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Financial Intermediaries and Liquidity Creation

GARY GORTON and GEORGE PENNACCHI*

ABSTRACT

Trading losses associated with information asymmetries can be mitigated by designing securities which split the cash flows of underlying assets. These securities, which can arise endogenously, have values that do not depend on the information known only to informed agents. Bank debt (deposits) is an example of this type of liquid security which protect relatively uninformed agents, and we provide a rationale for deposit insurance in this content. High-grade corporate debt and government bonds are other examples, implying that a money market mutual fund-based payments system may be an alternative to one based on insured bank deposits.

A WIDELY HELD VIEW is that the investor of modest means is at a disadvantage relative to large investors. This popular perception, dating from at least the early 19th century, has it that the small, unsophisticated investor—"the farmer, mechanic, and the laborer"—is least equipped to acquire information and is most often victimized by having to trade with better informed agents. U.S. history is repeatedly marked by incidents of real or imagined insider shenanigans and resulting popular initiatives against the "money trusts" and the "robber barons." This view is responsible for many institutions, e.g., the *SEC* antitrust legislation, and various forms of taxation. This argument has also influenced bank regulation where it has been used to justify government provision of deposit insurance as a matter of public policy.

The notion that informed agents can exploit uninformed agents has received some support from Kyle (1985) and Grinblatt and Ross (1985). They show that insiders can systematically benefit at the expense of uninformed traders when prices are not fully revealing. However, in these models the uninformed traders, called noise traders, are nonoptimizing agents; they simply trade and lose money. If informed agents can, somehow, systematically take advantage of uninformed agents, then it seems clear that the uninformed agents would be motivated to respond, possibly creating alternative mechanisms. In this essay we investigate whether financial institutions and security contracts will endogenously arise as a response to problems faced by uniformed investors with a need to transact. In

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particular, we ask whether there are a variety of solutions and whether government intervention might be a necessary feature of any of them.

We first consider an environment that is similar in spirit to the above traditional notion that investors might need to trade in markets where better informed agents are present. The uninformed agents in our model have uncertain consumption preferences but are optimizing agents. Like the previous research, we show that the informed agents may exploit the uninformed, even though here they are optimizing. However, this result holds only when certain contractual responses by the uninformed agents are precluded. We go on to consider how the uniformed agents would respond in order to protect themselves from losses to the insiders.

The central idea of the paper is that trading losses associated with information asymmetries can be mitigated by designing securities which split the cash flows of underlying assets. These new securities have the characteristic that they can be valued independently of the possible information known only by the informed. By using these securities for transactions purposes, the uninformed can protect themselves. While our focus is on trading contexts, Myers and Majluf (1984) have considered a related problem in corporate finance. When firm managers have inside information, the firm may face a lemons market in issuing new equity.[1] However, they show that, if a firm can issue default-free debt, then the firm does not have to pay a premium to outside investors. One conclusion of our paper, as discussed below, is that firms would be motivated to issue default-free debt even if there were no information assymmetries at the new issue date.

By focusing on information asymmetries within a trading context, we can develop a notion of a security's "liquidity." A liquid security has the characteristic that it can be traded by uninformed agents, without loss to insiders. We show how intermediation can create liquidity by splitting the cash flows of the underlying assets that they hold. By issuing debt and equity securities against their risky portfolios, intermediaries can attract informed agents to hold equity and uninformed agents to hold debt which they then use for trading purposes. The idea that intermediaries can alleviate the problem of trading against insiders provides a foundation for the demand for a medium of exchange such as money, which is often simply assumed in many monetary models (e.g., a cash-in-advance constraint).

Thus, we provide an argument for the existence of intermediation which is distinct from the previous literature. Recent research on the existence of intermediaries can be broadly divided into two literatures. One literature focuses on efficient lending arrangements when there exist information asymmetries between borrowers and lenders. Intermediaries are seen as the unique solution to such agency problems. Examples of research in this area include Diamond (1984) and Campbell and Kracaw (1980). Unlike this literature, which focuses solely on the asset side of intermediaries, our paper is similar to a second line of research which has investigated the properties of intermediaries' liabilities. In the seminal paper by Diamond and Dybvig (1983), banks provide liquidity by acting as risk-sharing arrangements to insure against depositors' random consumption needs.

[1] Rock (1986) considers a similar problem.

The intermediary contract prevents inefficient interruptions of production.

Like Diamond and Dybvig (1983), we are concerned with the idea that intermediaries provide liquidity. However, our notion of intermediaries as providers of liquidity differs in a number of important respects. As Jacklin (1987) and Cone (1983) have shown, a crucial assumption of Diamond and Dybvig (1983) is that agents cannot trade equity claims on physical assets. If a stock or equity market is open, this trading arrangement weakly dominates intermediation. Unlike Diamond and Dybvig, we do not arbitrarily rule out trading in a stock market. On the contrary, it is the presence of insiders in this market which motivates the formation of an intermediary. Second, our model differs in that the intermediaries here will explicitly issue debt and equity, serving as mechanisms that split cash flows. Finally, the existence of our intermediary does not rely on providing risk sharing or resolving inefficient interruptions of production. Our notion of liquidity as providing protection from insiders is fundamentally different.

Recent independent work by Jacklin (1988) is similar to ours in that, in the context of a Diamond and Dybvig-like model, he does not rule out trading in an equity market and shows that bank liabilities can prevent losses to informed insiders. However, the intermediary modeled by Jacklin does not issue debt and equity and is partly motivated on risk-sharing grounds. Our model differs in that intermediaries explicitly issue both debt and equity securities, thereby splitting the cash flows of their asset portfolio. Thus, in our setup, intermediaries explicitly create a new, liquid security. We also consider the feasibility of this intermediary contract by considering the conditions under which the intermediary can attract insiders to become equity holders. Thus, we justify the bank from first principles on grounds different from risk sharing.

Importantly, bank intermediation is not the unique solution for protecting uninformed agents. In our model, liquidity creation may be accomplished at the firm level without the need for bank intermediation. By issuing both equity and debt, firms can split the cash flows of their asset portfolios, thereby creating a security (corporate debt) which is safer than their underlying assets. This debt can serve as the basis of a safe security that may be used by uninformed agents for transaction purposes.

A key point is that private transactions contracts may not be feasible under certain conditions. This might be viewed as a "market failure" from the perspective of the uninformed agents and could justify a role for government intervention. The government can intervene on their behalf in several ways. One way of protecting the uninformed agents is by insuring the deposits of the banking system through a tax-subsidy scheme. A system of government deposit insurance can achieve the same allocation as when private bank transactions contracts are feasible. Alternatively, if it is infeasible for corporations to issue sufficient amounts of riskless debt, government intervention in the form of a Treasury bill market can improve uninformed agents' welfare by providing additional riskless securities. This form of intervention is shown to parallel that of the provision of deposit insurance since, in both cases, the government's role is to create a risk-free asset.

The paper proceeds as follows. In Section I the model economy is detailed. In Section II a stock market allocation when all agents are fully informed is set out

as a reference point. Section III considers the case of asymmetric information and shows how the informed agents can take advantage of uninformed agents by forming a coalition that trades in the stock market. Then, in Section IV the private intermediary contact, when feasible, is shown to break the informed agents' coalition. When private contracts are infeasible, we show in Section V that government intervention by insuring bank deposits or creating a government debt market can be beneficial in protecting uninformed agents. Section VI concludes.

I. The Model Economy

There are three dates in the model economy, $t = 0, 1, 2$, and a single consumption good. The following assumptions detail the model.

