Economic Theory **23**, 383–394 (2004)
DOI: 10.1007/s00199-003-0381-4

Economic Theory

Joint liability among bank borrowers*

Philip Bond

Northwestern University, Kellogg School of Management, Department of Finance, 2001 Sheridan Road, Evanston, IL 60208-2001, USA (e-mail: p-bond@northwestern.edu)

Received: September 4, 2002; revised version: March 21, 2003

Summary. A common feature of financial intermediaries is that the welfare of one borrower is adversely affected by the poor performance of other borrowers. That is, there exists a degree of joint liability among the borrowers of a financial intermediary. This paper provides an explanation for this observation. It demonstrates that in Krasa and Villamil's [14] formalization of a financial intermediary as a delegated monitor, intermediation with joint liability between borrowers Pareto dominates intermediation without joint liability.

Keywords and Phrases: Financial intermediation, Banks, Conglomerates, Delegated monitoring, Joint liability, Credit crunch.

JEL Classification Numbers: D8, E5, G2, G3.

1 Introduction

A common view of financial intermediaries is that they serve as *delegated monitors*. That is, instead of all providers of capital having to monitor an investment project, this task is delegated to a single intermediary. This view of intermediation has been formalized by Diamond [3], Williamson [20], Krasa and Villamil [14], and Hellwig [8]. The main finding of these papers is that intermediation performs better than direct investment whenever the intermediary is able to hold a sufficiently diversified investment portfolio. However, these papers have had relatively little to say about more detailed properties of financial intermediaries. The object of this short paper is to demonstrate that a similar framework to that used in these previous papers

* I am particularly indebted to Douglas Diamond and Robert Townsend for their advice on this paper. I thank an anonymous referee for helpful comments.

can also explain the existence of *joint liability* between the borrowers of a financial intermediary.

Empirically, the borrowers of a financial intermediary are often (at least partially) jointly liable. By this I mean that the welfare of each borrower is adversely affected by the poor performance of other borrowers. In some cases this joint liability aspect of borrowing is made explicit, as in the case of the use of joint liability lending groups by microcredit organizations such as the Grameen Bank.[1] However, there are many other cases in which borrowers are affected by the poor performance of other borrowers, even though this may not be explicitly described as joint liability. For instance, a voluminous literature (see especially Hubbard et al. [10]) has demonstrated that a bank borrower's access to future credit depends on the overall performance of the bank, and thus on the performance of the bank's other borrowers. Likewise, conglomerates resemble financial intermediaries in many dimensions, and the amount invested by a conglomerate division has been found to depend on the conglomerate's overall performance (see, e.g., Lamont [15]). Finally, one can also think of a firm's workers as being the entrepreneurs and the firm manager being a delegated monitor (i.e. intermediary). Poor performance by co-workers clearly raises the probability of job displacement arising from firm closure, and a wage reduction of the order of 25% has been documented following job-displacement – see, e.g., Jacobson et al. [11] or Kletzer [13]. In each of these cases, the welfare of an intermediary "borrower" is adversely affected by the performance of others – that is, joint liability exists in the sense defined above. There is nothing inevitable about any of these arrangements – in principle at least, the payoff of the intermediary's investors could be reduced by an amount sufficient to shield the intermediary's borrowers (or divisions or workers) from risk.

This paper will show that the joint liability of intermediary borrowers arises naturally in models of a financial intermediary as a delegated monitor – in particular, that of Krasa and Villamil [14] (henceforth KV). The main intuition is straightforward. Delegation of monitoring is valuable in this model because it is assumed that multiple investors are required to fund each borrower.[2] Consider now the situation faced by an intermediary whose income is too low to pay the face value of investor claims. He has two main options. On the one hand, he can default on the investor claims, with all the investors monitoring to check that default is really necessary (this is the only option allowed by Diamond [3] and by KV). On the other hand, he can go to the subset of borrowers who still have resources, and request a higher payment — that is, impose some form of joint liability. This second option entails the borrowers monitoring the bank to make sure these extra funds are really needed. But by the very assumption that drives intermediation in the first place – namely that there are more investors than entrepreneurs — this second option is cheaper in

[1] See Morduch [16] and Ghatak and Guinnane [5] for recent surveys of microcredit.

[2] Empirically, this assumption would appear to be reasonable, at least for the case of bank loans to small businesses. Kennickell et al. [12] report that the 1995 median US household bank balance was $2,100. On the other hand, the median loan size reported in the 1993 National Survey of Small Business Finance (NSSBF) is $50,000.

terms of aggregate expenditures on monitoring.[3] Since introducing a degree of joint liability among borrowers reduces total monitoring costs, it is possible to make all parties better off: the payments to the investors can be reduced, since they monitor less, while the expected payment made by the borrowers can be reduced (i.e. the interest rate lowered), since in aggregate the intermediary and investors monitor less.

