

Contemporary Banking Theory*

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We review the contemporary theory of financial intermediation. The focus is on contributions in the past 15 years or so that have advanced our understanding of why financial intermediaries exist, the credit allocation and other services they provide in spot and forward credit markets, the contractual nature and allocational consequences of the claims they issue, and the optimal design of bank regulation. *Journal of Economic Literature* Classification Numbers: 310, 312, and 314. © 1993 Academic Press, Inc.

1. INTRODUCTION

Spurred by a plethora of financial innovations and advances in information economics and option pricing, the theory of banking has been substantially reconfigured in the past 15 years. Our goal is to survey these

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recent developments in the banking literature, as well as their implications for public policy.¹

To put this literature in perspective, we begin with a brief discussion of the key issues in banking theory. The review is organized around six major issues. Each involves a puzzle that the contemporary literature has helped to illuminate. In many instances, the literature does not address the puzzle directly. Rather, smaller related questions are answered, so that it is only collectively that we are pointed toward the puzzle's solution. In Table I the six fundamental puzzles are listed along with the smaller questions related to each puzzle.

The first question is, why do we have financial intermediaries (FIs)? Available theories reformulate this question into, why are there numerous FIs, rather than one big one? This is akin to Arrow's observation that the real puzzle in the theory of the firm is why we have many firms rather than one big one (see Williamson (1975)). Our focus is on the role of FIs in providing brokerage and qualitative asset transformation (QAT) services. A broker brings together providers and users of capital without changing the nature of the claim being transacted, whereas a qualitative asset transformer processes risk in altering the attributes of the claim (see Niehans (1978)). In Section 2 we address the existence issue with a discussion of the services provided by FIs. The major lessons are summarized as follows:

- FIs reduce the costs of transacting with services ranging from brokerage to attribute transformation.
- With informational asymmetries, both depository and nondepository FIs gain from an increase in size because of lower incentive costs per agent. That is, the costs of brokerage as well as QAT are lowered indefinitely by diversification. However, in many circumstances, intermediaries will be of finite size.
- Given significant informational asymmetries regarding borrowers, bank loans are special in that they signal quality in a way that other forms of credit do not.
- Banks enhance aggregate investment and also improve its quality.

The second question, addressed in Section 3, asks why banks deny credit to some rather than charging higher prices. The main conclusions are:

- A profit-maximizing bank may ration credit if it knows less than borrowers do about payoff-relevant attributes, or if borrowers can make undetectable choices of assets or effort that affect the bank's return.

¹ Recent syntheses include Diamond (1989a), Hellwig (1990), Jacklin (1989), and Vives (1990). Ours is more comprehensive, and more polemical/judgmental.

TABLE I
THE KEY QUESTIONS/PUZZLES IN FINANCIAL INTERMEDIATION RESEARCH

The big question	Related smaller questions
(1) <i>Existence.</i> Why do we have financial intermediaries (FIs)?	• Should we have one large bank or numerous small banks? • Since many banks hold diversified portfolios of risky assets, are they merely mutual funds or do they also provide other services? • What services do non-depository FIs provide and why do they tend to be large? • How important is it that banks finance themselves with almost riskfree claims? • What are the determinants of the ownership structure of FI's?
(2) <i>Credit allocation.</i> Why do banks routinely deny credit rather, than charge borrowers higher prices?	• How does collateral affect credit rationing? • Is credit rationing a static or dynamic phenomenon? • Can credit contracting innovations resolve the problems that engender credit rationing?
(3) <i>Liquidity transformation.</i> Why do banks fund illiquid assets with liquid liabilities?	• How should banks be financed? • Why do banks use more non-traded liabilities than other firms of comparable size? • What role does the deposit contract play in bank runs and banking panics? • What is the role of governmental initiatives in staunching bank runs? • What is the relationship between runs and panics? • Other than non-tradeability, why do deposit contracts have the demandability feature? • What are the private sector alternatives to governmental deposit insurance? • Instead of providing governmental deposit insurance, is it preferable to alter the deposit contract to eliminate runs? • Can liquidity demand be satisfied without bank runs?
(4) <i>Maturity transformation.</i> What is the role of banks in maturity (duration) transformation?	• Why do banks originate loans for resale? Can securitization resolve problems originating with maturity transformation?
(5) <i>Bank regulation.</i> Should banks be regulated? If so, how?	• How should regulators address the moral hazard arising from the public safety net? • As a deterrent to bank runs, how does suspension of convertibility compare with deposit insurance? • How should deposit insurance be priced? • How do you build up charter values in banking? • What is the desirability of capital requirements and deposit interest rate ceilings?

TABLE I—*Continued*
THE KEY QUESTIONS/PUZZLES IN FINANCIAL INTERMEDIATION RESEARCH

The big question	Related smaller questions
(6) <i>Borrower's choice of financing source and market microstructure.</i> What is the role of FIs in the overall allocation of capital and how is this role affected by capital market microstructure?	• How do borrowers choose among banks, non-bank financial institutions, and the capital market? • What are the roles of brokers, dealers and specialists in the stock market?
(7) <i>Unresolved issues.</i> What are the major unresolved puzzles?	• What is the role of FIs in financial innovation? • What are the economic bases for differences among financial systems across countries and through time? • What are the issues in banking system design? • How should securities markets and nonbank financial intermediaries be structured and regulated?

- Credit history may play an important role in credit allocation.
- Collateral can reduce, but will not necessarily eliminate, credit rationing.
- A greater variety of credit-contracting variables permits the bank to more effectively address informational problems, resulting in reduced credit rationing.
- Loan commitments may lessen incentive problems and thereby reduce credit rationing.
- Agency costs that lead to rationing may amplify business cycles.

Our third question, addressed in Section 4, asks why banks finance illiquid assets with liquid liabilities. The key issue here becomes the design of the deposit contract. Once again, the theory has reformulated the question that motivated it. The main results are:

- The financing of illiquid loans with liquid deposits is a service provided by banks in an environment where random shocks perturb preferences for the timing of consumption.
- Nontradable deposit contracts that promise a "first come, first served" payoff offer unique economic benefits.²
- The deposit contract engenders bank runs, even without adverse information about the bank's assets.

² By a nontraded contract we mean one that promises a fixed payoff independent of interim information shocks that could alter investors' beliefs about the contract's value.

- Deposit insurance may be part of an optimal governmental intervention in a banking system vulnerable to runs and panics.
- The federal funds market may be motivated by the threat of bank runs, but free-rider problems can impede this market.
- FIs may create nondeposit liquid securities in response to demand from uninformed investors, and this service need not result in bank runs.

In addition to liquidity transformation, banks provide maturity transformation services. Our fourth question, examined in Section 5, addresses the costs and benefits to an intermediary of using short-term liabilities to finance longer-duration assets and the role of bank equity in this process. This issue bears on why banks hold some assets on their balance sheets and sell others, as well as why some loans are securitized. Thus, the theory has turned the traditional maturity transformation debate into a more fundamental discussion of whether the bank should finance an asset portfolio with deposits or by selling asset-backed claims. In a broader sense, this research touches upon optimal institutional and security design and provides the following insights:

- Maturity transformation may arise as a consequence of the bank's provision of liquidity.³ Informational frictions can make it optimal for the bank to finance long-lived assets with short-term deposits in order to have the bank's liabilities frequently repriced.
- The conditions that make it optimal for the bank to mismatch the duration of its assets and liabilities also lead to a potential underinvestment problem. Securitization addresses this underinvestment problem.

Progress in understanding the brokerage and QAT services of banks has advanced the study of bank regulation. Our fifth question, discussed in Section 6, then is, should banks be regulated, and if so, how? Regulatory intervention may lead to Pareto improvements when unequal access to information obstructs market mechanisms. Cast in informationally rich environments, contemporary banking theories suggest numerous circumstances in which market-mediated allocations may be inefficient. We may thus visualize a theory of banking in which public regulation is a component. Some of the findings are summarized below.

- Informational frictions that create a role for FIs also generate instability (unanticipated deposit withdrawals and premature asset liquidations), an extreme manifestation of which is a banking panic. Many banking regulations can then be understood as measures to reduce this form of instability (e.g., deposit insurance and lender of last resort facilities) or to

³ Even though duration is the appropriate metric, we refer to maturity transformation because the contemporary literature on this has dealt with zero-coupon bonds.

combat moral hazards arising from the distorted incentives of banks due to regulatory measures to improve stability (e.g., regulatory monitoring, asset proscriptions, and capital requirements).

- Fair, risk-sensitive deposit insurance pricing may be impossible.
- The ultimate reform of deposit insurance may be its elimination.
- It may be optimal to limit entry into banking.
- Increasing capital requirements may increase rather than reduce risk in banking.

Our sixth question, addressed in Section 7, asks about the role of FIs in the allocation of capital. This question has implications for corporate finance and capital market microstructure, as well as banking. Some of the important results are listed below.

- Borrowers face a variety of financing sources, ranging from venture capitalists to the capital market, and the borrower's choice among them depends on its credit history and its investment opportunities.
- Brokers, dealers, and specialists help to overcome informational problems created by differentially informed traders.

Despite striking advances, important unresolved issues remain in the theory of financial intermediation. There are four overarching questions. One relates to the economic incentives for innovations in the design of financial securities and the role of FIs in this process. The second seeks to understand the noteworthy differences across nations and through time in the relative proportions of corporate financing attributable to banks. This is the question of comparative financial systems. Once we understand the overall design of the financial system, we can focus on the specifics related to its components; this leads to our third and fourth questions. The third question deals with the optimal design of the banking system, in particular, its industrial organization, scope, and regulation. Finally, we need a better understanding of how securities markets ought to be structured. We discuss these issues briefly in concluding in Section 8.

2. FINANCIAL INTERMEDIATION SERVICES

FIs provide both brokerage and QAT services, as shown in Fig. 1. FIs often *specialize* in the provision of one or more of these services. Banks have traditionally provided virtually all of these services. Nondepository FIs, with some exceptions (e.g., investment banks and finance companies), tend to specialize more narrowly. For instance, rating agencies screen and certify, whereas investment counselors provide investment advice.

The benefits of brokerage stem from a cost advantage in information

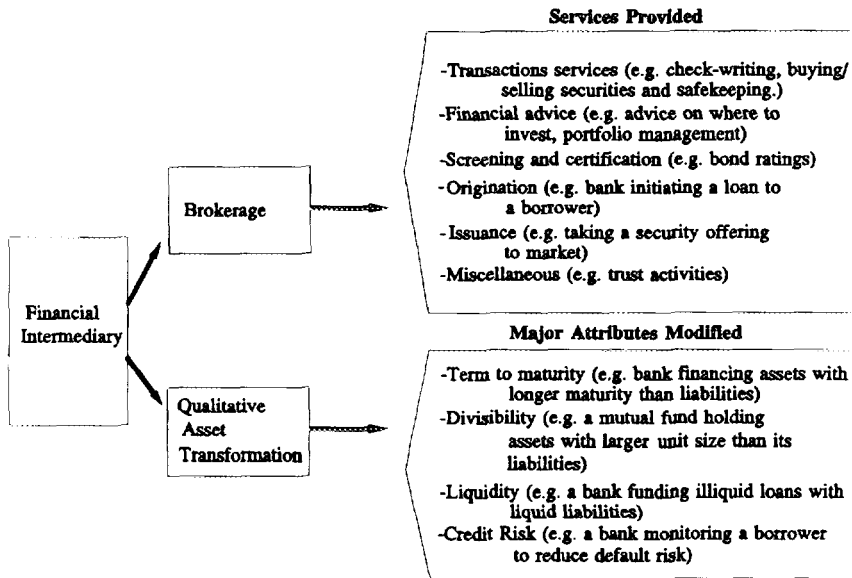


FIGURE 1.

production, which arises from two sources. First, a broker develops special skills in interpreting subtle signals. Second, brokers exploit *cross-sectional* (across customers) and *temporal* reusability of information (see Chan *et al.* (1986)). Reusability of information stems from a classic public good characteristic that makes it better for the initial information producer to specialize in its production and distribution. As for QAT, FIs typically transform claims as shown in Fig. 1.

The literature asks why *coalitions* of agents called firms arise to provide these intermediation services. The optimal size of the intermediary emerges as a related question. Our starting point is the informational framework of Leland and Pyle (LP, 1977). Hence, we ignore the earlier transactions cost theories (for example, Benston and Smith (1976); Fama (1980); and Gurley and Shaw (1962)), nor do we dwell on the "multiple services" approach of Campbell and Kracaw (1980).⁴ We believe that informational asymmetries are the most basic form of transactions costs, and thus information-based theories of intermediation provide a more fundamental interpretation.

⁴ Another approach is that of Campbell (1979) who suggests that intermediaries arise to provide confidentiality of strategic information that the lender requires from the borrower. See the survey by Santomero (1984) for a discussion of the earlier literature emphasizing transactions costs.

LP provided a major impetus to modern financial intermediation theory when they suggested a rationale for FIs that discover the qualities (mean returns) of individual assets/projects and then sell claims to diversified portfolios of these assets to primary investors. The paper argued informally that a bank can communicate proprietary information about borrowers at lower cost than can the borrowers individually. This suggested that an information-based foundation for the banking firm could be built that subsumed both brokers and asset transformers.