A1. Preferences

There are three types of agents:

(i) Agents with known preferences at $t = 0$, who derive utility from consumption at date $t = 2$ given by $U = C_2$.
(ii) Agents with preferences that are unknown at date $t = 0$, but which are realized at date $t = 1$ to have utility from consumption at date $t = 1$ given by $U = C_1$ but no utility from consumption at $t = 2$. These agents are called "early" consumers.
(iii) Agents with preferences that are unknown at date $t = 0$, but which are realized at date $t = 1$ to have utility from consumption at date $t = 2$ given by $U = C_2$ but no utility from consumption at date 1. These agents are called "late" consumers.

Agents of types (ii) and (iii) will collectively be called "liquidity traders." Let N equal the number of liquidity traders, which is assumed to be large relative to the number of agents with known preferences. At $t = 1$ the proportion of liquidity traders with preferences for early consumption is realized. (The remaining fraction consists of late consumers.) The realized proportion of early consumers may be low, proportion w_l, which is expected to occur with prior probability q_l, or high, proportion w_h, expected to occur with prior probability q_h. It is assumed that $w_h > w_l$.

A2. Endowments and Technology

At $t = 0$, all agents receive endowments of a capital good which when invested earn a return in the form of the consumption good at $t = 2$. Each liquidity trader is assumed to receive an endowment of one unit of the capital good, while type (i) agents with known preferences receive equal endowment shares of the capital good that total M units in aggregate. Capital is homogeneous, and each unit produces the same random return. Each capital unit produces either R_H units of the consumption good or R_L units of the consumption good at date $t = 2$, where $R_H > R_L > 0$. It is assumed that the probabilities at date $t = 0$ of each state occurring equal one half.

In addition to the capital good, all liquidity traders receive an endowment of e_1 units of the consumption good at $t = 1$, while type (i) consumers receive equal endowment shares of the consumption good at time $t = 2$ that total Me_2 units in aggregate. Each unit of the consumption good received by the liquidity traders at $t = 1$ can either be consumed at $t = 1$ or stored to yield a certain return of one unit of the consumption good at date $t = 2$.

A3. Information Sets

At date $t = 1$, uncertainty about capital returns and liquidity traders' preferences is resolved. It is assumed that type (i) consumers have access to this information at date $t = 1$; i.e., they know whether the return on capital will be high or low and whether the proportion of early consumers in the economy is high or low. Thus, we will hereafter refer to the type (i) consumers as the "informed" traders.

While liquidity traders find out at $t = 1$ whether they are early or late consuming individuals we will consider the case where they are not directly informed about the aggregate proportion of early consumers and the realized return on capital. In this case, information may or may not be revealed by the result of traders' actions at time $t = 1$. However, for purposes of comparison, we will first consider the "full-information" benchmark case where liquidity traders are assumed to directly receive information regarding the realized aggregate proportion of early consumers and the realized return on capital.

II. A Stock Market with Full Information

It is apparent that certain agents will desire to trade at $t = 1$. In particular, when some liquidity traders find that they are early consumers at $t = 1$, they will want to sell their entire endowment of the capital good for the consumption good at this time. In addition, other liquidity traders who discover that they are late consumers may want to sell their $t = 1$ endowment of the consumption good for the capital good if their expected return to holding capital is at least as good as their return to storing their consumption endowment.In general, the type (i) informed traders may desire to sell some of their capital good for the consumption good at time $t = 1$ in order to store it from $t = 1$ to $t = 2$. Whether informed traders want to sell capital will be an important issue when we consider the case of uninformed liquidity traders. However, it will become clear that ignoring the type (i) traders will not change the equilibrium for the full-information case.

Since each unit of capital invested at $t = 0$ is subject to the same source of risk (i.e., either all units produce a high return or all units produce a low return at $t = 2$), it will make no difference whether we think of agents individually investing their endowment of the capital good or giving it to firms who then issue to them shares reflecting a proportional claim to the capital's return at $t = 2$. Thus, a "stock market" is equivalent to individual investment of the capital good.

Let us then consider the stock market equilibrium in this full-information case. All agents' utility levels will be determined once we solve for the equilibrium price of the capital good in terms of the consumption good at date $t = 1$. We do

this for the four possible states of nature realized at date $t = 1$; $\{i,j\}$, $i = h,l$, $j = H,L$, where i refers to a high or low proportion of early consumers, while j refers to a high or low return on the capital good. Let p_{ij} denote the date $t = 1$ value of one unit of the capital good in terms of units of the consumption good when state i,j occurs.

At $t = 1$ early consumers will wish to purchase the consumption good in exchange for their endowment of one unit of the capital good. Early consumers, in total, own Nw_i units of the capital good which they are willing to sell. The aggregate quantity of the endowment good demanded by the early consumers is Nw_ip_{ij}. Since the late consumers are the only agents from whom the early consumers can buy endowment of the consumption good, the late consumers will end up selling some or all of their endowment of the consumption good to the early consumers. Let the amount of consumption good supplied by the late consumers be $S(p_{ij})$. If everything is supplied, then $S(p_{ij}) = Ne_1(1 - w_i)$. Otherwise, some amount less than $Ne_1(1 - w_i)$ will be supplied.

We now determine the price, p_{ij}, which clears the market at date $t = 1$ in each state of the world $\{i,j\}$. Market clearing equates the demand for the consumption good with supply. Thus,

$$Nw_ip_{ij} \leq Ne_1(1 - w_i). \tag{1}$$

There are two separate cases to consider, one where late consumers sell all of their consumption endowment (condition (1) holds with equality) and one where they sell only part, choosing to store some (condition(1) being strict inequality).

When there is no storage in equilibrium, condition (1) becomes an equality. Solving for the price of the capital good, we have

$$\text{(No Storage)} \qquad p_{ij} = \frac{e_1(1 - w_i)}{w_i}. \tag{2}$$

This case holds under the parametric restriction:

$$R_j > \frac{e_1(1 - w_i)}{w_i}. \tag{3}$$

When storage occurs in equilibrium, late consumers must be just indifferent between buying and holding the capital good and storing the consumption good, i.e.,

$$\text{(Some Storage)} \qquad p_{ij} = R_j. \tag{4}$$

This case holds when the inequality sign in condition (3) is reversed.

Hereafter, we will make the assumption that condition (3) holds for $j = H$, so that, in equilibrium, no storage will occur for the states $\{h, H\}$ and $\{l, H\}$, where the return on capital is high. In addition, we will assume that condition (3) does not hold for $j = L$, so that, in equilibrium, some storage will occur for the states $\{h, L\}$ and $\{l, L\}$, where the return on capital is low. These assumptions can be summarized by the following condition:

$$R_H > \frac{e_1(1 - w_l)}{w_l} > \frac{e_1(1 - w_h)}{w_h} > R_L. \tag{5}$$

Condition (5) amounts to assuming a sufficiently high variance in asset returns relative to the variance in the proportion of early consumers. This assumption will lead to a more interesting problem when we consider the effects of asymmetric information.

Note that, for this full information case, type (i) consumers have no incentive to trade in the capital good at date $t = 1$. Whenever there is a high return on capital, the rate of return on capital exceeds that of storing endowment, so type (i) consumers will choose not to sell capital. When there is a low return on capital, the rate of return on capital just equals the return to storage, so that type (i) traders are indifferent to purchasing endowment.