Related literature

To the best of my knowledge this is the first paper to seek to explain why borrowers of a financial intermediary are adversely affected by the poor performance of other borrowers. Perhaps most closely related is Winton's [21] argument that the coexistence of several seniority classes *among* debt-holders can be explained as a means of minimizing expected monitoring costs. Related in spirit are a couple of papers by Hellwig [6, 7] that consider banks as a mechanism for economy-wide risk-sharing and ask why deposit contracts are non-contingent with respect to aggregate shocks such as interest-rate changes. The current paper also views banks as mechanisms for risk-sharing, but asks instead why it is that in certain states all the risk is borne by intermediary borrowers, while intermediary lenders may be left unaffected. Finally, there is also a recent literature on why troubled banks cannot easily raise further funds to avoid reducing credit – see, e.g., Holmström and Tirole [9], Stein [17], Bolton and Freixas [1] and Webb [19]. This paper departs fundamentally from this literature by not assuming that deposit claims are both non-contingent and senior to all other claims on the bank. Instead, these features, together with intermediation itself, emerge endogenously from the basic frictions of the model.

2 Results

We will examine the same economy as that considered by KV (and follow their notational conventions as much as possible). Agents $i = 1, \ldots, I$ are risk neutral entrepreneurs and agents $j = 1, \ldots, J = yI$ are risk neutral investors, where $y \geq 2$ is an integer. Each entrepreneur i possesses a technology that transforms y units of an input into θ_i units of output, where θ_i is a random variable described below. Each investor possesses a single unit of the input good. Thus y investors are needed to "fund" each entrepreneur.

[3] This argument will apply in any model in which the deadweight cost of default is an increasing function of the number of agents defaulted on. Note that one model that does not have this property is Diamond's [3] formalization of an intermediary as a delegated monitor. There, the intermediary would in fact be indifferent between the two options described in the text – the deadweight loss incurred is a function only of the shortfall in funds.

The random variables θ_i are independent and identically[4] distributed on a probability space $(\Omega, \mathcal{A}, P)$, with a distribution function F and a density function f with respect to the Lebesgue measure. Let $\omega \in \Omega$ denote the state.

The realization of each entrepreneur's technology is assumed to be initially private information. However, any investor j can learn the realization by *monitoring* the entrepreneur, at a non-pecuniary effort cost c. As in KV, only investors who monitor acquire this information. To allow for intermediation, KV also allow investors to monitor a monitoring agent — i.e. an investor who acts as an intermediary and monitors the entrepreneurs. The cost of this second level of monitoring is c_I^*.

KV consider two-sided contracts of the following form. One of the investors (m say) acts as an intermediary and has a contract $(R(\cdot), S)$ with each entrepreneur, meaning that an entrepreneur with income realization w pays the intermediary $R(w)$ and is monitored if and only if $w \in S$. The contract $(R(\cdot), S)$ is required to satisfy feasibility (that is, $R(w) \leq w$) and incentive compatibility (that is, $R(\cdot)$ is constant[5] over S^c, with $R(S^c) \geq R(w)$ for any $w \in S$). Let $G_i(R(\cdot); \omega)$ denote the intermediary's income in state ω from entrepreneur i. Likewise, define $G^I(R(\cdot); \omega) \equiv (1/I) \sum_{i=1}^{I} G_i(R(\cdot); \omega)$. Let $F^I(\cdot)$ denote the density function of $G^I(\cdot)$.

Below we will be interested in the set of entrepreneurs who are *not* monitored in a state ω. We will refer to these entrepreneurs as being *successful*, and denote the set by

$$A(R(\cdot); \omega) \equiv \{i \in I : R(\theta_i(\omega)) = R(S^c)\} \ .$$

Also, let $C(R(\cdot); \omega)$ denote the total monitoring costs incurred by the intermediary in state ω,

$$C(R(\cdot); \omega) \equiv (I - |A(R(\cdot); \omega)|)\, c \ .$$

The intermediary m also has a contract $(R^*(\cdot), S^*)$ with each of the remaining $J-1$ investors, meaning that when the intermediary has an average income w^* from the entrepreneur contracts (i.e. $w^* = G^I(R(\cdot); \omega)$), he transfers $(I/(J-1))\, R^*(w^*)$ to each investor, and is monitored by each investor if $w^* \in S^*$. Feasibility and incentive compatibility are analogous to above.

