing.

If $v(\cdot)$ is close enough to linear, then the insurance gain from deposit insurance, the second term in (33) can be made arbitrarily small. Thus the insurance gains are dominated by the costs of redistribution when $\omega(\alpha^0)$ is strictly decreasing. ■

This proposition highlights the redistributive aspect of DI. Since the total resources in the economy are predetermined and agents are risk neutral, the only role of DI is to redistribute consumption. The nature of that redistribution depends on the deposits of each type, $d(r,\alpha^0)$ and the tax system. The social value of the redistribution is determined by $\omega(\alpha^0)$. When this is decreasing, so that the rich households have a lower weight and households are not very risk averse, then DI will not be provided *ex post.*

4.5 Taxation *ex ante*: Will DI Be Provided with Type Dependent Taxes?

Proposition 9 *Compare two tax schedules, $T(\cdot)$ and $\tilde{T}(\cdot)$. If $\tilde{T}(\cdot)$ induces a MPS on disposable income relative to $T(\cdot)$ then Δ falls when we replace $T(\cdot)$ with $\tilde{T}(\cdot)$.*

5 Bank Specific Runs and Deposit Insurance

Bank runs are not always systemic but instead may initially impact only a subset of banks. In this section we explore the issue of whether DI will be provided in the event of bank specific runs.

The fact that runs occur in a subset of banks implies that there is a second dimension for redistribution: across groups of agents depending on the state of their bank as well as across types of agents based on their endowments.

Suppose there is a run at a set of banks with a fraction n households. This creates two groups of agents, one group experiencing a bank run and the other with no run. Then we can write the payoff from DI and no DI as:

$$W^{DI} = n \int v(\bar{\alpha} + \chi(\alpha^0) - \bar{T}) f(\alpha^0) d\alpha^0 + (1-n) \int v(\bar{\alpha} + \chi(\alpha^0) - \bar{T}) f(\alpha^0) d\alpha^0. \tag{36}$$

The two terms here highlight the two regions though with DI the consumption levels are the same for each type.

As before, assume lump-sum taxation. If a fraction n of households are involved in a bank run, the lump-sum tax per household would be given by $\bar{T} = n \int [\chi(\alpha^0) - \phi(\alpha^0) d(\alpha^0)] f(\alpha^0) d\alpha^0$.

If, *ex post*, there is no deposit insurance, then social welfare is given by:

$$W^{NI} = n \int [\zeta v(\bar{\alpha} + \chi(\alpha^0)) + (1-\zeta) v(\bar{\alpha})] f(\alpha^0) d\alpha^0 + (1-n) \int v(\bar{\alpha} + \chi(\alpha^0)) f(\alpha^0) d\alpha^0. \tag{37}$$

The two terms here indicate the differential treatment across groups: in one there are runs and the uncertainty created by sequential service while in the other there is financial stability.

The key point of the multiple regions is that the tax paid by those in the failed bank is smaller due to the presence of the other banks because those in the other banks pay a share of the deposit insurance. Whether deposit insurance is then paid *ex post* depends, in part, on the relative size of these gains and costs.

Drawing upon the arguments in Cooper, Kempf, and Peled (2008) that consumption smoothing across regions will lead to bailouts, DI will in fact be provided if the only differences across households is due to the status of their bank. Here, instead of the regions in Cooper, Kempf, and Peled (2008), we have groups of households distinguished by whether their deposits are in a failed bank or not.

For this case, the gain to deposit insurance is:

$$\begin{aligned} \Delta \;\; = \;\; & \int n[v(c^E(\alpha^0) - \bar{T}) - \zeta v(\bar{\alpha} + \chi(\alpha^0)) - (1-\zeta) v(\bar{\alpha})] + \\ & (1-n)[v(c^E(\alpha^0) - \bar{T}) - v(c^E(\alpha^0))] f(\alpha^0) d\alpha^0. \end{aligned} \tag{38}$$

The following results use this definition of the utility differential.

Proposition 10 *If $F(\alpha^0)$ is degenerate, then the gains from deposit insurance are positive for any n.*

Figure 3: Partial Runs

Proof. When all households are identical, from (38), the expected utility difference across regions is given by:

$$\Delta = [v(c^E - \bar{T}) - n[\zeta v(\bar{\alpha} + \chi^E) + (1-\zeta)v(\bar{\alpha})] - (1-n)v(c^E). \quad (39)$$

To see that $\Delta > 0$, combine the second group of terms, subtracted from the first term. Since $v(\cdot)$ is strictly concave, this combining of terms decreases Δ. Hence we have

$$\Delta > [v(c^E - \bar{T}) - v(\chi^E(n\zeta + (1-n)) + \bar{\alpha}). \quad (40)$$

Using $\bar{T} = \chi^E(1-\zeta)n$ and arranging terms,

$$\Delta > [v(c^E - \bar{\chi}^E(1-\zeta)n) - v(\chi^E(n\zeta + (1-n)) + \bar{\alpha}). \quad (41)$$

Since $c^E = \chi^E + \bar{\alpha}$, the term on the right of (41) is zero implying $\Delta > 0$. This argument holds for any n. ■

If the distribution of α^0 is not degenerate, then the provision of DI entails redistribution in two dimensions: across regions and across household types. Proposition 10 makes clear that if there is only redistribution across regions, then DI will be provided. But we know from section 8 that in some cases, the redistribution across types created by DI may be welfare reducing so that this insurance is not provided.