Since type (i) agents do not trade, their expected utility (consumption) per unit of capital endowment at date $t = 0$ is

$$E[C_2] = e_2 + \bar{R}, \tag{6}$$

where $\bar{R} \equiv \frac{1}{2}(R_H + R_L)$.

The expected utility of liquidity traders can be computed from our previous results:

$$\begin{aligned} E[C_1 + C_2] = {} & \frac{q_h}{2}\left[w_h(e_1 + p_{hH}) + (1 - w_h)\left(R_H + \frac{e_1 R_H}{P_{hH}}\right)\right] \\ & + \frac{q_l}{2}[w_l(e_1 + p_{lL}) \quad + (1 - w_l)\,(R_L + e_1)] \\ & + \frac{q_h}{2}[w_h(e_1 + p_{hL}) + (1 - w_h)\,(R_L + e_1)] \\ & + \frac{q_l}{2}\left[w_l(e_1 + p_{lH}) + (1 - w_l)\left(R_H + \frac{e_1 R_H}{p_{lH}}\right)\right] \\ = {} & e_1 + \bar{R}. \end{aligned} \tag{7}$$

In what follows, we will compare the expected utility of the different agent types under alternative information and trading settings to the expected utilities given by (6) and (7).

III. A Stock Market with Asymmetric Information

Now suppose the model is the same as that of the previous section except that only type (i) agents, the "informed traders," are assumed to have direct knowledge of the return on capital and the proportion of early consumers at $t = 1$. In this section we restrict liquidity traders to hold their wealth only in the form of stock. Given this assumption we ask whether the informed agents can collude at date $t = 1$ to exploit the liquidity traders. First, we summarize what will happen at $t = 1$. Then we define an equilibrium. Finally, we show the existence of insider trading in equilibrium.

The liquidity traders, early and late consumers, do not know what return capital goods will earn. Nor do they know the proportion of early consumers in the economy. At date $t = 1$, however, the decision of the early consumers is straightforward. Regardless of possible information, they sell their capital goods for consumption goods. Late consumers must decide either to store their newly arrived endowments of the consumption good or to sell all or parts of these endowments for capital goods. This decision, made as a function of the market price, characterizes the behavior of the late consumers.

Informed agents know (as do all agents) that, in equilibrium, prices will reveal some or all information about the true state of the world. Consequently, they will need to coordinate their trading strategies (collude) in order to gain from their superior information. We assume that there is a sufficiently small number of informed agents such that they are able to form a trading coalition, if they individually so desire. Thus, at $t = 1$ the sequence of events is as follows. First, the informed agents communicate and choose an amount of capital goods that they will jointly supply in state $\{i, j\}$ knowing that uninformed agents will act competitively. We first solve this game between the informed agents. Then the equilibrium price is determined to clear the market between late consumers supplying endowment goods and early consumers, possibly together with informed agents, selling capital goods.

The amount supplied by the coalition in each state $\{i, j\}$ will be based on a strategy designed to make some states of nature indistinguishable from other states of nature when viewed by the uninformed agents. That is, the equilibrium prices in some states of nature will be the same as in other states of nature. In order for prices not to reveal the true states of nature in equilibrium, the optimal strategies of individual informed agents must be to supply no more capital goods than are supplied by the coalition acting on their collective behalf. The existence of the insider trading equilibrium will depend on showing that individual members of the informed agents' coalition have no incentive to deviate from the coalition strategy, by selling capital goods on their own unbeknownst to the coalition. In equilibrium it will be in the interest of each informed agent to be a member of the coalition and, once having committed capital for sale by the coalition, not to supply any additional capital. This is because, if any additional capital is supplied by individual informed agents (acting independently of the coalition), the equilibrium price will reveal the true state of the world. If this occurs, then no informed agent can benefit. We now briefly formalize this so that we can subsequently define an equilibrium.

Let $M_{ij} \leq M$ be the amount the coalition proposes to its members as the amount to be supplied in state $\{i, j\}$, with each member supplying an identical share. The coalition's strategy will be characterized by the amount of the capital good that the coalition supplies in state $\{i, j\}$, M_{ij}. We say that M_{ij} is a *self-enforcing Nash coalition* in state $\{i, j\}$ if any subcoalition of informed traders, taking the capital supplied by the complement of the subcoalition as given, chooses to abide by the per capita shares assigned by the whole coalition. If this is true for all possible subcoalitions, then the coalition M_{ij} is not subject to collapse since there is no incentive for any member or group of members to

deviate from the proposed m_{ij}.[2] We will refer to this coalition as the "Insider Coalition."

Market clearing will require that the price, say p^*_{ij}, equate the demand for consumption goods with the supply of consumption goods in state $\{i, j\}$:

$$Nw_i p^*_{ij} + M_{ij} p^*_{ij} = S(p^*_{ij}). \tag{8}$$

As before, the supply, $S(p_{ij})$, will be either all the endowments of the late consumers, $N(1 - w_i)e_1$, or some lesser amount if there is storage in equilibrium.

We now define a Nash-type equilibrium in this setting. An *Imperfectly Competitive Rational Expectations Equilibrium* is (a) a price system, $\{p_{ij}\}$, (b) specification of storage strategies for the late consumers, $S(p_{ij})$, and (c) a specification of insider coalition strategies, $\{M_{ij}\}$, such that, given $\{p_{ij}\}$, knowledge of the model, and the information set of the informed agents in state $\{i, j\}$, the storage and coalition strategies of the respective agent types are chosen such that (i) their respective *utilities are maximized*, (ii) $\{p_{ij}\}$ *clears the market* in state $\{i, j\}$, and (iii) $\{M_{ij}\}$ is *self-enforcing*.

Let $R^* = q_h' R_h + q_l' R_L$ be the uninformed late consumers' expectation at time 1 of the return on capital when state $\{l, L\}$ actually occurs, where q_h' and q_l' are their posterior probabilities of the states being $w_i = w_h$ and $w_i = w_l$, respectively. The following proposition demonstrates the existence of insider trading by the informed agents.

PROPOSITION 1 (Insider Trading): *Let $\{\hat{p}_{ij}\}$ be the full-information prices for states, $\{i, j\}$. If* (i) $e_1(1 - w_h)/w_h \leq R^*$ *and* (ii) $\dfrac{M}{N} \geq \dfrac{(w_h - w_l)}{(1 - w_h)}$, *then there exists Imperfectly Competitive Rational Expectations Equilibrium prices $\{p^*_{ij}\}$, where $p^*_{lH} = \hat{p}_{lH}$, $p^*_{hL} = \hat{p}_{hL}$, and $p^*_{hH} = p^*_{lL} = \hat{p}_{hH}$. That is, these prices are fully revealing in only two of the four states.*

Proof: We will verify that the following specification of prices and strategies constitutes an equilibrium for the assumed parameter values.

State $\{l, H\}$

$$p^*_{lH} = \frac{e_1(1 - w_l)}{w_l};\ M_{lH} = 0;\ S(p^*_{lH}) = N(1 - w_l)e_1 \qquad \text{(No Storage).}$$

State $\{h, L\}$

$$p^*_{hL} = R_L;\ M_{hL} = 0;\ S(p^*_{hL}) < N(1 - w_l)e_1 \qquad \text{(Some Storage).}$$

State $\{h, H\}$

$$p^*_{hH} = \frac{e_1(1 - w_h)}{w_h};\ M_{hH} = 0;\ S(p^*_{hH}) = N(1 - w_l)e_1 \qquad \text{(No Storage).}$$

[2] See Bernheim, Peleg, and Whinston (1987) for the motivation for this definition of a self-enforcing coalition. This equilibrium concept refines the set of possible Nash equilibria of the game between the insiders when they choose the Insider Coalition strategy. For our purposes it focuses attention on equilibria of interest, namely ones in which insider trading occurs.