Each investor requires an expected return of r, in return for providing the initial funding. Thus the participation constraints for the investors and intermediary are respectively

$$I \int R^*(w^*)\, dF^I(R(\cdot), w^*) - (J-1) \int_{S^*} c_I^* dF^I(R(\cdot), w^*) \geq (J-1)\, r \quad (1)$$

$$I \int (w^* - R^*(w^*))\, dF^I(R(\cdot), w^*) - I \int_S c dF(R(\cdot), w) \geq r \ . \quad (2)$$

In adopting this formulation, KV implicitly assume that *only other investors can monitor the intermediary*. We can relax this assumption by expanding the space

[4] In fact, it is not necessary to assume either that the random variables $\{\theta_i : i = 1, \ldots, I\}$ are independent or identically distributed. In particular, while independence helps in establishing that intermediation dominates direct investment, it does not play any role in the result of this paper that adding a degree of joint liability improves intermediation.

[5] Throughout, S^c denotes the complement of the set S.

of contractual possibilities to include intermediation with *joint liability among entrepreneurs*. Joint liability will allow the intermediary to raise further funds from the entrepreneurs in a contingent way.

The kind of joint liability arrangements that are feasible depend on exactly what it is that monitoring the intermediary reveals. At one extreme, any agent who monitors the intermediary may learn the full vector of transfers that he has received from other agents. At the other extreme, monitoring may reveal only the intermediary's aggregate income and aggregate monitoring expenditures: [6] that is, a monitoring agent is able to detect any income the intermediary attempts to hide, without learning the exact sources of this income. Below, for each of these extremes we exhibit joint liability arrangements that are Pareto superior to any member of the class of two-sided contracts considered by KV.[7]

Note that the aim of this paper is to demonstrate that intermediation with joint liability is Pareto superior to intermediation without joint liability. The economy considered is exactly that studied previously by KV, and the analysis is restricted to exhibiting Pareto dominating arrangements. While solving for an optimal arrangement in this environment does not appear tractable in general, Bond [2] is able to characterize the optimal arrangement in the simplest variant of this economy – just two entrepreneurs, each having a project with only two possible income realizations, and a large number of investors. Moreover, the analysis allows for investors to belong to different seniority classes, a possibility that the current paper follows KV in ignoring. It is found that even after allowing for different seniority classes, for a wide range of parameter values intermediation *without* joint liability is *not* the optimal arrangement. Instead, optimal arrangements feature multiple agents who monitor multiple times and play a key role in absorbing aggregate income fluctuations. Intermediation with joint liability is an example of such an arrangement. Thus there is reason to believe that the results of the current paper are robust to considering arbitrary contractual arrangements and seniority classes.

2.1 Monitoring reveals all transfers made to the intermediary

Given a two-sided contract $((R(\cdot), S), (R^*(\cdot), S^*))$ of KV, we consider adding joint liability as follows. If the vector of transfers received by the intermediary, $(G_i(R(\cdot);\omega))_{i\in I}$, falls in the set $X^* \subset \Re^I$, then the intermediary invokes the following joint liability arrangement:

1. The intermediary imposes an additional "joint liability" contract on the successful entrepreneurs $A(R(\cdot);\omega)$. Denote the additional contract by $\left(R^X, X\right)$. For feasibility we require $R(w) + R^X(w) \leq w$, while for incentive compatibility

[6] Note that if monitoring reveals the transfer made by each individual entrepreneur the monitoring activity of the intermediary can be inferred. Also, note that if monitoring revealed *nothing* about the intermediary's monitoring activity, then joint liability arrangements would be hard to sustain since they entail increased monitoring activity by the intermediary in order to reduce monitoring by the investors.

[7] If given a choice of which monitoring technology to employ, under some circumstances agents might actually choose the second and less informative option: when monitoring the intermediary reveals the transfer made by every entrepreneur, an entrepreneur's competitors may acquire valuable information.

we require that $R^X(\cdot)$ is constant over X^c, with $R^X(X^c) \geq R^X(w)$ for any $w \in X$.[8] It should be noted that the joint liability payment resembles the initial loan repayment. As such, the joint liability payment is enforceable whenever the legal regime functions well enough to enforce the original repayment of the loan, $R(\cdot)$.