The paper was flawed, however. Although the authors suggested the feasibility of diversified intermediaries providing delegated monitoring services in an adverse-selection economy akin to that of Rothschild and Stiglitz (1976), they were misled by an incorrect comparative static result. Instead of discovering the intuitive result that diversification reduces the average signaling cost per project, they erroneously found the opposite (see Diamond (1984)).

In two subsequent papers, Diamond (1984) and Ramakrishnan and Thakor (1984) formalized the ideas in LP. Both papers demonstrated the value of diversification in reducing monitoring costs. Whereas Diamond rationalized *depository* FIs that provide QAT, Ramakrishnan–Thakor explained *nondepository* FIs. We discuss below the arguments presented in these papers.

2.1. *Informational Asymmetries and the Nonintermediated Outcome*

Consider an economy with n investment projects, each having uncertain returns and $N \gg n$ primary investors. Each investor has one unit of endowment of the single commodity to invest, and each project requires $I \gg 1$ units of investment. Projects are initiated by entrepreneurs possessing private information about either (A) their ex ante prospects as in Ramakrishnan and Thakor (1984), or (B) their ex post realized return, as in Diamond (1984). The economy lasts for only these two periods and all consumption takes place in the second period. Cash flows are imperfectly correlated across projects; for simplicity, in scenario B, these are assumed to be independently, identically distributed (i.i.d.) random variables. Outside (nonentrepreneur) investors have two means of eliciting information about projects:

- (i) in scenario A, investors can acquire information either by incurring a monitoring cost of K per project or by observing the undiversified project holdings of strictly risk-averse entrepreneurs; and
- (ii) in scenario B, each investor can obtain this information either by incurring a monitoring cost of K per project or via a precommitment by each entrepreneur to pay D per project; if the entrepreneur fails to make the payment, he or she suffers a nonpecuniary penalty P which is suffi-

TABLE II
RESOLUTIONS OF INFORMATION ASYMMETRIES IN THE NONINTERMEDIATED CASE

Scenario	Cost of information acquisition through direct monitoring	Indirect information acquisition via entrepreneurial shareholding or payout commitment
(A) Ex ante informational asymmetry, risk-averse agents	$M \in [NK, NnK]$, where the monitoring cost M depends on extent of diversification desired by the risk-averse investor (M increases with the desired degree of diversification)	ns
(B) Ex post informational asymmetry, risk-neutral agents	$M = NK$	$n \times p \times \pi(D)$

Note. s is the average per project signaling cost (loss of entrepreneur's expected utility relative to the first-best) as in LP, and $\pi(D)$ is the probability that any project's cash flow (i.i.d. across projects) will be less than D . The terms s and $\pi(D)$ are endogenously determined in equilibrium, the former by the conditions of a separating signaling equilibrium, and the latter by a competitive rent exhaustion condition; see text for details.

ciently great to ensure that D is paid whenever the realized cash flow allows it.⁵

Assuming that all projects are funded ($nI = N$), the cost of resolving informational asymmetries by the two methods outlined above, neither involving intermediaries, are summarized in Table II.

2.2. Diversified Intermediaries

Now, suppose that a single FI is to monitor the (ex ante) quality of the (ex post) outcome of each project, resulting in a cost of nK , which is less than the direct monitoring cost, M , in the nonintermediated outcome in

⁵ The penalty P must be a dissipative cost. Moreover, it is not an exogenous bankruptcy cost; it is determined *endogenously* by the lender to ensure that the entrepreneur pays the debt obligation to the extent permitted by cash flow. These restrictions make it difficult to relate the model to debt contracting in practice. Diamond (1984) states that P could be interpreted either as the entrepreneur's loss in reputation due to default or as physical punishment. The reputational interpretation is strained, however, since the (competitive) lender would not be able to calibrate the damage to the borrower's reputation in order to guarantee repayment. Note also that "monitoring" refers to ex post cash flow auditing rather than pre-cash-flow-realization scrutiny of the borrower's actions in order to alter the cash flow distribution.

either scenario A or B. However, the FI must now convince the primary investors of the value of its assets. This may require that the FI incur a signaling cost of S in scenario A, or suffer nonpecuniary penalties of nP with probability $\pi^n(D)$ in scenario B; the penalty must increase in proportion to scale to ensure incentive compatibility in the ex post reporting of the n -fold larger cash flows. Therefore, intermediation is Pareto-improving if

$$\min[M, ns] > [nK + S] \quad (\text{Scenario A}) \quad (1A)$$

$$\min[M, nP\pi(D)] > [nK + nP\pi^n(D)] \quad (\text{Scenario B}) \quad (1B)$$

Diamond (1984) asks whether (1A) and (1B) will be satisfied under plausible conditions, if only asymptotically as n becomes large (holding N/n constant).

In scenario B, with risk-neutral agents, the answer is transparently yes. Since $\pi^n(D)$ is the probability that the sample average of cash flows across n i.i.d. projects will be less than D , the weak law of large numbers implies that (1B) holds for n sufficiently large, with a fixed $N/n > 1$ along the limiting sequence, if D is less than the population mean of the n i.i.d. project cash flows. Recently, Krasa and Villamil (forthcoming) have shown that (1B) may hold for n as low as 30. Hence, the theory can accommodate diseconomies of scale that may limit intermediary size.

What about scenario A? In the exponential utility and normal distributions model of LP—where entrepreneurs are asymmetrically informed about mean cash flows which they signal through undiversified insider holdings—feasibility is unclear. If the FIs have the same exponential utility as the entrepreneurs, each of whom is monitored at cost K , then $S = ns$. The reason is that, with (negative) exponential utility, the certainty equivalent of the sum of two independent risks ($\tilde{A} + \tilde{B}$) is simply the sum of the certainty equivalents of $\tilde{A}$ and $\tilde{B}$. Hence, with $S = ns$, (1A) cannot be satisfied with $K > 0$. However, if the FIs are *coalitions of agents* who can ensure each other's monitoring efforts and jointly signal the value of the diversified package of n projects, say with observable insider holdings, then $S < ns$, as would be implied by the corrected version of Proposition 3 in LP. Hence, for n sufficiently large so that the signaling costs of excessive insider holdings are lowered sufficiently, and a given $N/n > 1$, (1A) would ultimately be satisfied. For a model along these lines, see Ramakrishnan and Thakor (1984), who show that intermediation is beneficial because cooperation among the risk-averse agents comprising the intermediary results in two positive externalities. One is improved risk sharing, attainable because the prospects of individual agents are imperfectly correlated. The second, less obvious gain comes from the amelioration of moral hazard since the effort of each agent

stochastically increases that agent's direct payoff as well as the total payoff of the intermediary, a share of which accrues to that agent.⁶

If in the ex post informational asymmetry environment of scenario B, agents who individually intermediate diversified aggregates of projects are assumed to be risk averse, rationalizing intermediation is problematic. Diamond (1984) restricts agents' utility functions to ensure that diversification-based intermediation is valuable. However, these restrictions—that the third and fourth derivatives of the agents' utility functions be strictly positive—imply *risk-loving* behavior for sufficiently high wealth.⁷

Two types of diversification are relevant, one involving "sharing risks" and the other "adding risks." With sharing risks, N risk-averse agents invest in N (imperfectly correlated) gambles, and each agent spreads his investment across the N gambles (see Ramakrishnan and Thakor, 1984). With adding risks, a single agent bears all the N independent risks, and diversification occurs as N grows. Both Diamond (1984) and Ramakrishnan and Thakor (1984) show that with sharing of risks an intermediary provides risk-reduction benefits for each agent in the coalition, but Diamond (1984) also shows that adding risks (scenario B) is not Pareto improving unless the noted utility function restrictions are satisfied.

Ramakrishnan and Thakor (1984) also show that an infinitely large FI attains the *first best*, even though the effort contribution of each agent within the FI coalition is unobservable to outsiders. As in Diamond (1984), therefore, the optimal size FI is infinite. These theories then present a puzzle since we do not observe the predicted goliath FI. However, Millon and Thakor (1985) show that the Ramakrishnan and Thakor (1984) finding is sensitive to the assumption that cooperating agents within the FI can monitor each other costlessly. Millon and Thakor (1985) thus assume that internal monitoring is impossible, and information has systematic elements that provide cross-sectional information reusability gains. The optimal size of the intermediary in this setting is finite because intrafirm incentive problems arise for the FI as individual agents attempt to free ride on each other's efforts. As the nondepository FI grows larger, these incentive problems increase, at some point offsetting the information-sharing gains that increase with size. Thus, while the FI's ability to issue risk-free claims seems central in Diamond (1984) and Ramakrishnan and Thakor (1984), their basic intuition is sustained in settings with imperfectly diversified intermediaries that issue risky claims.

The view that FIs are delegated monitors is based on the need to re-

⁶ The result that an intermediary consisting of numerous agents who *cooperate*—in the sense that they allocate aggregate effort as a team—can improve upon the outcome attainable through bilateral contracting is a special case of the result that cooperation is of value under fairly general conditions. See Itoh (1991) and Ramakrishnan and Thakor (1991).

⁷ This restriction is unappealing because expression (1B) is assumed to hold asymptotically, so that agents prefer risk under the very conditions that ensure that expression (1B) holds.

solve the problem of monitoring the monitor. Diamond (1984) solves this problem by deploying a debt contract, whereas Ramakrishnan and Thakor (1984) use a compensation contract. Because these papers consider different types of informational distortions, they have varied implications. Borrowers with cash flows that are costlessly observable *ex post*, but about which little is known *ex ante*, would be monitored/screened by intermediaries motivated with compensation contracts. An example is a manufacturer with unknown productivity and a contract to deliver a prespecified quota of parts. In contrast, a borrower whose output capability is known *ex ante*, but whose output is difficult/costly to measure *ex post*, would be monitored by an intermediary motivated with a debt contract. An example is a firm of accountants with well-established credentials that provides tax consulting services in a predictable-demand environment. The payoff distribution for such a borrower is easy to assess, but the possibility of inflated expenses may make the net payoff realization costly to observe.

2.3. *Diversified Intermediaries as Brokers and Asset Transformers*

Diamond's (1984) FI is an asset transformer because it provides depositors a riskless claim while lending to risky entrepreneurs. Given the monitoring services, the FI is not simply a mutual fund. By contrast, the FI of Ramakrishnan and Thakor (1984) and Millon and Thakor (1985) is a pure broker because it merely produces information for resale (see, also, Allen (1990)).⁸

A second distinction between the two FIs inheres in the contractual relationship between the agent being screened/monitored and the FI. In the case of the broker, this relationship is constrained only by the restriction of no collusion/bribes. In the case of the asset transformer, however, the model must generate a nontraded debt contract as the optimal arrangement between the borrower and the FI. Townsend (1979) first provided an economic rationale for a debt contract when state realizations can be observed (monitored) *ex post* only at a cost by the providers of capital (see, also, Gale and Hellwig (1985)). A similar justification was provided in a banking context by Diamond (1984), but like Townsend only with *deterministic* monitoring. Mookherjee and P'ng (1989) analyze optimal costly monitoring schemes with a risk-neutral principal and risk-averse agent and show that in any optimal scheme that provides positive consumption in every state, all monitoring must be *random*. Moreover, given optimal monitoring, the optimal contract is *never* a debt contract.⁹

⁸ This distinction between the two types of FIs is significant because it leads to different resolutions of the moral hazard arising from the FI's propensity to underinvest in screening/monitoring, and may have implications for FI ownership structure as well (see Smith and Stutzer (1990)).

⁹ The usual justification for assuming deterministic monitoring is the difficulty in ensuring implementation of randomized schemes. Moreover, Allen and Gale (1992), De and Kale

The intermediaries discussed thus far influence the allocation of capital, but they do not explicitly affect aggregate investment in the economy. Boyd and Prescott (1986) and Chan (1983) have the FI conditioning aggregate investment. In Boyd–Prescott, the FI is a coalition of entrepreneurs who do not possess good projects and are therefore willing to invest in evaluating other entrepreneurs' projects. The FI channels the endowments of such entrepreneurs to good projects, thereby increasing aggregate investment in good projects. This is how the FI increases total project return.¹⁰ Chan (1983) has the FI facilitating the search for good projects; it thereby improves the quality of projects financed in equilibrium.

To summarize, intermediation is a response to the inability of market-mediated mechanisms to efficiently resolve informational problems. The models discussed consider different types of informational frictions and rationalize different types of FIs (banks, venture capitalists, financial newsletters, investment banks, and bond-rating agencies, among others). But informational friction is the commonality among all these papers. Thus, the welfare of transacting parties should improve when they use banks. James (1987) tests this hypothesis empirically and finds that borrowers experience abnormal returns when they announce bank loans; similar gains are not observed for nonbank debt. This finding was qualified by Lummer and McConnell (1989) who distinguish between new bank loans and renewals and find that renewals have a positive announcement effect, but that new bank loans do not.

FIs ameliorate informational pathologies that engender transactions costs. This is the insight that contemporary banking theory formalizes. Future work should develop more detailed testable hypotheses that refine that insight.

2.4. *Ownership Structure of FIs*

Should FIs be stockholder-owned or "mutuals"? A mutual is formally owned by its depositors, and possibly its borrowers. Fama and Jensen (1983a,b) hypothesize that different organizational forms arise to deal with various informational frictions, including the principal-agent problem created by the separation of ownership and control. They argue that financial mutuals' equity claims are always redeemable on demand (e.g., share deposits in a credit union or deposits in mutual savings institutions), which limits management's control of assets. Moreover, the absence of a

(1993), and Nachman and Noe (forthcoming) explain the use of debt contracts with risk-averse agents and observable earnings.