State $\{l, L\}$

$$p_{lL}^{*} = \frac{e_1(1 - w_h)}{w_h}; \; M_{lL} = \frac{N(w_h - w_l)}{(1 - w_h)}; \; S(p_{lL}^{*}) = N(1 - w_h)e_1 \qquad \text{(No Storage)}.$$

The proposed equilibrium prices in the first three states, $\{l, H\}$, $\{h, L\}$, and $\{h, H\}$, are the full-information prices. In the states $\{l, H\}$ and $\{h, L\}$, prices are fully revealing and are market clearing. It remains, then, to show that the actions of the insider coalition can cause prices to only partially reveal information in the states $\{h, H\}$ and $\{l, L\}$.

In state $\{l, L\}$, the return on the capital goods is low, and informed agents would like to sell their capital goods in exchange for consumption goods at the assumed equilibrium price. They will then store the consumption goods for one period. Since the proportion of the late consumers is low, w_l, the informed coalition can mimic the state $\{h, H\}$ where there are many late consumers and the informed agents don't enter the market.

Thus, if the late consumers supply all their endowment of consumption goods, then market clearing requires

$$Nw_l p_{iL}^{*} + M_{iL} p_{iL}^{*} = N\, e_1\, (1 - w_l). \tag{9}$$

Now, set $p_{hH}^{*} = p_{hH}^{*} = e_1 \dfrac{(1 - w_h)}{w_h}$ and solve for M_{lL}:

$$M_{lL} = \frac{N(w_h - w_l)}{(1 - w_h)}. \tag{10}$$

Condition (ii) of the proposition insures that insiders have sufficient capital for (10) to hold. By supplying M_{lL} units of the capital good in exchange for the endowment good, the insider coalition can create the false impression that the state is $\{h, H\}$ when, in fact, the state is $\{l, L\}$, However, for this to be successful, two further considerations need to be examined.

First, will late consumers choose to sell their endowment when they see the market clearing price p_{lL}^{*}? They will if, on average, it is profitable to do so, i.e., when condition (i) of the proposition holds:

$$p_{lL}^{*} = e_1 \frac{(1 - w_h)}{w_h} \leq R^{*} = q_h' R_H + q_l' R_L. \tag{11}$$

If late consumers form their expectation of the state being $\{l, L\}$ or $\{h, H\}$ in a Bayesian fashion, conditional on the fact that they, themselves, are late consumers, then

$$q_h' = q_h \frac{(1 - w_h)}{q_h(1 - w_h) + q_l(1 - w_l)},$$

$$q_l' = q_l \frac{(1 - w_l)}{q_h(1 - w_h) + q_l(1 - w_l)}.$$

Condition (11) says that, even though late consumers know that the informed coalition will cheat them in state $\{l, L\}$ and that this cannot be detected, still it

is optimal to sell all their endowment. It is optimal if q_h' is sufficiently large, so that most often the true (but unobserved) state is $\{h, H\}$.

Second, we must check that M_{lL} is a self-enforcing Nash coalition. If there is a total of M units of capital owned by the informed agents, and they are all in the coalition, then each can exchange M_{lL}/M per unit of the capital for endowment goods. Note that, if any member or group of members independently demands additional endowments, then the market clearing condition (9) will not hold at p_{lL}^* and the new price will reveal the collusion. Uninformed agents will infer the truth. If the state $\{l, L\}$ is revealed, late consumers will not be willing to sell their endowments. If there is a deviation from M_{lL}, then the informed agents as a group will not benefit, including the member or group who deviated. Therefore, since any deviation results in a fully revealing price and, hence, no benefits to informed agents, M_{lL} is self-enforcing. Q.E.D.

We can now calculate the expected utility per unit of capital endowment for the informed traders. While M is the total amount of capital endowment of the informed agents, the coalition can only sell M_{lL} units in state $\{l, L\}$. Therefore,

$$\begin{aligned} E(C_2) &= e_2 + \frac{R_H}{2} + \frac{q_h R_L}{2} + \frac{q_l}{2}\,[R_L + w_m(p_{lL}^* - R_L)] \\ &= e_2 + \bar{R} + \frac{q_l}{2} w_m (p_{lL}^* - R_L), \end{aligned} \tag{12}$$

where $w_m \equiv \dfrac{M_{lL}}{M} = \dfrac{N(w_h - w_l)}{M(1 - w_h)}$.

Since $R_L < p_{lL}^*$, by assumption (5), the expected utility of an informed trader exceeds the full-information expected utility since $w_m > 0$.

Likewise, we can calculate the expected utility of liquidity traders. It is straightforward to show that

$$E[C_1 + C_2] = e_1 + \bar{R} - \frac{q_1}{2}\,\frac{(w_h - w_l)}{(1 - w_h)}\,[p_{lL}^* - R_L]. \tag{13}$$

Note that this utility is less than that of the full-information case. We now turn to investigating whether the liquidity traders can prevent being victimized by the informed traders.

IV. Private Liquidity Creation

In the previous section, liquidity traders were not allowed to contract. The result was the existence of insider trading that increased the welfare of informed traders at the expense of the liquidity traders. We now allow the liquidity traders to respond by contracting. We show that allowing liquidity traders to contract can prevent insider trading by breaking the informed agents' coalition; i.e., the insider trading equilibrium analyzed in the previous section will no longer exist. Next, we show that an alternative equilibrium characterized by bank intermediation can exist. Finally, we show that the allocation achieved with the bank can be replicated at the firm level with corporations issuing riskless debt.

A. Bank Intermediation and Liquidity Creation

Suppose at date $t = 0$ the following contract is offered to agents. An intermediary will be set up which pools agents' capital and issues securities to them. Let $A = N_I + M_I$ be the total endowment of the capital good contributed by members of this intermediary as of date $t = 0$, where $N_I = N - N_S$ and $M_I = M - M_S$. The subscript I refers to the capital of agents joining the intermediary, and S refers to the capital of agents continuing to invest in the stock market. The total return of the intermediary's assets at date $t = 2$ is AR_i, $i = H, L$. Ownership of two types of claims on this capital is offered to agents: debt claims and equity claims. Let D and E (whose sum equals A) be the total amount of capital contributed by agents who own debt and equity claims, respectively.

The contract also imposes a debt-to-equity ratio ceiling such that the total payment promised to debt claim, DR_D, must be less than or equal to AR_L; i.e., debt claims are required to be riskless:

$$DR_D \leq AR_L = (D + E)R_L. \tag{14}$$

Therefore,

$$\frac{D}{(D + E)} \leq \frac{R_L}{R_D} \text{ or } E \geq \frac{D(R_D - R_L)}{R_L}. \tag{15}$$

We would like to consider whether offering agents this intermediary contract would affect the Imperfectly Competitive Rational Expectations Equilibrium analyzed in the previous section. Before stating a series of propositions related to this issue, we make an additional assumption that will simplify the proof of the first of these propositions. We assume that conditional on being a late consumer, the probabilities of the state being $w_i = w_h$ or $w_i = w_l$ are equally likely. If late consumers form expectations in a Bayesian manner, this implies

$$q_h(1 - w_h) = q_l(1 - w_l). \tag{16}$$

Now suppose that liquidity traders are allowed to offer the intermediary contract to all agents as a possible trading mechanism. It is clear that, for R_D sufficiently high, liquidity traders are better off holding bank debt. The question is whether the informed agents can be induced to defect from the Insider Coalition to become the bank's equity holders. If this occurs, the intermediary contract will be feasible and the equilibrium of the previous section will not exist.