Write $G_i^X\left(R^X(\cdot);\omega\right)$ for the payment received from entrepreneur i in state ω, where clearly $G_i^X\left(R^X(\cdot);\omega\right) = 0$ if either an entrepreneur i has not been successful, $i \notin A(R(\cdot);\omega)$, or if joint liability has not been invoked, $(G_i(R(\cdot);\omega))_{i\in I} \notin X^*$. As before, define $G^{XI}\left(R^X(\cdot);\omega\right) \equiv (1/I)\sum_{i=1}^{I} G_i^X\left(R^X(\cdot);\omega\right)$, the average of the joint liability payments.

2. The successful entrepreneurs monitor the intermediary. Each receives a payment $R^{X*}(\underline{w}^*)$ from the intermediary, where $\underline{w}^*$ is the vector of transfers the intermediary has received from the entrepreneurs, i.e.

$$\underline{w}^* = \left(G_i(R(\cdot);\omega) + G_i^X\left(R^X(\cdot);\omega\right)\right)_{i\in I}.$$

Having entrepreneurs subject to the joint liability payment monitor the intermediary serves two purposes. First, it prevents the intermediary from falsely claiming the need to invoke joint liability. Second, it enables the amount raised by the intermediary after invoking joint liability to be fine-tuned to the amount actually required to pay off the investors. This is an issue because there are states in which the average income of the successful entrepreneurs is very high, and so joint liability delivers surplus funds to the intermediary. Since intermediary agency lies at the heart of the model, we cannot simply ask the intermediary not to take these surplus funds. But by introducing the payment $R^{X*}(\cdot)$ we can effectively make the successful entrepreneurs junior claimants on the intermediary, and so allow them to recover some (or all) of the surplus funds the intermediary may have raised.

In this case, the joint liability contract is defined by the quadruple $\left(X^*, R^X(\cdot), X, R^{X*}(\cdot)\right)$. To recap, X^* specifies when joint liability is invoked, $\left(R^X(\cdot), X\right)$ is the additional joint liability payment contract imposed on the successful entrepreneurs, and $R^{X*}(\cdot)$ is a payment the intermediary may make back to each successful entrepreneur.

Regardless of the whether or not joint liability is invoked, the intermediary then makes a transfer $R^*\left(G^I(R(\cdot);\omega) + G^{XI}\left(R^X(\cdot);\omega\right)\right)$ to the investors. Note that since monitoring reveals the vector of transfers the intermediary has received, an intermediary who deviated by not invoking joint liability when he was intended to do so would be subsequently be detected if monitored.

Our main result is:

[8] The requirement that incentive compatibility should hold separately for $(R(\cdot), S)$ and $\left(R^X(\cdot), X\right)$ is stronger than stipulating a combined incentive compatibility constraint. Requiring incentive compatibility to hold separately avoids relaxing the KV assumption that monitoring is always deterministic, allowing us to focus instead on the effect of allowing entrepreneurs to monitor the intermediary.

Proposition 1 *Let* $((R(\cdot), S), (R^*(\cdot), S^*))$ *be a two-sided contract satisfying the participation constraints (1) and (2). Then there is an alternative two-sided contract* $\left(\left(\hat{R}(\cdot), \hat{S}\right), \left(\hat{R}^*(\cdot), \hat{S}^*\right)\right)$ *with a joint liability component* $\left(X^*, R^X(\cdot), X, R^{X*}(\cdot)\right)$ *that strictly increases the expected utility of all agents.*

The main difficultly in proving Proposition 1 is that although it is straightforward to see that introducing joint liability reduces monitoring costs in the aggregate, it is the monitoring costs of the investors that are decreased, while the expected payments from the entrepreneurs are actually increased. To compensate the entrepreneurs, their payments to the intermediary must then be reduced – but doing so raises the probability of the investors having to monitor the intermediary. The key step in the proof is to design a joint liability contract in such a way that all the extra payments made by the entrepreneurs when joint liability is invoked go to the investors. This is accomplished by having the intermediary return to the entrepreneurs any surplus funds raised when joint liability is invoked (by making a payment $R^{X*} > 0$). Then, when the entrepreneur payments are reduced to compensate them, the net effect is still a reduction in overall monitoring costs.

The proof is as follows. First, it is well known (see Townsend [18] and Gale and Hellwig [4]) that it is optimal for the intermediary-investor side of the contract to take the form of simple debt — the intermediary transfers *all* his income to the investors below some critical value $\bar{R}^*$, and consumes any income above $\bar{R}^*$. So without loss we can assume that $R^*(w) = \min\left\{w, \bar{R}^*\right\}$ and $S^* = \left\{w : w < \bar{R}^*\right\}$ for some $\bar{R}^*$.