¹⁰ Greenwood and Jovanovic (1990) provide a macro analysis in Boyd–Prescott framework. More agents are willing to pay the fixed costs of joining FI coalitions as the growth process augments their incomes.

secondary market for residual claims means that existing and prospective owners cannot rely on the capital market to determine the value of the mutual's assets. Thus, the mutual form is acceptable for organizations holding easily priced assets. What makes the mutual form the *preferred* structure is that it resolves the classic shareholder-depositor conflict regarding the appropriate level of risk. On the other hand, FIs holding harder to price assets might find that this agency benefit is more than offset by the disadvantage of financing opaque assets solely with nontraded demandable claims and may thus prefer stockholder ownership.

Smith and Stutzer (1990) provide an alternative explanation of the coexistence of mutuals and stocks emphasizing the risk-bearing and customer functions. In their analysis, mutuals arise endogenously as a self-selection mechanism to cope with asset valuation problems in the presence of both adverse selection and systematic risk. They consider a credit market with low- and high-default risk borrowers whose default probabilities are privately known to the borrowers and are also correlated with the lender's profits due to systematic risk. Credit contracts that base each borrower's repayment on the lender's aggregate profits are interpreted as mutual contracts and are shown to be Pareto improving because they incorporate an additional signal (the lender's profit). Smith and Stutzer indicate that their results are consonant with the experience of the Farm Credit System in the United States.

These theories also have implications for mutual-to-stock conversions, which have been widely observed in the savings and loan industry. The moral hazard theory of Fama and Jensen (1983a,b) and the dynamic perquisites-consumption model of Deshmukh *et al.* (1982) imply that mutual managers consume more perquisites than their stock counterparts (see Akella and Greenbaum (1988) for empirical support). However, as the U.S. savings and loan industry has become more competitive, managerial perquisites consumption has become more costly in terms of institutional failure probability. Competition therefore reduces optimal perquisites consumption, and the benefit of mutuality to managers diminishes. Managers also usually benefit in the initial stock sale due to underpricing, and this provides an incentive to convert from mutual to stock. Mester (1991) provides supporting empirical evidence.

3. THE ROLE OF ASSET TRANSFORMERS IN THE ALLOCATION OF CREDIT

Models of asset transformers reviewed in the previous section represent early efforts to understand the informational role of these institutions in the allocation of financial capital and real investment decisions. FIs

TABLE III
SUMMARY OF EQUILIBRIUM CONCEPTS

Papers	Equilibrium concept used
Stiglitz and Weiss (1981, 1983)	Bank maximizes expected return to depositors, where deposits are imperfectly elastic in supply
Bester (1985) and Besanko and Thakor (1987a,b)	Bank maximizes net project surplus accruing to depositors where deposits are elastically supplied

reduce Akerlof-type failures of price-mediated credit markets with informational frictions. Indeed, this is one rationale for the considerable attention given to FI existence. However, banks ration credit, a classic form of market failure. This section seeks to explain why. We also discuss credit contracting adaptations that may reduce rationing. The papers discussed employ different equilibrium concepts, which we summarize in Table 3.¹¹

3.1. Credit Rationing and Collateral

Credit rationing is taken to mean the denial of credit at *any* price. That is, the bank offers credit at a price at which demand exceeds supply. The early literature on credit rationing (e.g., Jaffee and Modigliani (1969)) noted that a bank would ration credit only if it faced rigidities in its loan interest rate that impeded Walrasian market clearing. Unfortunately, this did little more than restate the question since the source of the rigidities went unexplained.

This is the issue that Stiglitz and Weiss (SW, 1981) addressed in their analysis of a credit market with adverse selection and moral hazard. The key result in SW is that the bank's expected return could peak at an *interior* loan interest rate in the feasible interval. The intuition is as follows. In the case of adverse selection, the bank cannot distinguish among privately informed credit applicants with different risk attributes, and an increase in pooled interest rate on loans affects safer borrowers more adversely than it does riskier borrowers. An increase in the loan interest rate therefore drives safer borrowers out of the credit market before it induces exit by others. To see this, imagine two indistinguishable types of borrowers ("safe" and "risky"), and each seeks to borrow \$1 to finance a project that will pay a random amount, z , at the end of the period. The density and cumulative distribution functions of z are $f_S(\cdot)$ and $F_S(\cdot)$, respectively, for the safe borrower, and $f_R(\cdot)$ and $F_R(\cdot)$ for the risky borrower. Let the support of each density function be $(0, \infty)$ and the finite

¹¹ See, also, Winton's (1990, 1992) work on competition in the loan and deposit markets.

mean of each distribution be μ . $F_R(\cdot)$ is second-order stochastically dominated by $F_S(\cdot)$, i.e., $F_R(\cdot)$ is a mean-preserving spread of $F_S(\cdot)$. The reservation utility level of each borrower is $\bar{u}$ and everyone is risk neutral. Now, the maximum loan interest rate, i_S^* , that the safe borrower is willing to pay for a loan solves

$$\int_{[1+i_S^*]}^{\infty} [z - \{1 + i_S^*\}] dF_S(z) = \bar{u}, \quad (2)$$

and the maximum interest rate, i_R^* , that the risky borrower is willing to pay the bank satisfies

$$\int_{[1+i_R^*]}^{\infty} [z - \{1 + i_R^*\}] dF_R(z) = \bar{u}. \quad (3)$$

The assumed dominance of F_S over F_R implies that $i_R^* > i_S^*$. Thus, when increasing risk across a continuum of borrower types is defined through a sequence of second-order stochastic dominance relationships, any increase in the loan interest rate precipitates adverse selection with the exit of safer borrowers and consequently makes the credit applicant pool riskier on average.

The adverse-selection effect could reduce the bank's expected return as the loan interest rate increases. Now, if we assume that loans are financed exclusively with deposits, that the supply of deposits is upward sloping in the deposit interest rate, and that the interest rate paid on deposits is increasing in the loan interest rate, then we have the SW (1981) scenario of a credit demand schedule that is downward sloping and a credit supply schedule that is upward sloping in the loan interest rate. Only by coincidence would the credit demand and supply schedules intersect at the loan interest rate which maximizes the bank's expected return, and it is therefore possible for credit demand to exceed supply at that interest rate. Assuming that the bank wishes to maximize its expected return, it will be unwilling to extend credit to a rationed borrower even if a higher interest rate is offered.

The moral hazard in SW (1981) works analogously with a single borrower facing multiple investment opportunities. An increase in the loan interest rate affects the borrower's rents from safe versus risky projects differently. The borrower's preference for risk increases with the loan interest rate, so that a rate increase skews the borrower's project choice toward greater risk. This asset substitution results in the bank's expected return peaking at an interior loan interest rate as in the adverse selection case. According to SW (1981), credit rationing can spring from adverse selection, moral hazard, or both.

Two points are of note. First, the competitive rent exhaustion condition for banks works through competition for deposits. Hence, deposits are assumed to be scarce relative to loans. However, SW (1981) do not explain whether the competition for deposits is Bertrand or Walrasian. Yanelle (1989a) points out the different outcomes that Bertrand and Walrasian competitive models of intermediation can yield. The competitive equilibrium concept used by SW (1981) is also questionable because the bank maximizes depositors' expected return rather than their total surplus, which would subsume the volume of deposits as well as the interest rate paid. With an imperfectly elastic deposit supply, as assumed by SW (1981), the two maximands are not equivalent. Second, since the only contracting variable in SW is the loan interest rate, the equilibrium is by necessity pooling. Bester (1985) introduces collateral as an additional instrument and shows that it can sort privately informed borrowers in a separating equilibrium (see, also, Chan and Kanatas (1985)), thereby obviating rationing even if the collateral is insufficient to make loans riskless. Besanko and Thakor (1987a) show, however, that randomized rationing resurfaces when the constraint on collateral availability binds in a separating Nash equilibrium. Collateral nevertheless reduces rationing and is used even if it cannot eliminate rationing altogether.¹² In a companion paper, Besanko and Thakor (1987b) permit four contracting variables—the loan interest rate, collateral, loan size, and rationing probability—and show that rationing is always eschewed in a Pareto-efficient equilibrium as long as complete sorting can be achieved with the available contracting variables. This suggests that to explain credit rationing as a static phenomenon, credit contracting variables must be too few to achieve a complete sorting of borrowers. In practice, however, customer types may change, whereas banks face a cost in deploying additional contracting variables, so that complete sorting may not always be possible. Moreover, as Landsberger and Zamir (1993) have shown recently in the context of collateral-based signaling, the sorting ability of a credit-contracting variable declines if the bank and the borrower have dissimilar rankings of project quality.

SW (1983) explain the dynamic aspects of credit rationing in a two-period extension of their earlier framework. When borrowers can take hidden actions that may adversely affect the bank's return, it is *ex ante* efficient to threaten the borrower with second-period credit denial in the event of default on the first-period loan. This deters first-period risk tak-

¹² Chan and Thakor (1987) show that collateral resolves private information and moral hazard problems. Boot *et al.* (1991a) provide empirical support. Stulz and Johnson (1985) show that collateral can resolve underinvestment moral hazard.

ing, so that it is optimal to condition the credit allocation decision on the borrower's credit history. SW (1983) assume that the bank will carry out its threat if the borrower defaults. However, this is *not* time consistent because the bank forgoes potential second-period profits from lending. In a dynamic setting, such threats could possibly be made credible by introducing reputational considerations. But Chowdhry's (1991) initial effort at this illustrates the difficulty of formalizing this intuition.

Yet another shortcoming of the credit rationing literature is that it does not address the issue of rationing by an individual bank versus rationing by the entire banking system. When a borrower is rationed by a particular bank, he can seek credit from another bank. In economies with numerous banks, this is a thorny analytical problem.¹³ SW suggest that no bank would be willing to lend to a borrower rationed by another bank because the first credit denial signals bad news. This is plausible on its face. However, it does not fit either of the SW (1981) models or the Besanko and Thakor (1987a) model. In the static SW (1981) model, rationing is a random phenomenon; the bank's decision to ration is not based on any privileged information about the borrower. In the dynamic SW (1983) model, rationing is an *ex post* inefficient punishment device, and once again reveals nothing to discourage profitable credit extension by some other bank. In Besanko and Thakor (1987a), it is the better borrower who offers (limited) collateral and is therefore subject to being rationed, so that the "bad news" story is clearly incongruous. Thus, a literal extension of these models to the multibank case suggests that a borrower can eliminate the likelihood of being rationed by sequentially applying to banks. This suggests a role for search and application costs that deserves greater attention.¹⁴

At a more fundamental level, rationing models fail to address the role of the bank itself; the bank is merely a conduit for moving resources from savers to borrowers without any further justification. Moreover, the rationing models take the loan contract (debt) as given, even though equity could eliminate rationing. Clearly there remains a need for models in which the contract between bank and borrower is endogenized; banks can improve the allocation of credit and also may sometimes choose to ration

¹³ Chowdhry (1991) allows rationed borrowers to go to other banks and reflects this possibility *ex ante* in the incentive-compatibility conditions. The idea is that a bank may ration a borrower even if making the loan would be profitable because extending credit may damage its reputation for toughness. However, Chowdhry does not endogenously derive and incentive for a bank to desire a reputation for toughness.

¹⁴ Thakor and Callaway (1983) address these issues. Other approaches to credit rationing are in Keeton (1979) and Allen (1983). Empirical evidence on the significance of credit rationing appears in Berger and Udell (1992).

credit. Williamson (1987) endogenizes the debt contract in a rationing model, but does not provide a *raison d'être* for the bank.

Although the intended contributions are macroeconomic, much of the credit allocation research has been microeconomic. Credit rationing was initially used to explain how monetary policy might influence the real sector even when investment demand was insensitive to interest rates. As Bernanke (1983, 1988) points out, when credit rationing is admitted in a macro framework, the impact of monetary policy on the economy depends both on the amount of money banks create and on the volume of lending they do in the process.

Beginning with Blinder and Stiglitz (1983), many have explored the macro implications of rationing. For example, Greenwald and Stiglitz (1990) note that the Myers and Majluf (1984) equity rationing and the SW debt rationing makes firms risk averse, given financing constraints and the costs of potential bankruptcy. This sensitizes firms to their financial structure, and financial strength has real consequences. Moreover, rigidities arise in firms' behavior on price setting and employment. Bernanke and Gertler (1989) show that the kinds of agency problems that can lead to credit rationing can also engender real macroeconomic fluctuations, even without credit rationing. Their point is that higher borrower net worth reduces the agency costs of external financing, and since business upturns net worth, they lower agency costs and increase investment, thereby invigorating the upturn. Thus, agency costs amplify business cycles.

3.2. *Credit Rationing and Contracting Innovations: The Role of Loan Commitments in the Guaranteeing Function of Asset Transformers*

A loan commitment is a promise to lend in the future at the borrower's discretion on terms that are prespecified. Thakor *et al.* (1981) showed that a loan commitment can be viewed as a put option sold by the bank. When the commitment rate exceeds the customer's spot borrowing rate, the value of the customer's indebtedness exceeds the loan amount and the commitment option expires unexercised. However, when the commitment interest rate is below the customer's spot borrowing rate, the customer exercises the commitment and "puts" his debt to the bank. This observation permits Thakor-Hong-Greenbaum to use option pricing to value the commitment. Since then, this approach has been employed in many other papers to value different types of commitments (see, for example, Hawkins (1982)).