PROPOSITION 2 (Nonexistence of Stock Market Insider Equilibrium): *Consider a small number of liquidity traders, say N_I (close to zero), choosing to form a bank. Then, if the ratio of informed to uninformed agents' capital, $\frac{M}{N}$, is sufficiently large, there exists a rate of return on intermediary debt, R_D, such that* (i) *debt is riskless,* (ii) *liquidity traders prefer to invest their capital in the debt of the intermediary rather than the stock market, and* (iii) *individual informed agents prefer to invest their capital in the equity of the intermediary rather than the stock market insider coalition.*

Proof: See the Appendix.

Proposition 2 provides a condition under which individual liquidity traders and informed agents have an incentive to form an intermediary at time 0 rather than invest in the stock market. The higher the ratio of total capital of the informed agents to that of the liquidity traders, the smaller will be the expected profits of the informed agents in the Insider Coalition. Therefore, the higher this capital ratio, the smaller is the required rate of return on bank equity necessary to induce an individual insider to join the bank and defect from the Insider Coalition. Consequently, if the required return on bank equity is not too large, the rate of return on bank debt will be large enough to attract an individual liquidity trader away from the stock market as well.

The next proposition states that an equilibrium can exist where *all* liquidity traders choose to purchase the riskless debt of an intermediary and informed agents derive no advantage from operating an Insider Coalition in the stock market. The proof of this proposition assumes the following condition, which includes condition (5) assumed previously:

$$R_L < \frac{e_1(1 - w_h)}{w_h} < \bar{R} < \frac{e_1(1 - w_l)}{w_l} < R_H. \tag{17}$$

PROPOSITION 3 (Existence of an Intermediary Equilibrium): *If* $\frac{M}{N}$ *is sufficiently large, then there exists an equilibrium where* (i) *all liquidity traders purchase riskless debt of the intermediary and* (ii) *informed agents will choose to contribute equity capital.*

Proof: See the Appendix.

The intuition behind this result is that, if informed agents' capital is sufficiently large relative to that of the liquidity traders, it is feasible for a bank to issue sufficient riskless debt that can be used by all liquidity traders for transactions.[3] Implicitly, the existence of this bank contract allows the informed agents to be identified so that trade with them can be avoided. All liquidity traders who are early consumers will trade bank debt for endowment at date $t = 1$. Late consumers considering selling their endowment at date $t = 1$ will never choose to purchase stock market capital because they know that only informed agents will be supplying stock market capital for endowment, and then only when the return on capital is low. Thus, the stock market becomes an Akerloff (1970) "Lemons" market, and late consumers will choose to trade only with early consumers selling intermediary debt. In this sense, liquidity traders are able to "protect" themselves from possible disadvantageous trades with the better informed agents.

In summary, we have shown that conditions exist where liquidity traders are better off holding intermediary debt which is made riskless because some informed investors will voluntarily contribute equity capital for the intermediary. Under these conditions, with $N_I = N$ and $N_S = 0$, the advantage that the Insider

[3] In addition, as is shown in the Appendix, the greater R_L is, the higher is the feasible leverage of the intermediary, i.e., the smaller is the proportion of informed agents needed to join the intermediary to make its debt riskless. The greater the leverage, the less R_D needs to be lowered in order to raise the expected rate of return on the intermediary's equity in order to attract informed agents.

Coalition derives from superior information is completely eliminated. With no one to trade with at date $t = 1$ except other informed agents, informed agents' expected rate of return on stock is simply $\bar{R}$. With sufficient defections from the Insider Coalition, the competitive expected rate of return on intermediary equity will also approach $\bar{R}$, resulting in a deposit rate, R_D, with a limiting value equal to $\bar{R}$. Hence, the private intermediary contract can result in an allocation which gives all agents an expected utility arbitrarily close to the full-information case.

B. Corporate Debt and Liquidity Creation

So far we have implicitly assumed that "firms" do not issue debt. That is, when we considered the stock market equilibrium in Section III, we imagined individuals exchanging their capital with firms who issued them equity shares. In this section we briefly consider what happens if the firms are willing to buy capital at $t = 0$ in exchange for either debt or equity. So now there exists a market for corporate debt, such as commercial paper.

Suppose a firm offers to pay R_D per dollar of debt and issues an amount of riskless debt such that $DR_D = AR_L$, where $A = D + E$ is the firm's total assets. Then it is immediately apparent that the firm can offer the same riskless debt as the bank intermediary we described previously. All of the above arguments about the bank now apply to the firm. Agents need not directly hold the claims of firms, but mutual funds could arise to specialize in holding either debt or equity claims. In particular, funds similar to money market mutual funds could purchase the high-grade debt (e.g., commercial paper) of firms. As before, the equilibrium would be for all liquidity traders to buy claims on the debt fund and all informed traders to buy claims on the firm's equity. We comment further on this in our concluding remarks.

V. Deposit Insurance and a Government Debt Market

A deposit insurance system for banks can also satisfy the liquidity traders' desire for a safe asset for trading. In this section we show how deposit insurance can replicate the allocation of the previous section when intermediary debt is risky. In addition, we show that development of a government debt market is similar to deposit insurance, as it involves government creation of a risk-free asset. In a like manner, a government debt market can replicate the riskless corporate debt contract when riskless corporate debt is in insufficient supply. The government can succeed where private contracting fails due to its ability to enforce lump sum taxation. It is the revenue from this taxation that accounts for the government's ability to create riskless securities.

As Merton (1977) has observed, "the traditional advantages to depositors of using a bank rather than making direct market purchases of fixed-income securities . . . economies of scale, smaller transactions costs, liquidity, and convenience . . . are only important advantages if deposits can be treated as riskless." Presumably, if deposits were not riskless, then small agents would face information and surveillance costs necessary to evaluate the current risk of bank liabilities. Without this information, other informed agents might then take

advantage of them. Consequently, less informed agents would benefit if there were deposit insurance. Indeed, a stated goal of government deposit insurance is to protect the small investor.

Suppose that deposits are risky, i.e., $DR_D > AR_L$. This would be the case if, for example, the capital endowment of the informed agents were too small to provide enough riskless debt or if $R_L = 0$. In other words, if the low return rate state of the world is realized, then deposits will incur a capital loss. The insurance system works as follows. If R_L is realized, so that the bank would not be able to meet its promised payments at time $t = 2$, then the government is assumed to tax all late consuming agents in proportion to their endowment in order to raise enough revenue to pay off the bank debt at par.[4] The government will also charge an insurance premium at time $t = 2$ that the bank pays if it does not fail, i.e., when R_H is realized, which is allocated to all late consuming agents.

Let T be the tax revenue collected when the bank fails. In order to avoid a capital loss on deposits if R_L is realized, the amount of insurance needed is $T = DR_D - AR_L$. Each agent consuming at date $t = 2$ pays a share of T. At $t = 2$ there are informed agents who were endowed with M units of capital and $N(1 - w_i)$, $w_i = w_l$ or w_h, late consuming liquidity traders, each having been endowed with one unit of capital. This insurance arrangement will only be feasible if, regardless of the proportion of early consumers, the remaining agents can afford to pay the tax. Thus, feasibility requires

$$T/[M + N(1 - w_i)] < e_2,\ i = l,\ h, \tag{18a}$$

$$T/[M + N(1 - w_i)] < R_D + e_1 \frac{R_D}{p_{Di}},\ i = l,\ h. \tag{18b}$$

Informed agents have, at least, Me_2, their second-period endowment.[5] Thus, the tax per unit capital cannot exceed the e_2 endowment. This is requirement (18a) above. Similarly, (18b) requires that the late consuming liquidity traders, who have assets of $R_D + e_1 \frac{R_D}{p_{Di}}$, be able to afford the tax. (The values of p_{Di} are given by (A18) in the Appendix.)