Since the intermediary will be receiving transfers from the entrepreneurs in the case that joint liability is invoked, to make the entrepreneurs better off we need to reduce their regular payments. To this end, for any $\gamma \in [0,1]$ define

$$R_\gamma(\cdot) \equiv \gamma R(\cdot) \text{ and } S_\gamma = S \ .$$

Likewise, since the invocation of joint liability decreases the probability that the investors will need to monitor the intermediary, we can decrease the payments to the investors. Define

$$R^*_\gamma(w) = \min\left\{w, \gamma\bar{R}^*\right\} \text{ and } S^*_\gamma = \left\{w : w < \gamma\bar{R}^*\right\} \ .$$

Observe that for all $\omega \in \Omega$

$$\begin{aligned} G_i(R_\gamma(\cdot), \omega) &= \gamma G_i(R(\cdot), \omega) \\ R^*_\gamma\left(G^I(R_\gamma(\cdot); \omega)\right) &= \gamma R^*\left(G^I(R(\cdot); \omega)\right) \ . \end{aligned}$$

We want to design a joint liability arrangement that will be invoked when the intermediary's income is below $\gamma I\bar{R}^*$ (the point at which monitoring by investors becomes necessary), and which will succeed in raising enough resources to bring the intermediary's income over $\gamma I\bar{R}^*$. However, when the intermediary invokes joint liability he cannot be sure that entrepreneurs possess enough extra resources to accomplish this. For any desired probability of success $\zeta \in (0,1)$, select a $\delta > 0$ such that

$$\Pr\left(\theta_i \geq R(S^c) + \delta | \theta_i \geq R(S^c)\right) \geq \zeta \ .$$

That is, there is probability of at least ζ of a successful entrepreneur having the resources to pay a further δ to the intermediary.

We now turn to the definition of the joint liability component. For each $\gamma \in [0,1]$ we define a joint liability contract $\left(X_\gamma^*, R_\gamma^X(\cdot), X_\gamma, R_\gamma^{X*}(\cdot)\right)$. The joint liability set X_γ^* is defined by

$$X_\gamma^* = \left\{ (w_i^*)_{i \in I} \in \Re^I : \sum_{i=1}^I w_i^* \in [\gamma I \bar{R}^* - \gamma\delta, \gamma I \bar{R}^*) \right. \\ \left. \text{and } w_i^* = R_\gamma(S^c) \text{ for some } i \in I \right\} .$$

That is, the intermediary invokes joint liability whenever he needs at most another $\gamma\delta$ to avoid being monitored by the investors, and moreover there is at least one successful entrepreneur (from whom these resources might be acquired). Since the factor γ scales all payments equally, note that for all $\omega \in \Omega$, $(G_i(R_\gamma(\cdot));\omega)_{i\in I} \in X_\gamma^*$ if and only if $(G_i(R(\cdot));\omega)_{i\in I} \in X_1^*$.

The additional contract $\left(R_\gamma^X(\cdot), X_\gamma\right)$ must then enable the intermediary to get these resources. Define

$$R_\gamma^X(w) = \min\left\{\gamma w - R_\gamma\left(S_\gamma^c\right), \gamma\delta\right\} \\ X_\gamma = \left\{w : \gamma w < R_\gamma\left(S_\gamma^c\right) + \gamma\delta\right\} \backslash S_\gamma .$$

Since everything is scaled by a factor of γ, note that $G_i^X\left(R_\gamma^X(\cdot), \omega\right) = \gamma G_i^X\left(R_1^X(\cdot), \omega\right)$, while $X_\gamma = X_1$.

Define the return transfer[9] $R_\gamma^{X*}(\cdot)$ to the entrepreneurs in such a way that in joint liability the intermediary never takes any more than he needs,

$$R_\gamma^{X*}\left((w_i^*)_{i\in I}\right) = \frac{1}{\left|\left\{w_i^* \geq R_\gamma\left(S_\gamma^c\right)\right\}\right|} \max\left\{0, \sum_{i=1}^I w_i^* - \gamma I \bar{R}^*\right\} .$$

Given the two-sided contract $\left((R_\gamma(\cdot), S_\gamma), \left(R_\gamma^*(\cdot), S_\gamma^*\right)\right)$ with joint liability component $\left(X_\gamma^*, R_\gamma^X(\cdot), X_\gamma, R_\gamma^{X*}(\cdot)\right)$, we can work out the total expected transfer that the entrepreneurs make in joint liability states. We denote this quantity by $Z(\gamma)$, i.e.

$$Z(\gamma) = \Pr\left((G_i(R_\gamma(\cdot);\omega))_{i\in I} \in X_\gamma^*\right) \\ \times E_\omega[\min\left\{IG^{XI}\left(R_\gamma^X(\cdot);\omega\right), \gamma I\bar{R}^* - IG^I(R_\gamma(\cdot);\omega)\right\} \mid (G_i(R_\gamma(\cdot);\omega))_{i\in I} \\ \in X_\gamma^*] .$$

Again, note that $Z(\gamma) = \gamma Z(1)$.