One reason for being interested in loan commitments is their sheer volume; Duca and Vanhooose (1990) note that 80% of all commercial bank lending in the United States is done under commitments. A second reason

is that commitments may reduce rationing. Boot *et al.* (1987, 1991b) and Boot and Thakor (1991) show that both effort-aversion and asset-substitution moral hazards are more effectively addressed by borrowing via loan commitments than in the spot market. The intuition is as follows. The loan interest rate is distortionary because an increase reduces the borrower's marginal return to effort, or the expected return from choosing a relatively safe project. With a loan commitment, however, the bank can promise to lend in the future at a loan interest rate low enough to deter these moral hazards. The rate required may be so low, however, that the bank suffers an expected loss despite the alignment of lender-borrower incentives. The bank's compensation for this expected loss is a commitment fee paid up front by the borrower. Since the borrower treats this fee as a sunk cost at the time it makes its project/effort choice, the first best is attainable. Using similar reasoning, Berkovitch and Greenbaum (1990) show that loan commitments can eliminate the underinvestment incentives of a levered firm identified by Myers (1977). Morgan (1993) highlights the ability of a loan commitment to increase the optimal loan size in a costly state-verification framework, even without moral hazard. Thus, a loan commitment enables a bank to both guarantee credit availability and to process credit risk.¹⁵ Moreover, by ameliorating moral hazard at the time the borrower makes the investment decision, loan commitments can solve one of the problems that engender credit rationing in SW (1981, 1983).

A third reason for being interested in loan commitments is that they enable banks to more efficiently manage their financial and reputational capital. Boot *et al.* (forthcoming) point out that the material-adverse-change clause in the loan commitment contract gives banks the discretion to repudiate the contract, and thus enables them to write down their reputational capital in order to conserve the financial capital that would be lost by honoring the contract. Likewise, the bank augments reputational capital by honoring its commitments.

A fourth reason is that loan commitments can frustrate monetary policy. An increase in short-term interest rates, created by a monetary policy initiative to reduce bank lending, will lead to greater takedowns under commitments as precommitted borrowing rates look more attractive relative to spot rates. Consequently, monetary policy has a perverse effect, at least in the short run (see Deshmukh *et al.* (1982)).

¹⁵ Loan commitments can have a signaling role as well (see Kanatas (1987), Thakor (1989), and Thakor and Udell (1987)). Moreover, Greenbaum *et al.* (1991) suggest that the sale of loan commitments can facilitate the bank's planning by helping it to estimate future loan demand, whereas Deshmukh *et al.* (1982) show that the amount of lending done by a bank depends on the extent of its participation in spot versus forward credit markets.

Given the similarity between the payoff structures of loan commitments and put options, it is natural to ask why this market is bank dominated rather than exchange dominated. There are two main reasons. First, commitments are customized to borrowers' needs. Second, a put option purchased by a firm that is in (unobservable) financial distress may exacerbate moral hazard between the time of commitment purchase and takedown since the borrower's commitment-related payoff at exercise increases with a deterioration in its financial condition prior to exercise. The loan commitment combats this potential hazard through bank monitoring and the material-adverse-change clause (neither of which has a counterpart in exchange-traded puts), so as to preserve the gains from attenuating moral hazard at the investment/commitment-takedown stage.

4. LIQUIDITY TRANSFORMATION: DEPOSIT CONTRACTS, RISK SHARING, AND COORDINATION

4.1. *Why Are Banks Financed with Nontraded, Liquid Deposit Claims?*

Bryant (1980) adapted ideas from the labor-market and insurance literatures (see Hart (1983)) in explaining the role of deposit contracts. Deposits are shown to insure against random shocks to investors' preferences for the timing of consumption/withdrawal. Deposits can serve such a role because of the nonconvexity in establishing individual insurance markets for each of the many small risks that impinge on an agent's income, health, and property. The sum of these risks, whose realization affects the agent's demand for withdrawals, is insured by the deposit contract. This differs from a multiperiod debt contract wherein an agent wishing to withdraw before term must sell the claim at the secondary market price. With a deposit contract, by contrast, the issuer commits to a fixed price. This raises the question, why is a nontraded instrument used to insure the depositor against preference shocks?

Bryant (1980), Diamond and Dybvig (1983), and Jacklin (1987) explain the nontraded aspects of deposits as follows. Even if no random aggregate shocks affect the secondary market prices of traded debt contracts, deposit contracts may provide an ex ante Pareto-superior allocation when preferences for the timing of consumption are subject to random individual shocks. Two reasons are offered. First, with ex ante identical agents, the optimal deposit contract attains the equally weighted welfare optimum, whereas the allocation with the traded debt contract corresponds to the competitive-exchange equilibrium which obtains when agents start

out with equal endowments but make heterogeneous trades due to interim preference shocks. Second, in seeking the welfare optimum, the deposit contract must respect incentive-compatibility constraints across allocations assigned to agents with differing values of the realized preference parameter. The traded debt contract must satisfy the stronger *coalitional* incentive compatibility constraints applicable even after trading opportunities are introduced. Thus, in general, it is optimal for deposit contracts to be nontraded.¹⁶

However, the dominance of the nontraded deposit contract is predicated on the payoff attributes of the long-lived assets financed by the deposits. When the resource balance constraints or payout commitments in deposit contracts depend on favorable return realizations of bank assets, sufficiently unfavorable returns may make such payouts infeasible. If some agents, who do not inherently wish to consume early, obtain adverse information about future returns, they may withdraw earlier at the precommitted terms offered in the deposit contract. Of course, even if traded debt or equity contracts were used, payoff-relevant information of this sort would affect asset-holding preferences and hence the interim secondary market prices of traded long-lived assets. However, there is a difference in the way in which such asset-return shocks affect investors' realized payoffs from risky deposits versus traded debt or equity contracts.

If early liquidation of long-lived investment technologies is costly, then information-based bank runs associated with deposits imply randomized allocations across informed depositors and possibly uninformed depositors with a desire for early consumption. This occurs only in the lower tail of the probability distribution of information about future returns on long-lived assets. In contrast, if these assets are financed with traded debt or equity contracts, then the secondary market prices for early withdrawal would be affected by interim information about asset returns over the entire range of the probability distribution of such information. Thus, the *ex ante* welfare dominance of deposit contracts over traded debt contracts in insuring random shocks to intertemporal consumption preferences may not hold for asset-return information distributions with a fat lower tail.

¹⁶ A referee has raised the question of what it means to make the deposit contract nontraded. For example, in Jacklin's (1987) framework, if depositors who withdraw in the interim stage can enter into a separate debt contract with those who withdraw late, then even though the deposit contract is nontraded, this arrangement destroys the insurance provided by demand deposits. Our view is that when a nontraded deposit contract is offered, out of the contract trades such as the one described above are simply proscribed by covenants in the deposit contract. Alternatively, we can think of such a restriction as part of the economic environment, say, through spatial separation as emphasized by Wallace (1988).

Holding the correlation (signal-to-noise ratio) between interim information and future asset returns fixed, this would imply that less risky asset portfolios would be better suited to deposit financing and riskier ones might be better financed with traded equity or debt contracts. In their examples, Jacklin and Bhattacharya (1988) find this to be the case.

4.2. *Deposits and Bank Runs*

Deposit financing makes banks vulnerable to runs. To see this, note that the resource balance constraints imposed in designing the optimal deposit contract are predicated on agents in each preference category choosing the intertemporal withdrawal pattern assigned to that category. As long as "no envy" constraints across categories hold, such behavior is a Nash equilibrium across agents with different preferences. However, there may be other Nash equilibria, often (with ex ante identical agents) Pareto inferior, which result in allocations and asset liquidation patterns that differ from those of the optimal deposit contract. This point is made in Diamond and Dybvig (1983), who term such a coordination failure a bank run. The intuition is as follows. Assuming that the nontraded debt contract must honor a sequential service constraint (SSC), the withdrawal decision of an agent whose preference shock does not necessitate consumption at the interim date will depend on the equilibrium strategies of other agents. Thus, if the agent believes that others will not withdraw, then he prefers the larger future payoff to the interim date withdrawal, and the good Nash equilibrium obtains. But if the agent believes others will withdraw prematurely, then the SSC provides an incentive to be early to withdraw; a bank run emerges as a bad Nash equilibrium.

4.3. *Bank Runs, Suspension of Convertibility, and Deposit Insurance*

When private arrangements fail to eliminate coordination failures, governmental intervention is a natural consideration. This literature examines the circumstances under which suspension of convertibility will staunch a bank run and those under which it will be desirable to provide deposit insurance.

Both Bryant (1980) and Diamond and Dybvig (1983) advocate federal deposit insurance, but for different reasons. Bryant suggests that deposit insurance eliminates incentives for agents to seek socially wasteful information in the presence of undiversifiable systematic risk. Deposit insurance also has the added benefit of eliminating the need for welfare-depleting randomization of consumption across agents in the interim period, and thereby preventing premature and dissipatively costly asset liquidations.

In Diamond–Dybvig, deposit insurance adjusts for an aggregate shock,

but this is not a shock to asset return prospects. Rather, it is randomness in the proportion of agents wishing to consume early. Deposit insurance is meant to alter the payoffs on deposit contracts to correspond to the realized proportion of "early diers." Even though the bank in Diamond–Dybvig is representative, it is unable to tailor its deposit payoffs to the realized aggregate preference shock because of the SSC. Diamond–Dybvig argue that governmental deposit insurance is able to achieve this tailoring because excessive early withdrawals lead to governmental money creation, and the resulting inflation reduces real payoffs on nominal deposit contracts, as is optimal given the bad aggregate preference shock realization.

Deposit insurance also eliminates the Pareto-inferior bank run equilibrium because the optimal deposit contract schedule, conditioned on the realized aggregate shock, always has the feature that waiting to withdraw dominates early withdrawal combined with storage for later consumption.¹⁷ In the absence of an aggregate preference shock, a precommitment not to liquidate more than the desirable proportion of assets early (suspension of convertibility) will eliminate the bad equilibrium, since future payoffs to a "nonpanicker" are unaffected by the panic of others. Diamond–Dybvig justify deposit insurance with the observation that this mechanism fails under aggregate uncertainty. But we doubt the role envisioned by Diamond–Dybvig for deposit insurance—Bhattacharya's (1982) negative results on the welfare optimality of shock-contingent monetary policy argue against a reliable monetary interpretation of their mechanism.

Since the Diamond–Dybvig policy prescriptions stem from a model in which a bank run is a sunspot phenomenon, it is natural to ask if the logic extends to informationally induced runs. Chari and Jagannathan (1988) provide an answer by combining (i) shocks to information about the returns on long-lived assets (Bryant, 1980) whose premature liquidation is costly and (ii) shocks to the proportion of depositors seeking early withdrawal (Diamond and Dybvig, 1983).¹⁸ Uninformed agents are unable to distinguish these two shocks and therefore judge the future deposit payoffs from the length of the withdrawal queue. Two results are obtained. First, given their noisy rational expectations equilibrium, there exist parameter values that imply a *unique* bank run equilibrium. In such an equilibrium, even agents not seeking early consumption will attempt to

¹⁷ In a clever variation of Diamond–Dybvig, Postlewaite and Vives (1987) provide an example in which deposit contracts result in panics as a unique Prisoners' Dilemma outcome in some states of nature. However, as they note, their deposit contract parameters are not optimal, given the preferences and technologies.

¹⁸ Unlike Diamond–Dybvig, Chari–Jagannathan assume universal risk neutrality so that the bank does not arise endogenously to improve risk sharing.

withdraw early since they cannot distinguish among the two types of withdrawal queue members. Second, when bank run equilibria obtain, suspension of convertibility that restricts early withdrawals to the lowest anticipated fraction of agents desiring early consumption sometimes improves agents' expected utility (see, also, Villamil (1991)). However, suspension of convertibility is not a first-best measure in Chari–Jagannathan since some agents genuinely desiring early withdrawal/consumption are denied access to their bank deposits in some states. We postpone to Section 6 a discussion of whether deposit insurance that eliminates the incentives of depositors to monitor the bank's investments might do better for depositors' welfare.

4.4. *Bank Runs Versus Panics*

A bank run relates to an individual bank; a panic is a simultaneous run on many banks. A model of banking panics must explicitly address the contagion effects of runs. Neither Diamond–Dybvig nor Chari–Jagannathan model panics. However, the Chari–Jagannathan model is amenable to an adaptation that would permit it to predict contagion effects. If informed “livers” (those who wish to consume late) obtain information regarding bank-specific and systematic risks, then runs might lead to panics. Gorton (1988) develops and empirically tests a model along these lines. Correlations among runs in Gorton's model arise from the information about systematic risk that is signaled by the run on one bank; contagion is therefore not a sunspot phenomenon. His empirical tests strongly suggest that banking panics in the pre-deposit insurance era were systematic events triggered by the first large (information) shock following a business cycle peak.