If the bank does not fail, then the bank pays an insurance premium of ϕ to the rest of the economy, which consists of all informed agents and depositors. The expected return to the bank equity holders in the presence of deposit insurance is

$$E[R_E]E = (½)[R_H(D + E) - (R_D + \phi)D] + (½)\cdot 0. \tag{19}$$

It is straightforward to solve for a fair insurance premium. Since bank failure and bank solvency are equally likely, i.e., R_L and R_H each occur with probability one half, a fair insurance premium equates the amount paid as a premium in the high state with the amount of insurance coverage in the low state:

$$\phi D = T = DR_D - (D + E)R_L, \tag{20}$$

[4] The government is assumed to observe the bank failure at date $t = 2$.

[5] Informed agents holding bank equity have only e_2 per unit of initial endowed capital since their bank equity is worthless, while informed agents in the stock market have $e_2 + R_L$.

which implies that

$$\phi = R_D - \frac{(D + E)}{D} R_L. \tag{21}$$

Substituting (21), the expression for the fair deposit insurance premium, into (19) yields

$$E[R_E]E = R(D + E) - R_D D. \tag{22}$$

As in the previous section, consider a competitive equilibrium where the expected rate of return on equity approaches $\bar{R}$. In this case, equation (22) shows that R_D also approaches $\bar{R}$. Therefore, the allocation under the deposit insurance scheme gives agents the same expected utility as in the case of the private uninsured intermediary considered in the previous section. In summary, we have shown the following.

PROPOSITION 4 (Deposit Insurance): *When bank debt is risky, the tax-subsidy scheme $\{T, \phi\}$, defined above, can implement an allocation which gives all agents the same expected utility as in the riskless private bank deposit allocation.*

Similar to government intervention as a deposit insurer, we can consider whether government intervention can benefit uninformed agents when firms issue corporate debt, as was described previously. Let us start from the assumption that each firm issues riskless debt such that

$$A_i R_L \geq D_i R_D, \tag{23}$$

where A_i and D_i are the assets and debt of firm i, respectively. However, suppose that the assets of firms are of sufficient risk to preclude uninformed agents from placing their entire wealth in risk-free corporate debt. In this case, government intervention in the form of a government debt market can allow uninformed agents to replicate the allocation of the previous Section IV.*B*, where riskless corporate debt was in sufficient supply.

As with the deposit insurance scheme, the government can create additional two-period risk-free securities backed by lump sum taxation of agents' endowment in period 2. The government simply issues claims on second-period endowment equal to the difference between uniformed agents' time 0 endowment and the supply of risk-free corporate debt, so that the government sells bonds for capital equal to $N - D$ at time 0. Since government and firm debt are perfect substitutes, they each pay a two-period return of R_D, implying that the time $t = 2$ maturity value of government bonds B equals

$$B = (N - D)R_D. \tag{24}$$

The government is assumed to invest the capital it acquires at time 0, either directly investing it itself or giving it to firms which issue it equity shares. At time $t = 2$, this investment is worth $(N - D)Ri$, $i = H, L$. The short fall (excess) between this investment return and the promised payments on bonds, B, is made up by lump sum taxation (subsidization) of late consumers, subject to feasibility requirements similar to (18a) and (18b). Competitive equilibrium implies that the expected return on equity as well as the return on riskless debt will equal $\bar{R}$.

Thus, the additional debt supplied by the government can allow uninformed agents to purchase sufficient risk-free securities to meet their demands for liquidity. Hence, this intervention can also restore the uninformed agents an allocation which gives them the same expected utility as in the full-information case.

VI. Conclusion

The historically popular notion that informed agents can benefit at the expense of uninformed agents is true in the setting which we have analyzed. Informed agents can form an insider coalition which is self-enforcing and can benefit at the expense of the lesser informed agents. When this condition exists, a demand for liquid securities by uninformed agents will result. By splitting risky cash flows, liquid securities are created which have the effect of eliminating the potential advantage possessed by better informed agents.

Liquidity can be created through the formation of banks. We have formalized a traditional rationale for the existence of banks and deposit insurance, namely that they provide a riskless transactions medium that eliminates the need of uninformed agents to trade in assets whose returns are known by better informed agents. By issuing deposits, banks create "riskless" securities for trading purposes. In instances where bank asset risk is such that uninsured deposits cannot be made riskless, we have shown that deposit insurance can replicate the allocation achieved with riskless private bank deposits.[6] In addition, liquid securities can also be created through the formation of corporate debt or government securities markets. As an alternative to bank intermediation, firms can split risky cash flows, thereby creating a safer security (debt).

An empirical implication of our model is that transactions securities should be the most actively traded assets. This is consistent with the relatively high turnover in ownership of insured bank liabilities and Treasury securities. Corporate debt, on the other hand, is much less actively traded, suggesting that our assumption that firms can create riskless securities simply by splitting the cash flows of their underlying assets is not completely accurate.

For tractability, we studied a model with a single source of asset risk. Clearly, with multiple sources of asset risk, diversification would provide another, perhaps complementary, channel for the reduction of risk. This channel implies combining imperfectly correlated assets to reduce risk, rather than splitting cash flows. These issues are investigated in Gorton and Pennacchi (1989). The creation of mutual funds holding a diversified portfolio of corporate debt can alleviate the inability of individual firms to create riskless debt. For example, money market mutual funds are large holders of commercial paper, and the shares of these funds provide a potentially important transactions medium.[7]

[6] An issue which we have not considered concerns possible equilibria where banks exist but their uninsured bank deposits are risky. In this situation we conjecture that the liquidity traders would be better off than without the bank but clearly would not be as well off as the case of riskless bank debt. The value of risky bank debt would depend on the state of nature, but to a lesser extent than would stock. Informed traders might still use their information advantage.

[7] Currently, the transactions services provided by money market mutual fund shares may by inhibited by regulation which denies these mutual funds independent access to the payments system. Money market mutual fund check and wire transfers must be carried out through commercial banks.

Due to the recent growth of the market for short-term corporate debt, the possibility of substituting money market mutual fund shares for bank debt is intriguing.[8] A public policy debate has smoldered around whether such alternative instruments should be encouraged or restricted as transactions media. In our analysis there is not reason to prefer bank debt over money market mutual funds. However, extending our analysis to consider the regulatory distortions and monitoring costs associated with bank deposit insurance might lead to a preference for a money market mutual fund-based transactions system.

Appendix

Proof of Proposition 2: Step 1 of the proof is to consider the situation of the liquidity traders. Given the feasibility of the intermediary, we derive the conditions under which they are better off purchasing the intermediary's debt rather than investing their capital in the stock market. Step 2 considers the informed agents and shows that, under the conditions derived in step 1, they may be individually better off by becoming equity holders in the intermediary rather than being members of the Insider Coalition that operates in the stock market. Thus, if informed agents are willing to contribute equity capital, the intermediary contract is feasible.