[9] Recall that any specification of the transfer function $R^{X*}(\cdot)$ is incentive compatible since whenever joint liability is invoked, all successful entrepreneurs monitor the intermediary.

Take $\varepsilon > 0$, and choose γ so that the combined utility of the entrepreneurs is ε higher under the two-sided contract $\left(\left(R_\gamma(\cdot), S_\gamma\right), \left(R^*_\gamma(\cdot), S^*_\gamma\right)\right)$ with joint liability component $\left(X^*_\gamma, R^X_\gamma(\cdot), X_\gamma, R^{X*}_\gamma(\cdot)\right)$ than it was under the original contract. That is, γ is chosen to solve

$$IE_\omega\left[G^I\left(R(\cdot);\omega\right)\right] = IE_\omega\left[G^I\left(R_\gamma(\cdot);\omega\right)\right] + Z(\gamma) + \varepsilon$$
$$+c^*_I E_\omega\left[\left|A\left(R_\gamma(\cdot);\omega\right)\right| \mid \left(G_i\left(R_\gamma(\cdot);\omega\right)\right)_{i\in I} \in X^*_\gamma\right] \Pr(\left(G_i\left(R_\gamma(\cdot);\omega\right)\right)_{i\in I}$$
$$\in X^*_\gamma)$$

or equivalently

$$IE_\omega\left[G^I\left(R(\cdot);\omega\right)\right] = \gamma IE_\omega\left[G^I\left(R(\cdot);\omega\right)\right] + \gamma Z(1) + \varepsilon$$
$$+c^*_I E_\omega\left[\left|A\left(R(\cdot);\omega\right)\right| \mid \left(G_i\left(R(\cdot);\omega\right)\right)_{i\in I} \in X^*_1\right] \Pr(\left(G_i\left(R(\cdot);\omega\right)\right)_{i\in I}$$
$$\in X^*_1)\ . \qquad (3)$$

Note that joint liability is invoked in states which would have lead to investors monitoring under the original two-sided contract, i.e. $\left(G_i\left(R(\cdot);\omega\right)\right)_{i\in I} \in X^*_1$ only if $G^I\left(R(\cdot);\omega\right) \in S^*$. Since there are clearly fewer successful entrepreneurs than investors in all states ($\left|A\left(R(\cdot);\omega\right)\right| < J$), it follows that

$$IE_\omega\left[G^I\left(R(\cdot);\omega\right)\right] > c^*_I E_\omega\left[\left|A\left(R(\cdot);\omega\right)\right| \mid \left(G_i\left(R(\cdot);\omega\right)\right)_{i\in I} \in X^*_1\right]$$
$$\times \Pr\left(\left(G_i\left(R(\cdot);\omega\right)\right)_{i\in I} \in X^*_1\right)$$

since otherwise there is no way the participation constraints (1) and (2) could have been satisfied under the original contract. Thus for all ε sufficiently small, there exists a unique $\gamma \in [0,1]$ such that (3) holds.

Next, consider the change ΔU_J in the combined utility of the $J-1$ investors. We know

$$\Delta U_{J-1} \geq (\gamma - 1)\, IE_\omega\left[R^*\left(G^I\left(R(\cdot);\omega\right)\right)\right] + \gamma Z(1)$$
$$+\zeta c^*_I (J-1) \Pr\left(\left(G_i\left(R(\cdot);\omega\right)\right)_{i\in I} \in X^*_1\right)\ .$$

The first term is the scaling down of all payments by γ, the second term follows since all joint liability payments end up with the investors, and the third term is a lower bound on the expected reduction in monitoring costs when joint liability is invoked. Since $E_\omega\left[R^*\left(G^I\left(R(\cdot);\omega\right)\right)\right] \leq E_\omega\left[G^I\left(R(\cdot);\omega\right)\right]$ by feasibility, (3) implies that

$$\Delta U_{J-1} \geq -\varepsilon + c^*_I\left(\zeta(J-1) - E_\omega\left[\left|A\left(R(\cdot);\omega\right)\right| \mid \left(G_i\left(R(\cdot);\omega\right)\right)_{i\in I} \in X^*_1\right]\right)$$
$$\times \Pr\left(\left(G_i\left(R(\cdot);\omega\right)\right)_{i\in I} \in X^*_1\right)\ .$$

Since $J-1 > I \geq \left|A\left(R(\cdot);\omega\right)\right|$ for all $\omega \in \Omega$, it follows that $\Delta U_{J-1} > 0$ for all ζ close enough to 1 and ε close enough to 0.