4.5. *Alternatives to Deposit Insurance: Voluntary Reserves and Federal Funds*

A federal funds market is one possible alternative to deposit insurance, and it is examined by Bhattacharya and Gale (1987). They consider a Bryant–Diamond–Dybvig-type economy with two time periods and agents who sustain interim date preference shocks that affect their consumption and deposit withdrawal patterns. Each bank is assumed to experience a privately observed local shock that determines the proportion of its deposit base that is withdrawn at the end of period 1. While the fraction of deposits withdrawn at an individual bank is random, there is no aggregate uncertainty in the fraction of the economywide withdrawal. Each bank determines the fraction $l \in [0,1]$ of the deposits it receives at the beginning of period 1 to invest in a low-yield short-maturity asset paying off at the end of period 1; the complement $(1 - l)$ is invested in a high-

yield asset paying off at the end of period 2. Although the high-yield asset is costly to liquidate before the end of period 2, the bank can borrow for one period from another bank at the end of period 1. Depositors are risk averse and the bank is operated (as in Diamond–Dybvig) like a mutual, owned by its depositors.

The first-best bank contract for insurance of preference shocks calls for each bank investing some fraction l^* of its initial deposits in the short-maturity asset. At the end of the period, a bank whose deposit withdrawals exceed the payoff yielded by its short-maturity asset can borrow in the interbank market. Since there is no aggregate uncertainty, first-period withdrawals can be precisely satisfied by the aggregate payoff to the banking system from investment in the short-maturity asset. Moreover, when each agent's utility function exhibits a relative risk-aversion coefficient greater than unity, the optimal insurance of preference shocks implies that early withdrawers get strictly more than the technological rate of return on the short-maturity investment.

However, Bhattacharya–Gale show that if banks' choices of l^* are only privately observed, the interbank loan market, clearing in the usual competitive Walrasian fashion, will not attain the first best. To see this, suppose counterfactually that it is a Nash equilibrium for all banks to choose l^* . If one could ensure that each would indeed choose l^* , then each bank could sell shares with an appropriate dividend stream across periods 1 and 2, and trading in an interbank equity market would insure their depositors perfectly.¹⁹ However, given that each bank is assumed to choose l^* , it pays for an individual bank to deviate from the conjectured equilibrium by reducing l below l^* and diverting this investment to the higher-yielding asset that pays off at the end of period 2. Doing this increases depositors' wealth. Consequently, each bank has an incentive to free ride to increase its depositors' feasible consumption set and decrease l to zero.

Thus, interbank coordination, seeking to insure bank-specific preference shocks through interbank lending, must overcome this free-rider problem through a more complicated, precommitted second-best contract. Bhattacharya–Gale characterize the optimal contract and show that under plausible conditions it involves limited interbank lending and short-maturity investments that are positive but below the first-best level.²⁰

¹⁹ This is a special feature of the corner preferences assumed by Diamond and Dybvig (1983) and Bhattacharya and Gale (1987). In general, given l^* , trading of such equity shares in period 1 will not lead to the ex ante expected utility-maximizing allocation when interim realizations of the preference shocks lead to agents having interior consumption preferences (satisfying Inada conditions) across periods 1 and 2, as in Bryant (1980) and Jacklin (1987).

²⁰ Chari (1989) shows that interbank lending eliminates panics and achieves optimal risk sharing if investments in liquid reserves are observable and convertibility is suspended whenever the aggregate demand for withdrawals exceeds the aggregate supply of funds.

4.6. *Bank Runs and the SSC*

We now revisit the issue of the SSC which precludes conditioning individual deposit payoffs on the realized aggregate preference shock. In Diamond and Dybvig (1983), the optimal contract for financing the bank indeed calls for such conditioning. Eliminating the SSC has been suggested as a way of eliminating runs and the need for deposit insurance. However, the SSC serves a purpose. Calomiris and Kahn (1991) and Calomiris *et al.* (1991) show that demandable debt with the SSC deters managerial fraud as well as asset-substitution moral hazard. The demandability of deposits motivates some depositors to engage in costly monitoring of bank behavior and to withdraw their funds if they detect fraud or unacceptably high asset risk. Moreover, free riding by depositors on the monitoring of others is discouraged by the SSC.

This conclusion is obtained, however, in the context of uninsured deposits. In the Calomiris–Kahn and Calomiris–Kahn–Krasa models, there is no need for deposit insurance because monitoring depositors withdraw only when they observe untoward behavior. Since these depositors are not error-prone in their inspections, a bank run is beneficial in these models, in contrast to earlier work. This makes it difficult to compare the endogenous SSC in these two papers with the exogenous SSC of earlier models. Is it plausible to have the SSC in models in which it prompts disruptive bank runs, simply because it solves a problem in models in which it leads to socially efficient bank runs? Moreover, if monitoring were sufficiently noisy in the Calomiris–Kahn and Calomiris–Kahn–Krasa papers, runs would be *ex post* inefficient and deposit insurance could make sense. But then, because of elimination of duplication, monitoring is more efficiently performed by the deposit insurer, rather than by depositors. Why then do we need the SSC?

4.7. *Liquidity Transformation Unrelated to Bank Runs*

Thus far we have discussed liquidity transformation in the context of bank runs and panics. There are economic incentives for liquidity transformation, however, that are unrelated to runs. Gorton and Pennacchi (1990) and Subrahmanyam (1991) have proposed that FIs create liquid securities in response to demand by uninformed investors. Defining a liquid security as one that embodies virtually no private information, these papers formalize the intuition that trading in liquid securities like diversified stock and bond portfolios and bank deposits protect uninformed investors from losses they would suffer in trading illiquid (information-sensitive) securities with those possessing superior information. The creation of such information-insensitive claims by nonbank FIs satisfies liquidity demand without the possibility of bank runs.

5. MATURITY TRANSFORMATION: DEBT MATURITY AND SECURITIZATION

5.1. *Maturity Transformation and the Bank*

Maturity transformation is a process whereby assets are financed with liabilities of a shorter maturity. The bank's gain from maturity transformation is twofold: (i) a reward for bearing interest rate risk, and (ii) a reward for the creation of liquidity (see Thakor (1992)). As for (i), a positive "term premium" in the yield curve provides a maturity mismatching incentive to the FI. The greater this mismatch, the higher will be the expected value as well as the volatility of the FI's return on equity (see Deshmukh *et al.* (1983) and Niehans and Hewson (1976)).

In the case of (ii), although the intermediary can presumably create liquidity without duration transformation, liquidity creation may be facilitated by maturity mismatching. For example, the credible provision of liquidity by a bank would hinge on the bank screening and monitoring its borrowers to ensure that loan quality satisfies the conditions needed for the loans to be liquid. Screening and monitoring incentives are enhanced if the bank's liabilities are shorter in duration than its loans because the availability as well as the pricing of deposits would be contingent on many noisy evaluations of the bank's screening/monitoring over the life of the loan portfolio. Maturity mismatching imposes a market discipline on the bank; recall the earlier discussion of demandable debt in Calomiris *et al.* (1991).

Flannery (1992) theorizes that loans may be long in maturity due to borrowers' long-term, illiquid technologies, so the question is optimal deposit maturity. Since banks' assets, especially those for which the value of intermediation is high, are typically information-sensitive, and banks have opportunities for asset substitution, it is costly for the bank to issue long-term debt with covenants that deter asset substitution. Flannery assumes that depositors have access to payoff information when short-term deposits are repriced. This makes it preferable *ex ante* for the bank to be subject to frequent market reassessments which leads to the optimality of short-term liabilities. Diamond (1991b) offers a different intuition. If depositors can only noisily evaluate the bank's prospects and bank insiders earn nonmarketable control rents, then even a solvent bank may suffer dissipative liquidation costs (lost control rents) if it is undervalued at the time of refinancing. Duration transformation is therefore linked to the bank's liquidity production and the accuracy with which bank insiders are able to transmit proprietary information about their loan portfolio to depositors. Related intuition appears in Sharpe (1991).

5.2. *Securitization*

In the setting of the previous subsection, an underinvestment problem arises because *new* depositors are sold a claim against the bank's *aggregate* loan portfolio. The reason is as follows. For the bank to have its new deposits priced correctly, depositors must have as much information as the bank about *all* of its assets. With asymmetric information and a single pooled equilibrium price across unobservably heterogeneous banks, a lemons problem causes undervalued banks to forgo projects that would have been profitable in the first-best case. Exploiting such opportunities would mean that existing shareholders would have to sacrifice too large a claim against preexisting assets. This problem, first articulated by Myers and Majluf (1984) and reexamined by Diamond (1991b) in a debt maturity context, suggests that much of the distortive consequences of deposit financing can be avoided if the bank could sell new depositors a secured claim on the *incremental* loans financed with their deposits. Securitization achieves this (see James (1988)).²¹

Benveniste and Berger (1987) also show that securitization with recourse permits a bank to prioritize the claims of its depositors. Those who buy the securitized asset have first claim on that asset in case the bank is insolvent, and they have the option to not exercise that claim if they so wish. In the latter case, they are treated like other depositors. This improves risk sharing, as those with the greatest risk aversion gravitate to the securitized claim. Securitization permits the bank to issue deposit-type claims of different seniorities without violating the legal restriction that U.S. banks cannot prioritize ordinary deposit claims.

The securitization decision is a choice between deposit financing and capital market financing. The bank's choice, in particular the extent to which the loan buyer has recourse to the originating bank, can signal its private information to the market, and thereby bridge the informational gap encountered with a standard deposit contract. Greenbaum and Thakor (1987) suggest that securitization is limited only by the (cross-sectional) requirements of the perfectly separating signaling schedule. Pennacchi (1988) notes that the bank's incentive to monitor the borrower is weakened when the loan is securitized, and that this limits the range of assets that can be profitably securitized, even though credit enhancement by the originator is intended to partially restore monitoring incentives (see, also, Gorton and Pennacchi (1993)). In particular, securitization is

²¹ James (1988) refers to this securitization as a loan sale with recourse. James' point is that a securitized loan can be viewed as a loan sold to investors with recourse to the bank, or a collateralized deposit.

likely to be greater for assets requiring less bank monitoring.²² The effect of securitization on aggregate investment is analyzed in Boyd and Smith (1993).

The liquidity and risk sharing discussed in this section resolve private information problems and are alternatives to the deposit contract-based resolution analyzed in Section 4. Although the deposit contract serves a purpose, its nontradability and other features come at a cost. Securitization may be an optimal contracting response to the disadvantages of deposit funding, even apart from cash-asset reserve and capital requirements. This is because liquidity and efficient risk sharing are possible with securitization without the SSC. An integrated analysis of these issues is as yet unavailable.

6. DO BANKS NEED TO BE REGULATED?

Deposit-funded banks are vulnerable to runs, and the banking system may therefore be vulnerable to panics. Private arrangements to cope with these pathologies are beset with free-rider problems that distort equilibria away from the first best. To minimize such distortions, the government may introduce a lender of last resort facility and/or deposit insurance. However, such interventions create problems of their own. As shown by Merton (1977, 1978), deposit insurance is a put option which encourages excessive risk taking. This then necessitates a regulatory response. As Merton and Bodie (1992) note, this response may include monitoring, risk-based premiums, cash-asset reserve and capital requirements, portfolio restrictions, and limits on discount window borrowing. This provides a starting point for an analysis of bank regulation.

6.1. *Deposit Insurance and Suspension of Convertibility*

Runs can be prevented with deposit insurance or suspension of convertibility. Since both are second-best measures, it is difficult to choose between them. This is transparent for the former, when the proportion of “early diers” is stochastic, but a bit more subtle for the latter.²³

²² Ramakrishnan and Thakor (1984) have FIs investing in costly monitoring, but ultimate investors hold the claims as with securitization. As suggested earlier, these are loans for which ex ante screening is more important than postlending monitoring; this dovetails with our conclusion regarding securitizable assets. On the other hand, when postlending monitoring is more important, banks fund loans with deposits, as in Diamond (1984).

²³ Our claim that deposit insurance is a second-best measure contrasts with Diamond and Dybvig’s (1983) about the optimality of deposit insurance in conjunction with a governmental taxing scheme that affects the nominal price level. We believe it unlikely that agents in a panic will pause to consider the price level consequences of money growth that would allow

Consider first the case in which long-term investments can be prematurely liquidated only at a cost. Then, suspension of convertibility is like random taxation of those seeking early withdrawals, whereas deposit insurance funded by distortionary taxes is like deterministic (given the state of nature) taxation. For the case in which agents have general preferences, it is not clear which policy would be superior.²⁴ With a convex cost of liquidating long-term investments early and with convertibility suspended only beyond the lowest anticipated proportion of early diers, depositor's adverse information about future asset payoffs would prompt beneficial asset liquidation by banks in some nonpanic states. With deposit insurance, depositors have no incentive to become informed about asset returns, and hence no such liquidation would occur. For depositor-initiated liquidations to be beneficial, depositors must have information that bank managers/regulators lack, or there must be managerial/regulatory agency problems that delay liquidations.²⁵

6.2. Pricing Deposit Insurance

Risk-insensitive deposit insurance pricing is widely blamed for many U.S. banking industry woes of recent years. In a recent paper, however, Chan *et al.* (CGT, 1992) cast doubt on the implementability of risk-sensitive deposit insurance pricing. They focus on precontract private information and asset-substitution moral hazard related to deposit insurance and show that bank charter values must be sufficient to guarantee the incentive compatibility of risk-sensitive deposit insurance pricing. Keeley (1990) provides empirical support for the inverse relationship between bank risk taking and charter value. The basic argument in CGT, absent asset-substitution moral hazard, but with the bank privately informed about its assets, is that any risk-sensitive deposit insurance pricing scheme must be incentive compatible and should avoid two undesirable features of the erstwhile flat pricing scheme: (i) cross-subsidization of riskier banks by safer counterparts, and (ii) intrusive regulatory auditing

banks to fund withdrawals. Calomiris and Gorton (1990) question the historical relevance of the Diamond–Dybvig bank runs story. Moreover, Engineer (1989) shows that if the horizon in Diamond and Dybvig (1983) is extended to four periods and one adds a subset of agents with preferences weighted toward consumption in the fourth period, then suspension of convertibility does not always prevent a bank run.