Step 1: Let p_{Dij} be the number of endowment units received in exchange for one unit of the debt claim at date $t = 1$ when the state is $\{i, j\}$, where $i = l, h$, and $j = L, H$. Because of the risk neutrality of uninformed agents, at time $t = 1$ it must be the case that

$$\frac{R_D}{p_{Dij}} = \frac{R^e}{p_{ij}} \equiv r_{ij}, \tag{A1}$$

where R^e is the uninformed late consumers' expectation at time $t = 1$ of the return on the capital good at time $t = 2$ and r_{ij} is defined to be this common expected reinvestment rate when state $\{i, j\}$ occurs.

We can now calculate the time $t = 0$ expected utility of an uninformed agent who invests capital in the stock market, $E_S[C_1 + C_2]$, and the utility of an uninformed agent who invests capital in the debt of the intermediary, $E_I[C + C_2]$.

$$E_S[C_1 + C_2] = \sum_{\{i,\, j\}} \frac{q_i}{2}(w_i(e_1 + p_{ij}) + (1 - w_i)r_{ij}(e_1 + p_{ij})), \tag{A2}$$

$$E_I[C_1 + C_2] = \sum_{\{i,\, j\}} \frac{q_i}{2}(w_i(e_1 + p_{Dij}) + (1 - w_i)r_{ij}(e_1 + p_{Dij})). \tag{A3}$$

The difference between (A3) and (A2) will determine whether uninformed agents have an incentive to invest in the intermediary.

$$E_I[C_1 + C_2] - E_S[C_1 + C_2] = \sum_{\{i,\, j\}} \frac{q_i}{2}(p_{Dij} - p_{ij})(w_i + (1 - w_i)r_{ij}). \tag{A4}$$

[8] Perhaps an unplanned benefit of large government budget deficits has been an increased supply of riskless debt, further adding to the feasibility of a transactions system backed by money market instruments.

To determine the sign of (A4), we need to compute the prices p_{Dij} and p_{ij}. As in Section III of the text, these prices will, in general, depend on the parameters of the model as well as the actions of the informed agents. Analogous to condition (5) in the text, we state the following conditions:

$$R_H > \frac{e_1(1 - w_l)}{w_l} + \frac{N_I}{N_S}\left(\frac{e_1(1 - w_l)}{w_l} - R_D\right), \tag{A5}$$

$$R_L < \frac{e_1(1 - w_h)}{w_h} + \frac{N_I}{N_S}\left(\frac{e_1(1 - w_h)}{w_h} - R_D\right). \tag{A6}$$

Note that, for N_I sufficiently small relative to N_S, conditions (A5) and (A6) will hold if condition (5) holds. Thus, we wish to examine the incentives for a small group of uninformed agents to join as intermediary, given that there currently exists a large number in the stock market.

Analogous to the results of Section III, if conditions (A5) and (A6) hold, then states $\{l, H\}$ and $\{h, L\}$ are fully revealing, while an Insider Coalition can form to purchase endowment in state $\{l, L\}$ to mimic the prices of all securities in state $\{h, H\}$. Using (A1) and equating demands and supply of the endowment good lead to the following set of state-contingent prices and time $t = 1$ reinvestment rates:

(No Storage) $\quad p_{DlH} = \dfrac{e_1(1 - w_l)N\,R_D}{w_l(N_I R_D + N_S R_H)},\ p_{lH} = p_{DlH}\dfrac{R_H}{R_D},\ r_{lH} = \dfrac{R_D}{p_{DlH}},$

(Storage) $\quad p_{DhL} = R_D,\ p_{hL} = R_L,\ r_{hL} = 1,$

(No Storage)

$$p_{DlL} = p_{DhH} = \frac{e_1(1 - w_h)N\,R_D}{w_h(N_I R_D + N_S R^*)},\ p_{lL} = p_{hH} = p_{DlL} = \frac{R^*}{R_D},$$
$$r_{lL} = r_{hH} = \frac{R_D}{p_{DlL}}, \tag{A7}$$

where R^* is the late consumers' expectation at time 1 of the return on capital at date 2, when the state is only partially revealed to be either $\{l, L\}$ or $\{h, H\}$. The formula for R^* is given in equation (11) of the text. Substituting these prices and reinvestment rates into (A4) and simplifying, one obtains

$$E_I[C_1 + C_2] - E_S[C_1 + C_2] =$$
$$\tfrac{1}{2}(R_D - R^*)\left[\frac{(1 - w_h)N\,e_1(q_h w_h + q_l w_l)}{w_h(N_I R_D + N_S R^*)} + q_h(1 - w_h) + q_l(1 - w_l)\right] \tag{A8}$$
$$+ \tfrac{1}{2}(R_D - R_H)q_l(1 - w_l)\left[\frac{N\,e_1}{N_I R_D + N_S R_H} + 1\right] + \tfrac{1}{2}(R_D - R_L)q_h.$$

It is straightforward to verify that (A8) is a strictly increasing function of R_D and, for R_D sufficiently large, uninformed agents will prefer joining the intermediary. Furthermore, we can also show that there exists a value of $R_D < \bar{R}$ for

which (A8) will be positive when all uninformed investors initially invest in the stock market, i.e., when N_I is small. Taking the limit as $N_I \to 0$ (or $N_S \to N$),

$$\lim_{N_I \to 0} E_I[C_1 + C_2] - E_S[C_1 + C_2] =$$

$$\tfrac{1}{2}(R_D - R^*)\left[\frac{(1 - w_h)}{R^* w_h} e_1(q_h w_h + q_l w_l) + q_h(1 - w_h) + q_l(1 - w_l)\right] \tag{A9}$$

$$+ \tfrac{1}{2}(R_D - R_H) q_l (1 - w_l)\left(\frac{e_1}{R_H} + 1\right) + \tfrac{1}{2}(R_D - R_L) q_h.$$

Setting the right-hand side of equation (A9) to zero, we can solve for the minimum return on intermediary debt, R_D^m, for which uninformed agents are as well off joining the intermediary as they are staying in the stock market. For the simplifying case of condition (16), that, conditional on being a late consumer, the probability of the state being h or l is equally likely ($R^* = \bar{R}$), we have

$$R_D^m = \bar{R} - q_l(1 - w_l)\left(\frac{R_H - R_L}{2}\right)\left[\frac{w_h}{1 - w_h} - \frac{e_1}{R_H}\right]/\theta, \tag{A10}$$

where

$$\theta \equiv \left[\frac{(1 - w_h)}{w_h}\frac{e_1}{\bar{R}}(q_h w_h + q_l w_l) + q_l(1 - w_l)\left(3 + \frac{e_1}{R_H}\right) + q_h\right] > 0.$$

The term in brackets on the right-hand side of (A10) is strictly positive because of condition (5). Since (A9) is continuous and strictly increasing in R_D, it must also be strictly positive for some value of R_D less than $\bar{R}$.

Step 2: Given that liquidity traders have an incentive to leave the stock market and join the intermediary for $R_D > R_D^m$, we now show that the intermediary contract will be feasible if informed agents can be induced to provide equity financing rather than invest their capital with the stock market Insider Coalition.

The informed agents who are members of the stock market Insider Coalition will sell their capital to mimic the state $\{h, H\}$ when the state is actually $\{l, L\}$. They purchase endowment in the amount:

$$M_{lL} = \frac{(w_h - w_l)}{(1 - w_h)}(N_S + N_I R_D / R^*), \tag{A11}$$

which results in their time 0 expected utility per unit capital being

$$E[C_2] = e_2 + \bar{R} + \frac{q_l}{2}\frac{M_{lL}}{M_S}(p_{lL} - R_L), \tag{A12}$$

where p_{lL} is given by (A7).