It remains only to check that change in the intermediary's utility, ΔU_m, is positive. We know that

$$\Delta U_m + \Delta U_{J-1} \geq (\gamma - 1)\, E_\omega\left[G^I\left(R(\cdot);\omega\right)\right] + \gamma Z(1)$$
$$+\left(\zeta(J-1)\, c^*_I - (1-\zeta)\, Ic\right) \Pr\left(\left(G_i\left(R(\cdot);\omega\right)\right)_{i\in I} \in X^*_1\right)$$

since the increase in the intermediary's expected monitoring costs is at most the cost of monitoring all successful entrepreneurs who have less than $R(S^c) + \delta$ resources, an event with probability less than $1 - \zeta$. As above, substituting in (3) implies that $\Delta U_m + \Delta U_{J-1} > 0$ for all ζ close enough to 1 and ε close enough to 0. If $\Delta U_m > 0$ we are done, while if $\Delta U_m \leq 0$ it is straightforward to decrease the payments[10] from the intermediary to the investors until both $\Delta U_m > 0$ and $\Delta U_{J-1} > 0$ hold. This completes the proof.

2.2 Monitoring reveals only aggregates

In constructing the joint liability arrangement of Proposition 1, we used the information revealed about the distribution to make sure that joint liability is only invoked when there is at least one successful entrepreneur, to allow the return transfer R_γ^{X*} to depend on the number of successful entrepreneurs, and to allow monitoring investors to check that the intermediary has invoked joint liability if he was meant to. We will now show that even when monitoring the intermediary reveals only information about aggregates it is possible to preserve these features – though at the cost of introducing more monitoring.

Given a two-sided contract $((R(\cdot), S), (R^*(\cdot), S^*))$, we consider adding joint liability as follows. If the intermediary's combination of aggregate income and aggregate monitoring expenses, $\left(G^I(R(\cdot);\omega), C(R(\cdot);\omega)\right)$ belongs to the set $X^* \subset \Re^2$, then the intermediary invokes the following joint liability arrangement:

0. The intermediary sends a message to each successful entrepreneur (i.e. all $i \in A(R(\cdot);\omega)$) announcing that joint liability is in effect. Each of these successful entrepreneurs then monitors the intermediary. This monitoring ensures both that the intermediary never invokes joint liability in a state ω in which $\left(G^I(R(\cdot);\omega), C(R(\cdot);\omega)\right) \notin X^*$, and allows the successful entrepreneurs to learn the value of $|A(R(\cdot);\omega)|$.
1. The intermediary monitors *all* successful entrepreneurs. Each entrepreneur $i \in A(R(\cdot);\omega)$ makes an additional transfer $R^X(\theta_i(\omega))$ to the intermediary. The transfer function R^X must satisfy feasibility ($R(w) + R^X(w) \leq w$ for all w). Since the intermediary monitors all entrepreneurs, there is no additional incentive compatibility constraint. Note that the intermediary's aggregate monitoring costs are now Ic – he monitors *all* entrepreneurs. The random variables $G_i^X\left(R^X(\cdot);\cdot\right)$ (the intermediary's joint liability transfer from entrepreneur i) and $G^{XI}\left(R^X(\cdot);\cdot\right)$ (the intermediary's average joint liability transfer from all entrepreneurs) are defined as before.
2. The successful entrepreneurs monitor the intermediary for a second time, in order to learn the intermediary's aggregate income after receiving the joint liability payments. The intermediary makes a payment $R^{X*}\left(G^I\left(R^X(\cdot);\omega\right) + G^{XI}\left(R^X(\cdot);\omega\right), |A(R(\cdot);\omega)|\right)$ to each of them.

Thus in this case, a joint liability contract is defined by the triple $\left(X^*, R^X(\cdot), R^{X*}(\cdot)\right)$.

[10] Decreasing the payments may also result in further reduction of monitoring costs.

Regardless of the whether or not joint liability is invoked, the intermediary then makes a transfer $R^* \left(G^I \left(R\left(\cdot\right);\omega\right) + G^{XI}\left(R^X\left(\cdot\right);\omega\right)\right)$ to the investors. Since monitoring reveals the aggregate monitoring expenditure of the intermediary, and as noted the aggregate expenditure under joint liability equals Ic, the intermediary cannot deviate by not invoking joint liability without the investors detecting this deviation.