²⁴ If one goes beyond the ex ante representative agents modeling discussed above, and argues that poorer agents would be slower to queue for their deposits, then distributional considerations might lead to deposit insurance being the superior policy instrument.

²⁵ Boot and Thakor (1993) analyze distortions in closure decisions by self-interested regulators who perceive a reputational damage from closure. Gorton (1985) shows that suspension of convertibility can signal the bank's private information about asset value when depositors can verify this value only ex post at a cost. This leads to the bank suspending convertibility only when asset liquidation is suboptimal.

to discover banks' portfolio characteristics. Condition (i) leads CGT to focus on perfectly separating outcomes, whereas condition (ii) calls for the deployment of a revelation mechanism. CGT show that with capital requirements linked to risk-sensitive deposit insurance premia, these two conditions are satisfied, with the equilibrium having riskier banks choosing relatively low capital requirements and high premia per dollar of insured deposits, and safer banks opting for higher capital requirements and lower premia. The key result in CGT is that this, or any other revelation mechanism, works only if the capitalized value of the bank's future rents is significant. The reason is that any perfectly separating, direct revelation scheme in such a setting is distortive. Moreover, the distortions necessary for incentive compatibility violate the banks' participation constraints if these latter constraints are binding at the optimum in an uninsured regime, as they would be if the capitalized value of future rents for each bank was zero without deposit insurance. The moral hazard part of CGT's argument is more transparent—the threat of charter loss can deter moral hazard only if the charter value exceeds the immediate gain to the bank from asset substitution.

6.3. *Charter Values in Banking*

Charter values arise from subsidies to banks and/or controlled entry. Given increasing competition, the prospects seem remote that risk-sensitive deposit insurance pricing will resolve private information and moral hazard problems. The prescription implicit in CGT is that regulatory initiatives aimed at improving the profitability of banks should precede other reforms such as risk-sensitive deposit insurance pricing.

One nonmarket approach to reviving bank charter values was proposed by Buser *et al.* (BCK, 1981). BCK suggest that charter value arises from subsidized deposit insurance, and that these subsidies are used by the insurer to control asset-substitution moral hazard; threats to cut off subsidies through bank closure are employed to restore the desired asset-choice incentives. The socially optimal combination of direct and indirect subsidies (through entry restrictions) remains an open question.

Of course, governmental intervention may be unnecessary if banks' risk-taking incentives were held in check by reputational concerns and informational rents. But for reputation to deter risk taking, banks must earn reputational rents from choosing low-risk projects, as borrowers do in Diamond's (1989b) model. It is not clear, however, that such banking rents can be sustained in competitive settings. The reason, as noted by Bhattacharya (1982), derives from Bertrand competition for outputs and inputs subsequently analyzed by Stahl (1988) and Yanelle (1989a,b). Consider an uninsured bank that finances an asset with deposits in an environment with pervasive risk neutrality. The asset pays off over two periods

and depositors are also paid over the two periods, conditional on the bank surviving two periods; the bank may be liquidated after the first period if it cannot pay off depositors. The first- and second-period asset payoffs are x (a random variable) and $x(1 + r)$, respectively, where r is an exogenously given appreciation rate in the bank's asset return. The bank can choose the probability distribution, $F(x)$, of asset payoffs from a commonly known feasible set, where M is the statistical mean of x . Let $i < r$ be the promised interest rate on deposits each period. The feasible set of F 's has distributions which differ in M and risk (in the Rothschild and Stiglitz (1970) sense). This set has the property that there is a one-to-one mapping from M to F that is continuous in the supremum norm, and the depositors' expected return is decreasing in M for every i . Of course, for a given M , depositors' expected return is increasing in i . The bank chooses M and i to maximize its shareholders' expected return. Bhattacharya shows that the bank's choice of M depends on the wedge, $r - i$, and that for a given r there is an i^* such that the bank chooses the socially efficient (highest) M for all, $i \leq i^*$. However, since $\partial M / \partial i = 0$ locally at $i = i^*$, the bank can raise i slightly above i^* and attract additional deposits because depositors are offered a higher expected return. Thus, at least in the absence of constraints on deposit pricing, the choice of i^* is not sustainable in a private equilibrium, and banks' asset choices are not socially efficient; regulation may be needed to sustain rents and desirable asset-choice incentives. Deregulation of U.S. banking during the 1980's appears to have ignored this point; see, also, Besanko and Thakor (1992).

The above analysis takes r as exogenous, however. Sharpe (1990) and von Thadden (1990) develop promising approaches to endogenizing r and have examined rent creation possibilities. Both consider multiperiod interactions between banks and borrowers, wherein the incumbent bank acquires an advantage owing to its knowledge of the borrower's quality.²⁶ Both papers conclude that the bank's informational advantage could lead to ex post rents that create potential distortions. In von Thadden's model the distortion manifests itself in some borrowers investing myopically, choosing lower-valued projects that have a higher probability of paying off early and thereby dissipating the incumbent bank's informational advantage.²⁷ In Sharpe's model, the informationally advantaged bank

²⁶ In earlier work, Greenbaum *et al.* (1989) also shows that lenders can accumulate proprietary information about their borrowers so that the optimal loan rate exceeds the incumbent lender's cost of funds and also exceeds the average cost of funds for competing lenders. Potential lenders offer loan rates that are lower than their cost of funds in order to attract the customer and earn positive expected profits in the future.

²⁷ This is similar to Thakor (forthcoming) where investment myopia is encountered in equilibrium in a model in which managers maximize shareholder wealth.

charges excessive second-period loan rates, and is thus forced by ex ante competition to charge a lower first-period rate. With a downward sloping demand schedule for loans, this results in too much credit being allocated to new borrowers and too little to old. This research appears to support the idea that regulatory restrictions on entry into banking may be necessary to sustain the rents needed to deter banks from excessive risk (see, also, Besanko and Thakor (1993)). However, these restrictions also are likely to distort credit allocation and borrowers' project choices.

6.4. *Capital Requirements and Deposit Interest Rate Ceilings*

Capital is widely believed to reduce the bank's incentive to choose riskier assets. However, Kahane (1977) showed that capital requirements by themselves may be ineffective in controlling bank risk, and may even induce the bank to choose riskier assets (see, also, Koehn and Santomero (1980)). Since then, others have argued that capital requirements are less effective in deterring bank risk than is widely believed. For example, Besanko and Kanatas (1993) show that a higher capital requirement may lead to greater outside equity, which could increase moral hazard because managers (insiders) have a reduced stake in the bank. Similarly, Genotte and Pyle (1991) find that a higher capital requirement can induce higher risk, necessitating greater regulatory intrusions.

Increasing capital requirements also has distributional entailments. Besanko and Thakor (1992) show that an increase in capital requirements increases the equilibrium loan size and decreases the equilibrium loan interest rate, but reduces the equilibrium deposit rate. Thus, even if the capital requirement deters bank risk taking, its effect on depositor welfare needs to be considered. A higher capital requirement acts as a tax on depositors that discourages bank risk taking, a measure strikingly similar to earlier Reg Q ceilings that sought restrain risk taking by reducing interbank competition for deposits.

Subsequent to Bhattacharya's (1982) endorsement of deposit interest ceilings as a way to sustain bank rents, the issue was examined by Smith (1984) who developed a model in which depositors are privately informed about their future consumption needs and banks are Nash competitors for deposits in a game in which the uninformed banks move first. When a Nash equilibrium exists, banks induce self-selection by offering depositors contracts that promise different vectors of first- and second-period consumptions. Nash equilibria often fail to exist in such games (see Rothschild and Stiglitz (1976)). Smith interprets this existence failure as instability in the banking system. An interesting aspect of the analysis is that instability can arise despite a lender of last resort (LOLR) and with-

out any panic-run-based need for deposit insurance. Since it is interbank competition that leads to the possible nonexistence of equilibrium, Smith makes a case for regulating deposit interest rates as a way to limit instability.

6.5. *Other Bank Regulation Issues*

It is widely believed that bank regulation solves safety net moral hazards (see, for example, Dewatripont and Tirole (1993)). That is, safety net initiatives like deposit insurance and LOLR facilities are designed to improve banking stability,²⁸ but they induce excessive risk taking and socially suboptimal capital and cash asset reserves.²⁹ This necessitates further regulation aimed at restraining these perverse incentives.³⁰

This tension between a banking safety net and the attendant moral hazards raises a host of interesting issues. Recent research emphasizes the SSC of the deposit contract in causing bank runs and panics and the importance of deposit insurance in reducing the likelihood of panics. So we need a better understanding of the *raison d'être* of the demand deposit contract and the SSC. Wallace (1988) explains that if the deposit insurer were also subjected to the SSC, deposit insurance might fail to eliminate runs and panics. Gorton and Pennacchi (1991), Kareken (1983), and others have suggested that equity claims against money market mutual

²⁸ Emmons (1993) examines the socially optimal choice between deposit insurance and a lender of last resort (LOLR) facility.

²⁹ We have chosen to sidestep many of the interesting issues related to cash-asset reserve requirements and the LOLR. For some recent theoretical contributions to the reserve-requirements debate, see Greenbaum and Thakor (1989) and Kanatas and Greenbaum (1982). Friedman and Schwartz (1963) present empirical evidence that liquidity crises were endemic under the National Bank Act despite reserve requirements. Loewy (1991) develops a model that generates predictions consistent with the Friedman and Schwartz (1963) evidence. The problems with the LOLR facility are similar to those with the federal funds market analyzed by Bhattacharya and Gale (1987). Moreover, Kanatas (1986) shows that any gain attainable through deposit insurance reform alone can be vitiated by banks' exploitation of the discount window.

³⁰ Previous attempts to address this issue include Chan and Mak (1985) who examine the effect of deregulation from the standpoint of maximizing the small saver's welfare, subject to a participation constraint for the bank. Matutes and Vives (1991) examine multiple regulatory instruments and conclude that if banking instability is interpreted as multiple equilibria arising from coordination failures among depositors, then interbank competition does not necessarily imply greater instability, although such competition is socially excessive in an unregulated equilibrium. Kane (1981, 1984) provides a unifying framework to understand the expanding scope of regulation by defining the concept of the *regulatory dialectic*. This concept embodies cyclical interaction between political and economic pressures in regulated markets, treating political processes of regulation and economic processes of regulatee avoidance as opposing forces that adapt continuously to each other, thereby spawning an increasing array of regulations.

funds could be endowed with all of the transactions attributes of demand deposits, and that threat of banking panics—and with it the need for deposit insurance—would be eliminated because this contract would not be constrained by a SSC.

Yet others (Boot and Greenbaum (1993) and Merton and Bodie (1993)) argue that the insured deposit contract can be retained, but only to finance a narrowly defined set of relatively safe assets. This narrow bank could be part of a larger bank that is free to fund other assets with uninsured liabilities. The narrow bank is a form of *direct regulation* that proscribes specific activities. The extant alternative, *indirect regulation*, seeks to incent optimal choices with capital requirements, closure policy, accounting rules, and the like. The choice between direct and indirect regulation deserves careful study, particularly because it has implications for the current debate about increasing bank powers in the United States (see Boot and Greenbaum (1992) for a discussion). We suspect that a satisfactory analysis of this issue must confront the question of the uniqueness of banks in creating liquidity with the demand deposit contract; recall our discussion in Section 4.7. The recent work of Rajan (1993) provides an initial stab at the choice between universal banking and commercial banking, i.e., the U.S. and European banking designs.

The literature on the choice of regulatory design has also recently focused on the effects of regulatory self-interest. Kane (1990) provides anecdotal evidence describing the distortions created by the delegation problem between taxpayers and regulators. Campbell *et al.* (1992) assume an effort-averse regulator and show that regulatory monitoring and capital requirements are partial substitutes. Boot and Thakor (1993) analyze the reputational incentives of a regulator responsible for monitoring banks' asset choices and determining when to close banks. They show that a reputation-seeking regulator will delay bank closure relative to the social optimum; based on this, they recommend limiting regulatory discretion. Kane (1989) analyzes a similar reputational incentive on the part of managers of the federal deposit insurance fund to conceal losses to the fund. Kane and Yu (1993) provide empirical estimates of taxpayer losses due to such regulatory forbearance.

Even within the current framework of indirect regulation, there are compelling issues, such as regulatory forbearance and the accounting standard. Market Value Accounting (MVA) has received considerable attention because of the incentive distortions associated with GAAP (Generally Accepted Accounting Principles) accounting. Research on this issue, however, is fragmentary. The three main issues relate to measuring the values of nontraded assets, the possible behavioral distortions associated with reporting of point estimates of variables that are observable only as intervals, and the potential investment distortions arising from the

informational frictions that impede MVA adoption. Numerous papers have addressed the first question (e.g., Berger *et al.* (1991) and White (1988)), but the two latter questions remain largely unexplored (see O'Hara (1993) for a start).