To better appreciate this tradeoff, we extended the example introduced in section 4.4.1 to allow for runs at a subset of banks. Recall that in the example taxes were type independent. We used the same parameter values as earlier with $\gamma_0 = \gamma_1 = 2$ and the welfare weight of the poor equal to 0.90. Hence, from Figure 1, if there is a run in all banks, we know that deposit insurance is not welfare improving.

Figure 3 shows the results of our experiment. Along the horizontal axis is the fraction of households involved in a bank run. If all households are in a run, then there is a social utility loss from deposit insurance. This utility loss falls as the fraction of household involved in a bank run falls. The utility loss is zero when the fraction is about 80%. Below that critical value, the utility difference is positive and hence deposit insurance will be provided.

Thus this figure illustrates the tradeoffs involved when there are two dimensions to the heterogeneity. If there are runs at all banks, the costly redistribution across income groups outweighs the insurance gains from deposit insurance. But, if the fraction of banks is sufficiently small, then the costs of redistribution across income classes falls relative to the insurance gains across households experiencing runs and those not experiencing runs.

We can go a step further and replace our assumption of lump-sum taxes to allow them to depend upon the household type. In particular, suppose

$$T(\alpha^0) = (\chi^E(\alpha^0) - \phi(\alpha^0)d(\alpha^0))n. \tag{42}$$

With this tax scheme, the lump sum tax of household type α^0 is proportional then it is also the case that deposit insurance will be provided.

Proposition 11 *If taxes satisfy (42), then the gains from deposit insurance are positive for any* n.

Proof. Consider a particular household type. From (38), the expected utility difference for that type is given by:

$$\Delta(\alpha^0) = [v(c^E(\alpha^0) - T(\alpha^0)) - n[\zeta v(\bar{\alpha} + \chi(\alpha^0)) + (1-\zeta)v(\bar{\alpha})] - (1-n)v(c^E(\alpha^0)). \tag{43}$$

To see that $\Delta(\alpha^0) > 0$ for all α^0, combine the second group of terms, subtracted from the first term. Since $v(\cdot)$ is strictly concave, this combining of terms decreases $\Delta(\alpha^0)$. Hence we have

$$\Delta(\alpha^0) > [v(c^E(\alpha^0) - T(\alpha^0)) - v(c^E(\alpha^0)(1 - n(1-\zeta) + n(1-\zeta)\bar{\alpha})). \tag{44}$$

Using the definition of ζ, $T(\alpha^0)$ from (42) and arranging terms, we write

$$\Delta(\alpha^0) > [v(c^E(\alpha^0) - \chi^E(\alpha^0)(1-\zeta)n) - v(c^E - (1-\zeta)n(c^E(\alpha^0) - \bar{\alpha})). \tag{45}$$

As, $\chi^E(\alpha^0) = c^E(\alpha^0) - \bar{\alpha}$, the term on the right of (45) is zero so that $\Delta(\alpha^0) > 0$.

This argument is true for each type (α^0). Hence $\Delta > 0$. ■

6 Conclusion

This paper studied the provision of deposit insurance in the absence of commitment. We interpreted deposit insurance broadly to encompass a variety of forms of *ex post* bailout of financial intermediaries. While steps taken recently to support the financial system in a number of countries may have been warranted, these *ex post* interventions have a consequence: agents will now realize that governments will make *ex post* decisions on deposit insurance.

If so, it is natural to understand the conditions under which deposit insurance will be supplied *ex post*. In our environment, the planner's allocation involves both redistribution and the provision of deposit insurance. But, in decentralized settings in which household differences appear as differences in deposit levels, a tradeoff emerges between risk sharing and the redistribution created by the funding of the transfers inherent in a deposit insurance system. In some cases, these redistribution costs may be large enough to offset insurance gains.

In the absence of commitment to deposit insurance, the concerns for financial stability first illustrated by Diamond and Dybvig (1983) resurface. From our analysis, a key point is the tax system used to finance deposit insurance. A tax system which is sufficiently redistributive and thus reduces the redistribution costs of deposit insurance is conducive to the *ex post* provision of deposit insurance. As we argued in this paper, if the tax system is set *ex post* along with deposit insurance, then the government can optimally choose the net transfer and avoid the conflict between insurance and redistribution. But if the deposit insurance must be financed by an *ex ante* tax system that allows for redistributions from the poor to the rich through the provision of deposit insurance, then the credible of deposit insurance is weakened. This was illustrated through out discussion of lump-sum taxes.

There is another intriguing situation to study the provision of deposit insurance: too big to fail. In that setting, there is a fundamental heterogeneity across banks. Some are more essential to the financial system than others. It will be of interest to extend this study to allow those asymmetries across financial institutions and understand conditions for deposit insurance in that environment.

References

Cooper, R., H. Kempf, and D. Peled (2008): "Is it is or it is ain't my obligation? Regional Debt in a Fiscal Federation," *International Economic Review*, 49, 1469–1504.

Cooper, R., and T. Ross (1998): "Bank runs: liquidity costs and investment distortions," *Journal of Monetary Economics*, 41(1), 27–38.

Diamond, D., and P. Dybvig (1983): "Bank Runs, Deposit Insurance and Liquidity," *Journal of Political Economy*, 91, 401–19.

Ennis, H., and T. Keister (2009): "Bank runs and institutions: the perils of intervention," *The American Economic Review*, 99(4), 1588–1607.

Wallace, N. (1988): "Another attempt to explain an illiquid banking system: The Diamond and Dybvig model with sequential service taken seriously," *Federal Reserve Bank of Minneapolis Quarterly Review*, 12(4), 3–16.