Relative to the case in which monitoring reveals the full vector of transfers, the above construction necessitates more monitoring when joint liability is invoked. That is, conditional on joint liability being invoked total monitoring costs are $|A\left(R\left(\cdot\right);\omega\right)|\left(c_I^* + c + c_I^*\right)$ as opposed to a maximum of $|A\left(R\left(\cdot\right);\omega\right)|\left(c_I^* + c\right)$ in the previous case. However, the following variant of Proposition 1 still holds. (The proof almost exactly parallels the proof of Proposition 1 and is omitted.)

Proposition 2 *Suppose that at least* **three** *investors are required to fund each entrepreneur ($y \geq 3$) and the cost of monitoring the intermediary is at least equal to the cost of monitoring an entrepreneur ($c_I^* \geq c$). Then for any two-sided contract $\left(\left(R\left(\cdot\right), S\right), \left(R^*\left(\cdot\right), S^*\right)\right)$ satisfying the participation constraints (1) and (2), there exists an alternative two-sided contract $\left(\left(\hat{R}\left(\cdot\right), \hat{S}\right), \left(\hat{R}^*\left(\cdot\right), \hat{S}^*\right)\right)$ with a joint liability component $\left(X^*, R^X\left(\cdot\right), R^{X*}\left(\cdot\right)\right)$ that strictly increases the expected utility of all agents.*

References

1. Bolton, P., Freixas, X.: Equity, bonds, and bank debt: capital structure and financial market equilibrium under asymmetric information. Journal of Political Economy **108**, 324–351 (2000)
2. Bond, P.: Bank and non-bank financial intermediation. Working Paper (2003)
3. Diamond, D.W.: Financial intermediation and delegated monitoring. Review of Economic Studies **51**, 393–414 (1984)
4. Gale, D., Hellwig, M.: Incentive-compatible debt contracts: the one-period problem. Review of Economic Studies **52**, 647–663 (1985)
5. Ghatak, M., Guinnane, T.: The economics of lending with joint liability: a review of theory and practice. Journal of Development Economics **60**, 195–228 (1999)
6. Hellwig, M.: Liquidity provision, banking and the allocation of interest rate risk. European Economic Review **38**, 1363–1389 (1994)
7. Hellwig, M.: Banks, markets, and the allocation of risks in the economy. Journal of Institutional and Theoretical Economics **154**, 328–345 (1998)
8. Hellwig, M.F.: Financial intermediation with risk aversion. Review of Economic Studies **67**, 719–742 (2000)
9. Holmström, B., Tirole, J.: Financial intermediation, loanable funds, and the real sector. Quarterly Journal of Economics **112**, 663–691 (1997)
10. Hubbard, R.G., Kuttner, K., Palia D.: Are there bank effects in borrowers' costs of funds? Evidence from a matched sample of borrowers and banks. Journal of Business **75**, 559–581 (2002)
11. Jacobson, L.S., LaLonde, R.J., Sullivan, D.G.: Earnings losses of displaced workers. American Economic Review **83**, 685–709 (1993)
12. Kennickell, A., Starr-McCluer, M., Sunden, A.: Family finances in the U.S.: Recent evidence from the Survey of Consumer Finance. Federal Reserve Bulletin, January: 1–24 (1997)
13. Kletzer, L.G.: Job displacement. Journal of Economic Perspectives **12**, 115–136 (1998)
14. Krasa, S., Villamil, A.P.: Monitoring the monitor: An incentive structure for a financial intermediary. Journal of Economic Theory **57**, 197–221 (1992)

15. Lamont, O.: Cash flow and investment: Evidence from internal capital markets. Journal of Finance **52**, 83–109 (1997)
16. Morduch, J.: The microfinance promise. Journal of Economic Literature **37**, 1569–1614 (1999)
17. Stein, J.C.: An adverse-selection model of bank asset and liability management with implications for the transmission of monetary policy. RAND Journal of Economics **29**, 466–486 (1998)
18. Townsend, R.M.: Optimal contracts and competitive markets with costly state verification. Journal of Economic Theory **21**, 265–293 (1979)
19. Webb, D.C.: The impact of liquidity constraints on bank lending policy. Economic Journal **110**, 69–91 (2000)
20. Williamson, S.D.: Costly monitoring, financial intermediation, and equilibrium credit rationing. Journal of Monetary Economics **18**, 159–179 (1986)
21. Winton, A.: Costly state verification and multiple investors: the role of seniority. Review of Financial Studies **8**, 91–123 (1995)