Optimal bank regulation design must also address the viability of nation-based regulation in light of increasingly integrated global markets.

7. FINANCING SOURCES: BANKS VERSUS CAPITAL MARKETS

7.1. *Borrowers' Choice of Financing Sources*

The borrower's choice between bank loans and direct debt financing has recently been analyzed by Diamond (1991a) who maintains that relatively new borrowers without well-established reputations have the most to gain from bank monitoring and hence choose bank loans. More reputable borrowers choose the capital market. Rajan (1992) suggests that banks extract information-related rents for which there is no counterpart in direct borrowing. In Rajan's model, the bank has an advantage in dealing with asset-substitution moral hazard, but its rent extraction causes the borrower to undersupply effort relative to the first best. Since these rents are available only when the borrower's project succeeds, Rajan argues that borrowers who anticipate a sequence of very profitable future projects would prefer arms length (direct) financing. Whereas Diamond's reputational prediction about the borrower's choice of financing source is retrospective, Rajan's prediction is prospective. Wilson (1992) argues that the resolution of intrafirm incentive problems for the borrower calls for a harsh (nonrenegotiable) budget constraint, as provided by arms length financing. Using a somewhat different approach, Berlin and Mester (1992) suggest that borrowers who are relatively poor credit risks—and about whom information is more volatile—take bank loans with stringent covenants because this makes it easier to renegotiate. Hence, with bank loans, the arrival of new information in the postcontracting stage leads to less ex post inefficiencies than with public debt. Seward (1990) shows that with multiple information problems, there is a role for multiple classes of financial claimants, so that efficiency is improved if the economy provides both direct and intermediated credit contracts.

A third possible financing source, namely venture capitalists (VC), is considered by Chan *et al.* (1990). Their analysis suggests a three-tier hierarchy of financing sources. The most inexperienced borrowers, who are unsure of their management skills, choose VCs, whereas those with better established skills but without a credit reputation approach banks. Larger firms with both skilled management and a reputation for creditworthiness choose capital market financing. Table IV summarizes these insights about the financing source choice.

TABLE IV
CHOICE OF FINANCING SOURCES AND THEIR ATTRIBUTES

Financing source		
VC	Bank	Capital market
Unestablished management skills, (Chan <i>et al.</i> , 1990)	Well-established management skills but no credit reputation (Chan <i>et al.</i> , 1990).	Well-established management skills and good credit reputation (Chan <i>et al.</i> , 1990).
	Poor prospects for future profits (Rajan, 1992)	Good prospects for future profits (Rajan, 1992).
	High credit risk (Berlin and Mester, 1992).	Low credit risk (Berlin and Mester, 1992).
	Unestablished credit reputation (Diamond, 1991a).	Established credit reputation (Diamond, 1991a).
	Intrafirm incentive problems not severe (Wilson, 1992).	Severe intrafirm incentive problems (Wilson, 1992).

The organization of the credit market also affects the borrower's choice of financing source as well as the allocation of credit. This point is developed by Dewatripont and Maskin (1991) who study a two-period credit market with adverse selection and moral hazard. They show that decentralized credit markets (the Anglo-Saxon design) deter poor projects but may also pass up profitable long-term projects. On the other hand, centralized credit markets (the German-Japanese design) suffer from the soft-budget-constraint problem of persistence with unprofitable projects.³¹ These considerations explain numerous differences in investment behavior across countries. Dewatripont–Maskin ignore the possibility of borrower signaling analyzed by von Thadden (1990). If poor projects are those that yield high payoffs early, then introducing the von Thadden cash flow signaling in Dewatripont–Maskin will result in a stronger likelihood of profitable long-term projects being eschewed.

7.2. Allocation of Capital and the Capital Market Microstructure

Market microstructure relates to the institutional details of how securities are traded and how prices are influenced by the information contained in order flows. Grossman and Stiglitz (1980) recognized that prices cannot

³¹ Wilson (1992) formalizes a similar intuition in providing a theory of corporate liquidity based on the tension between the higher cost of external financing relative to internal financing and the existence of the soft budget constraint with internal financing.

reveal too much of the information obtained at a cost by informed agents or else information acquisition incentives are undermined. Hence, prices must be noisy aggregators of proprietary information. To sustain this noise in prices, an appropriate amount of anonymity in trading is required, i.e., the intermediating broker should be unable to distinguish between transaction orders from informed and uninformed traders. Otherwise, the market maker could invert the order quantity function and infer what the informed know. Hence, the intermediation process involved in crossing buy and sell orders influences prices and allocations, as does the competitive structure of the intermediation market. For example, Glosten and Milgrom (1985) show that the *a priori* uninformed stock specialist will set a higher bid-ask spread when he believes there are more informed traders in the market, and Easley and O'Hara (1987) show that order sizes are informative. More recently, Roell (1990) has shown that dual-capacity traders—those who act both as brokers and dealers—can trade profitably on their own accounts without “front running.” Considerably other work has been done to explain price patterns and the merits of alternative trading rules.

The research done to date on the design of securities exchanges and related normative issues suggests links between capital market microstructure and the intermediation theories that have been the focus of this paper. The banking theories suggest that borrowers about whom little is known are best served by banks that are able to screen and monitor these borrowers most effectively. There is, of course, another reinforcing reason. Market microstructure theories tell us that such borrowers are likely to have large bid-ask spreads, implying high transactions costs for investors and hence high costs of capital for these firms (see Barclay and Smith (1988)). Consequently, smaller, less well-known firms use banks, both due to banks' superior screening/monitoring and due to the relatively high cost of financing in the capital market. These patterns may be modified as automated trading systems become more common; for example, Dornowitz (1990) shows that price discovery is greater with such systems than with floor trading. Further advances await a synthesis and integration of the financial intermediation and market microstructure literatures (see Yavas (1992)).

8. CONCLUDING REMARKS

We conclude with a brief discussion of four major unresolved issues in financial intermediation. First, we need to refine our understanding of financial innovation. There is an emerging literature on optimal security design which seeks to explain the economic incentives for financial contracts such as debt, equity, collateralized mortgage obligations, and others (see, for example, Allen and Gale (1988, 1991), Madan and Soubra

(1991), and Boot and Thakor (forthcoming)). Although marketing costs play a role in the Madan–Soubra analysis, the role of FIs in the design, pricing, and distribution of new financial contracts remains only sketchily understood. Promising clues for future research on this issue are provided by Ross (1989) and Merton (1989). Ross stresses marketing and agency costs which play a prominent role in his institutions-based theory of financial innovation. Merton suggests that the Hakansson (1979) paradox—contingent claims can be priced using no-arbitrage arguments only if these claims are redundant and hence without social value—can be resolved in a financial intermediation context by assuming that some agents face significant transactions costs that FIs do not.

Second, how do we explain the observed differences in the sizes of the FI sectors across countries and through time? Allen (1993) explores this issue. His intuition is that capital markets tend to be relatively large in economies where borrowers manage assets for which optimal decision rules are difficult to compute and the multiple signals of performance typically provided by the capital market yields valuable guidance about these rules. Much more remains to be done on this topic.³² Research on comparative financial systems must probe the technological, socioeconomic, and historical parameters conditioning the evolution of banks and capital markets.³³ The study of comparative financial systems should enrich our understanding of international differences as well as economic development. It should inform public policy and guide the development of embryonic credit and financial markets of Eastern Europe.

Third, along with an understanding of financial system design, we need a better understanding of the components of the system. In particular, our theories must tell us more about the optimal design of a banking system. Are bank mergers welfare improving?³⁴ What is the appropriate role of government in the banking system? For example, in some countries (France and India), the banking industry is in large part government owned. Even where banks are privately owned, they are often the recipients of governmental subsidies. How concentrated should the banking industry be? Should banks be universal? Is narrow banking a good idea? Should regulation be direct or indirect? How can regulators' incentives be aligned with those of the taxpayers?

³² Bhattacharya and Chiesa (1993) focus on the differing incentives of stock market lenders versus banks to protect the privacy of information about borrowers.

³³ See, for example, Greenbaum and Higgins (1983) who discuss the manner in which regulation and the existing structure of institutions affect incentives for financial innovation which, in turn, influence the future evolution of contracts, institutions, and markets.

³⁴ The evidence is mixed. For example, Gorton and Rosen (1992) suggest that there is little to be gained from large mergers per se, whereas Berger and Humphrey (1992) suggest otherwise. Srinivasan (1992) concludes that efficiency gains across mergers vary, so that regulators should proceed on a case-by-case basis.

Finally, how should securities markets be structured? Over-the-counter markets in the United States have gained significantly at the expense of the organized exchanges. Securities trading is relevant for banking theory because banks and capital markets compete with each other.³⁵ This point is also made by Merton (1993) who suggests that FIs and capital markets function in both *competitive* and *complementary* roles. Complementarity arises from the role played by FIs in experimenting with financial innovations, some of which are eventually adapted for capital market trading, and the new opportunities for FIs arising from the ability to trade claims in liquid capital markets. Combining the insights of the market micro-structure literature with those of financial intermediation promises a rich harvest of new advances.

REFERENCES

- AKELLA, S. R., AND GREENBAUM, S. I. (1988). Savings and loan ownership structure and expense preference, *J. Banking Finance* **12**, 419–437.
- ALLEN, F. (1983). Credit rationing and payment incentives, *Rev. Econ. Stud.* **50**, 639–646.
- ALLEN, F. (1990). The market for information and the origin of financial intermediation, *J. Finan. Intermediation* **1**, 3–30.
- ALLEN, F. (1993). Stock markets and resource allocation, in “Capital Markets and Financial Intermediation” (C. Mayer and X. Vives, Eds.), pp. 81–107. Cambridge Univ. Press, Cambridge.
- ALLEN, F., AND GALE, D. (1988). Optimal security design, *Rev. Finan. Stud.* **1**, 229–264.
- ALLEN, F., AND GALE, D. (1991). Arbitrage, short sales, and financial innovation, *Econometrica* **59**, 1041–1068.
- ALLEN, F., AND GALE, D. (1992). Measurement distortion and missing contingencies in optimal contracts, *Econ. Theory* **2**, 1–28.
- BARCLAY, M. J., AND SMITH, C. W. (1988). Corporate payout policy: Cash dividends versus open-market repurchases, *J. Finan. Econ.* **22**, 61–82.
- BENSTON, G., AND SMITH, C. W. (1976). A transactions cost approach to the theory of financial intermediation, *J. Finance* **31**, 215–231.
- BENVENISTE, L. M., AND BERGER, A. N. (1987). Securitization with recourse: An instrument that offers uninsured bank depositors sequential claims, *J. Banking Finance* **11**, 403–424.
- BERGER, A. N., AND HUMPHREY, D. B. (1992). Megamergers in banking and the use of cost efficiency as an antitrust defense, *Antitrust Bull.* **37**, 541–600.
- BERGER, A. N., AND UDELL, G. F. (1992). Some evidence on the empirical significance of credit rationing, *J. Polit. Econ.* **100**, 1047–1077.

³⁵ The 1992 banking scandal in India illustrates this link. Apparently, a private investor borrowed huge amounts from government-owned banks to take dominant positions in the stock market. When the loans—ostensibly secured by the investor's stockholdings—were called, there was a squeeze because the liquidations of security holdings needed for loan repayment would have precipitated sharp stock price declines. The scandal resulted in a government investigation and a closure of the stock market for weeks.