Note that, for $R_D < R^*$, M_{lL} is less than its value for the case where $N_I = 0$, which was analyzed in Section III, while p_{lL} is less than p_{lL}^* given in Section III. Thus, the expected utility of the informed agents falls in this case if M_S stays the same. Now if some informed agents defect from the Insider Coalition and

invest their capital, equal to M_I, in the equity of the intermediary, their expected return will be

$$E[M_I R_E] = \bar{R}(N_I + M_I) - R_D N_I. \tag{A13}$$

If the intermediary's capital constraint is binding so that N_I and M_I follow the debt and equity proportions given in equation (15), then the expected return on intermediary equity equals

$$E[R_E] = \bar{R} + (\bar{R} - R_D)\frac{R_L}{(R_D - R_L)}. \tag{A14}$$

Thus, comparing (A14) with (A12), we see that an informed agent who invests in the equity of the intermediary will have a higher expected return than an informed agent in the Insider Coalition if

$$\frac{(\bar{R} - R_D)}{(R_D - R_L)}R_L > \frac{q_l}{2}\frac{(N_S + N_I R_D/R^*)}{M_S}\frac{(w_h - w_l)}{(1 - w_h)}(p_{lL} - R_L). \tag{A15}$$

Consider the incentive for informed investors to defect from the stock market coalition when initially N_S is close to N. Taking the limit of (A15) as N_I goes to zero and rearranging terms result in

$$(\bar{R} - R_D) > \frac{q_l}{2}\frac{N}{M}\frac{(w_h - w_l)}{(1 - w_h)}\left[\frac{e_1(1 - w_h)}{w_h R_L} - 1\right](R_D - R_L). \tag{A16}$$

Now suppose R_D is set such that $\bar{R} > R_D \geq R_D^m$, where R_D^m is given by (A10). Then both sides of condition (A16) are strictly positive, but the right-hand side of (A16) can be made sufficiently small for M sufficiently large. (Note that R_D^m is independent of M.) Thus, for M/N sufficiently large, a return on intermediary debt can be offered which gives both uninformed and informed agents the incentive to start an intermediary.

Proof of Proposition 3: We first take the feasibility of the intermediary for $N_I = N$ as given and later show that this holds for M/N sufficiently large. If all liquidity traders initially invest in the riskless debt of the intermediary, consider the possibility of the informed traders being able to strategically purchase the endowment of the late consumers when the return on stock market capital is low.

Given condition (17), consider a return on intermediary debt, R_D, such that

$$e_1\frac{(1 - w_h)}{e_1 w_h} < R_D \leq \bar{R}. \tag{A17}$$

Similar to the analysis of Section II in the text, it is straightforward to show that a full-information equilibrium would result in the time $t = 1$ prices of intermediary debt equal to

$$\text{(Some Storage)} \qquad p_{Dlj} = R_D, \qquad j = L, H,$$

$$\text{(No Storage)} \qquad p_{Dhj} = e_1(1 - w_h)/w_h, \qquad j = L, H. \tag{A18}$$

In other words, some storage occurs whenever there is a low proportion, w_l, of early consumers, and no storage occurs whenever there is a high proportion, w_h, of early consumers. In equilibrium, the price of stock market capital will satisfy

$$p_{ij} = p_{Dij}E[R_j]/R_D = p_{Dij}\frac{R_j}{R_D}. \tag{A19}$$

Now consider the case of asymmetric information. Stock market insiders would like to be able to purchase endowment and sell stock market capital at time 1 when the return on capital is low, R_L. Potentially, they could do this, as before, when state $\{l, L\}$ occurs, by purchasing endowment from late consumers. However, rational late consumers would never choose to sell their endowment for stock market capital because the only sellers of stock market capital are informed agents, who the late consumers know would only choose to sell capital when the return is R_L. Unlike the situation considered in Section III, where liquidity traders invested in the stock market at time 0, late consumers will now realize that they will only be trading capital with informed agents, and then only when the return on capital is R_L. Hence, late consumers will only offer a price for stock market capital of

$$p_{ij} = p_{Dij}\frac{R_L}{R_D}. \tag{A20}$$

At this price, there would be no incentive for informed agents to purchase endowment. Since late consumers would only sell endowment for the riskless debt of early consumers, p_{Dij} would always be equal to its full-information price given in (A18). This results in the expected utility of uninformed agents being equal to

$$E[C_1 + C_2] = e_1 + R_D \tag{A21}$$

and the stock market Insider Coalition being devoid of power, their return on capital simply being equal to $\bar{R}$. Hence, in order to attract informed agents to contribute to the intermediary, R_D need only be an arbitrarily small amount less than $\bar{R}$, and uninformed agents' utility would approach their full-information level. In addition, it is straightforward to show that individual liquidity traders would never choose to invest their capital in the stock market rather than the intermediary since, if they turn out to be an early consumer, they can only sell their capital to late consumers at a price which always reflects the return on capital being R_L given by (A20).

Finally, to show that this equilibrium is feasible, informed agents must have sufficient capital in order to purchase the minimum amount of intermediary equity required to make the intermediary's debt riskless. Using condition (15), with $D = N$ we have

$$\frac{M}{N} > \frac{(R_D - R_L)}{R_L}. \tag{A22}$$

Note that the larger R_L is, the smaller is the amount of equity capital needed to enable the intermediary's debt to be riskless.

REFERENCES

Akerloff, G., 1970, The market for lemons: Qualitative uncertainty and the market mechanism, *Quarterly Journal of Economics* 84, 488–500.

Bernheim, B. Douglas, Bezalel Peleg, and Michael Whinston, 1987, Coalition-proof Nash equilibria, *Journal of Economic Theory* 42, 1–12.

Campbell, T. and W. Kracaw, 1980, Information production, market signalling and the theory of financial intermediation, *Journal of Finance* 35, 863–881.

Cone, Kenneth, 1983, *Regulation of Depository Institutions*, Ph.D. Thesis, Stanford University.

Diamond, D., 1984, Financial intermediation and delegated monitoring, *Review of Economic Studies* 51.

——— and P. Dybvig, 1983, Bank runs, liquidity and deposit-insurance, *Journal of Political Economy* 91, 401–419.

Gorton, Gary and George Pennacchi, 1989, Security baskets and index-linked securities, Working paper, The Wharton School, University of Pennsylvania.

Grinblatt, Mark S. and Stephen A. Ross, 1985, Market power in a securities market with endogenous information, *Quarterly Journal of Economics*, 1143–1167.

Jacklin, Charles, 1987, Demand deposits, trading restrictions, and risk sharing, in Edward D. Prescott and Neil Wallace, eds.: *Contractual Arrangements for Intertemporal Trade* (University of Minnesota Press, Minneapolis).

———, 1988, Demand equity and deposit insurance, Mimeo, Stanford University.

Kyle, Albert S., 1985, Continuous auctions and insider trading, *Econometrica* 53, 1315–1336.

Merton, Robert C., 1977, An analytic derivation of the cost of deposit insurance and loan guarantees, *Journal of Banking and Finance* 1, 3–11.

Myers, Stewart and Nicholas Majluf, 1984, Corporate financing and investment decisions when firms have information that investors do not have, *Journal of Financial Economics* 13, 187–222.

Rock, Kevin, 1986, Why new issues are underpriced, *Journal of Financial Economics* 15, 187–212.