- BERGER, A. N., KING, K. K., AND O'BRIEN, J. M. (1991). The limitations of market value accounting and a more realistic alternative, *J. Banking Finance* **15**, 753–783.
- BERKOVITCH, E., AND GREENBAUM, S. I. (1990). The loan commitment as an optimal financing contract, *J. Finan. Quant. Anal.* **26**, 83–95.
- BERLIN, M., AND MESTER, L. (1992). Debt covenants and renegotiation, *J. Finan. Intermediation* **2**, 95–133.
- BERNANKE, B. (1983). Non-monetary effects of the financial crisis in the propagation of the great depression, *Amer. Econ. Rev.* **73**, 257–263.
- BERNANKE, B. (1988). Monetary policy transmission: Through money or credit? *Fed. Res. Bank Philadelphia Bus. Rev.* 3–11.
- BERNANKE, B., AND GERTLER, M. (1989). Agency costs, net worth, and business fluctuations, *Amer. Econ. Rev.* **79**, 14–31.
- BESANKO, D., AND KANATAS, G. (1993). "The Regulation of Bank Capital Regulations: Do Capital Standards Promote Bank Safety?" Northwestern University.
- BESANKO, D., AND THAKOR, A. V. (1987a). Collateral and rationing: Sorting equilibria in monopolistic and competitive credit markets, *Int. Econ. Rev.* **28**, 671–689.
- BESANKO, D., AND THAKOR, A. V. (1987b). Competitive equilibrium in the credit market under asymmetric information, *J. Econ. Theory* **42**, 167–182.
- BESANKO, D., AND THAKOR, A. V. (1992). Banking deregulation: Allocational consequences of relaxing entry barriers, *J. Banking Finance* **16**, 909–932.
- BESANKO, D., AND THAKOR, A. V. (1993). Relationship banking, deposit insurance and bank portfolio choice, in "Capital Markets and Financial Intermediation" (C. Mayer and X. Vives, Eds.), pp. 292–318. Cambridge Univ. Press, Cambridge.
- BESTER, H. (1985). Screening vs. rationing in credit markets with imperfect information, *Amer. Econ. Rev.* **75**, 850–855.
- BHATTACHARYA, S. (1982). Aspects of monetary and banking theory and moral hazard, *J. Finance* **37**, 371–384.
- BHATTACHARYA, S., AND CHIESA, G. (1993). "Proprietary Information, Financial Intermediation, and Research Incentives," University of Delhi and University of Brescia.
- BHATTACHARYA, S., AND GALE D. (1987). Preference shocks, liquidity, and central bank policy, in "New Approaches to Monetary Economics" (W. A. Barnett and K. J. Singleton, Eds.), pp. 69–88. Cambridge Univ. Press, Cambridge.
- BLINDER, A. S., AND STIGLITZ, J. E. (1983). Money, credit constraints, and economic activity, *Amer. Econ. Rev.* **73**, 297–302.
- BOOT, A. W. A., AND GREENBAUM, S. I. (1992). American banking legislation, recent, in "The New Palgrave Dictionary of Money and Finance," pp. 35–37. MacMillan, London.
- BOOT, A. W. A., AND GREENBAUM, S. I. (1993). Bank regulation, reputation and rents: Theory and policy implications, in "Capital Markets and Financial Intermediation" (C. Mayer and X. Vives, Eds.), pp. 262–285. Cambridge Univ Press, Cambridge.
- BOOT, A. W. A., GREENBAUM, S. I., AND THAKOR, A. V. (forthcoming). Reputation and discretion in financial contracting, *Amer. Econ. Rev.*
- BOOT, A. W. A., AND THAKOR, A. V. (1991). Off-balance sheet liabilities, deposit insurance and capital regulation, *J. Banking Finance* **15**, 825–846.
- BOOT, A. W. A., AND THAKOR, A. V. (1993). Self-interested bank regulation, *Amer. Econ. Rev.* **83**, 206–212.
- BOOT, A. W. A., AND THAKOR, A. V. (forthcoming). Security design, *J. Finance* **48**.
- BOOT, A. W. A., THAKOR, A. V., AND UDELL, G. F. (1987). Competition, risk neutrality and loan commitments, *J. Banking Finance* **11**, 449–471.

- BOOT, A. W. A., THAKOR, A. V., AND UDELL, G. F. (1991a). Secured lending and default risk: Equilibrium analysis and monetary policy implications, *Econ. J.* **101**, 458–472.
- BOOT, A. W. A., THAKOR, A. V., AND UDELL, G. F. (1991b). Credible commitments, contract enforcement problems and banks: Intermediation as credibility assurance, *J. Banking Finance* **15**, 605–632.
- BOYD, J., AND PRESCOTT, E. C. (1986). Financial intermediary coalitions, *J. Econ. Theory* **38**, 211–232.
- BOYD, J. H., AND SMITH, B. D. (1993). "Intermediation and the Equilibrium Allocation of Investment Capital: Implications for Economic Development," Federal Reserve Bank of Minneapolis.
- BRYANT, J. (1980). A model of reserves, bank runs, and deposit insurance, *J. Banking Finance* **4**, 335–344.
- BUSER, S. D., CHEN, A. H., AND KANE, E. (1981). Federal deposit insurance regulatory policy and optimal bank capital, *J. Finance* **36**, 51–60.
- CALOMIRIS, C., AND GORTON, G. (1990). "The Origins of Banking Panics: Models, Facts, and Bank Regulation," Rodney White Center, Working Paper 11-90, University of Pennsylvania.
- CALOMIRIS, C., AND KAHN, C. (1991). The role of demandable debt in structuring optimal banking arrangements, *Amer. Econ. Rev.* **81**, 497–513.
- CALOMIRIS, C. W., KAHN, C. M., AND KRASA, S. (1991). "Optimal Contingent Bank Liquidation Under Moral Hazard," University of Illinois.
- CAMPBELL, T. S. (1979). Optimal investment financing decisions and the value of confidentiality, *J. Finan. Quant. Anal.* **14**, 913–924.
- CAMPBELL, T. S., CHAN, Y., AND MARINO, A. M. (1992). An incentive based theory of bank regulation, *J. Finan. Intermediation* **2**, 255–276.
- CAMPBELL, T. S., AND KRACAW, W. A. (1980). Information production, market signalling, and the theory of financial intermediation, *J. Finance* **54**, 863–882.
- CHAN, Y. (1983). On the positive role of financial intermediation in allocation of venture capital in a market with imperfect information, *J. Finance* **38**, 1543–1568.
- CHAN, Y., GREENBAUM, S. I., AND THAKOR, A. V. (1986). Information reusability, competition and bank asset quality, *J. Banking Finance* **10**, 243–253.
- CHAN, Y., GREENBAUM, S. I., AND THAKOR, A. V. (1992). Is fairly priced deposit insurance possible? *J. Finance* **47**, 227–246.
- CHAN, Y., AND KANATAS, G. (1985). Asymmetric valuations and the role of collateral in loan agreements, *J. Money, Credit, Banking* **17**, 84–95.
- CHAN, Y., AND MAK, K. T. (1985). Depositors' welfare, deposit insurance, and deregulation, *J. Finance* **40**, 959–974.
- CHAN, Y., SIEGEL, D., AND THAKOR, A. V. (1990). Learning, corporate control and performance requirements in venture capital contracts, *Int. Econ. Rev.* **31**, 365–381.
- CHAN, Y. S., AND THAKOR, A. V. (1987). Collateral and competitive equilibria with moral hazard and private information, *J. Finance* **42**, 345–363.
- CHARI, V. V. (1989). Banking without deposit insurance or bank panics: Lessons from a model of the U.S. national banking system, *Fed. Res. Bank Minneapolis Quart. Rev.* **3**–19.
- CHARI, V. V., AND JAGANNATHAN, R. (1988). Banking panics, information, and rational expectations equilibrium, *J. Finance* **43**, 749–761.
- CHOWDHRY, B. (1991). What is different about international lending? *Rev. Finan. Stud.* **4**, 121–148.

- DE, S., AND KALE, J. (1993). Contingent payments and debt contracts, *Finan. Manage.* **22**, 106–122.
- DESHMUKH, S. D., GREENBAUM, S. I., AND KANATAS, G. (1982). Bank forward lending in alternative funding environments, *J. Finance* **37**, 925–940.
- DESHMUKH, S. D., GREENBAUM, S. I., AND KANATAS, G. (1983). Interest rate uncertainty and the financial intermediary's choice of exposure, *J. Finance* **38**, 141–148.
- DESHMUKH, S. D., GREENBAUM, S. I., AND THAKOR, A. V. (1982). Capital accumulation and deposit pricing in mutual financial institutions, *J. Finan. Quant. Anal.* **17**, 503–532.
- DEWATRIPONT, M., AND MASKIN, E. (1991). "Credit and Efficiency in Centralized and Decentralized Economies," Discussion Paper 1512, Harvard Institute of Economic Research.
- DEWATRIPONT, M., AND TIROLE, J. (1993). "The Prudential Regulation of Banks," CEPR/ESF Conference on Financial Regulation, Toulouse, France.
- DIAMOND, D. W. (1984). Financial intermediation and delegated monitoring, *Rev. Econ. Stud.* **51**, 393–414.
- DIAMOND, D. W. (1989a). Asset services and financial intermediation, in "Financial Markets and Incomplete Information" (S. Bhattacharya and G. M. Constantinides, Eds.), pp. 272–283. Rowman and Littlefield, Lanham, MD.
- DIAMOND, D. W. (1989b). Reputation acquisition in debt markets, *J. Polit. Econ.* **97**, 828–862.
- DIAMOND, D. W. (1991a). Monitoring and reputation: The choice between bank loans and directly placed debt, *J. Polit. Econ.* **99**, 689–721.
- DIAMOND, D. W. (1991b). Debt maturity structure and liquidity risk, *Quart. J. Econ.* **106**, 709–737.
- DIAMOND, D. W., AND DYBVIIG, P. (1983). Bank runs, deposit insurance, and liquidity, *J. Polit. Econ.* **91**, 401–419.
- DOMOWITZ, I. (1990). The mechanics of automated trade execution systems, *J. Finan. Intermediation* **1**, 167–194.
- DUCA, J., AND VANHOOSE, D. D. (1990). Loan commitments and optimal monetary policy, *J. Money, Credit, Banking* **22**, 178–194.
- EASLEY, D., AND O'HARA, M. (1987). Price, trade size, and information in securities markets, *J. Finan. Econ.* **19**, 69–90.
- EMMONS, W. (1993). "Deposit Insurance and Last-Resort Lending as Delegated Monitoring: A Theory of Banking 'Safety Nets,'" Dartmouth University.
- ENGINEER, M. (1989). Bank runs and the suspension of deposit convertibility, *J. Monet. Econ.* **24**, 443–454.
- FAMA, E. F. (1980). Banking and the theory of finance, *J. Monet. Econ.* **10**, 10–19.
- FAMA, E., AND JENSEN, M. (1983a). Separation of ownership and control, *J. Law Econ.* **26**, 301–325.
- FAMA, E., AND JENSEN, M. (1983b). Agency problems and residual claims, *J. Law Econ.* **26**, 327–349.
- FLANNERY, M. J. (1992). "Debt Maturity and the Deadweight Cost of Leverage: Optimally Financing Banking Firms," University of Florida.
- FRIEDMAN, M., AND SCHWARTZ, A. J. (1963). "A Monetary History of the United States: 1867–1960," Princeton Univ. Press (for National Bureau of Economic Research), Princeton, NJ.
- GALE, D., AND HELLWIG, M. (1985). Incentive-compatible debt contracts: The one-period problem, *Rev. Econ. Stud.* **52**, 647–663.

- GENNOTTE, G., AND PYLE D. (1991). Capital controls and bank risk, *J. Banking Finance* **15**, 805–824.
- GLOSTEN, L. R., AND MILGROM, P. R. (1985). Bid, ask and transaction prices in a specialist market with heterogeneously informed traders, *J. Finan. Econ.* **14**, 71–100.
- GORTON, G. (1985). Bank suspension of convertibility, *J. Monet. Econ.* **15**, 177–193.
- GORTON, G. (1988). Banking panics and business cycles, *Oxford Econ. Pap.* **40**, 751–781.
- GORTON, G., AND PENNACCHI, G. (1990). Financial intermediaries and liquidity creation, *J. Finance* **45**, 49–71.
- GORTON, G., AND PENNACCHI, G. (1993). "Banks and Loan Sale: Marketing Nonmarketable Assets," University of Illinois–University of Pennsylvania, mimeo.
- GORTON, G., AND ROSEN, R. (1992). "Overcapacity and Exit from Banking," Wharton School, University of Pennsylvania.
- GREENBAUM, S. I., AND HIGGINS, B. (1983). Financial innovation, in "Financial Services: The Changing Institutions and Government Policy" (J. Benston, Ed.), pp. 213–234. Prentice Hall, Englewood Cliffs, NJ.
- GREENBAUM, S. I., KANATAS, G., AND VENEZIA, I. (1989). Equilibrium loan pricing under the bank–client relationship, *J. Banking Finance* **13**, 221–235.
- GREENBAUM, S. I., KANATAS, G., AND VENEZIA, I. (1991). Loan commitments and the management of uncertain demand, *J. Real Estate Finance Econ.* **4**, 351–366.
- GREENBAUM, S. I., AND THAKOR, A. V. (1987). Bank funding modes: Securitization versus deposits, *J. Banking Finance* **11**, 379–401.
- GREENBAUM, S. I., AND THAKOR, A. V. (1989). Bank reserve requirements as an impediment to signaling, *Econom. Enquiry* **27**, 75–91.
- GREENWALD, B. C., AND STIGLITZ, J. E. (1990). Asymmetric information and the new theory of the firm: Financial constraints and risk behavior, *Amer. Econ. Rev.* **80**, 160–165.
- GREENWOOD, J., AND JOVANOVIĆ, B. (1990). Financial development, growth and the distribution of income, *J. Polit. Econ.* **91**, 1076–1107.
- GROSSMAN, S., AND STIGLITZ, J. E. (1980). On the impossibility of informationally efficient markets, *Amer. Econ. Rev.* **70**, 393–608.
- GURLEY, J., AND SHAW, E. (1962). "Money in a Theory of Finance," Brookings, Washington.
- HAKANSSON, N. H. (1979). The fantastic world of finance: Progress and the free lunch, *J. Finan. Quant. Anal.* **14**, 717–734.
- HART, O. D. (1983). Optimal labour contracts under asymmetric information: An introduction, *Rev. Econ. Stud.* **58**, 3–35.
- HAWKINS, G. D. (1982). An analysis of revolving credit arrangements, *J. Finan. Econ.* **10**, 59–81.
- HELLWIG, M. (1990). Banking, intermediation, and corporate finance, in "European Financial Integration," (A. Giovannini and C. Mayer, Eds.), pp. 35–63. Cambridge Univ. Press, Cambridge.
- ITOH, H. (1991). Incentives to help in multi-agent situations, *Econometrica* **59**, 611–636.
- JACKLIN, C. (1987). Demand deposits, trading restrictions, and risk-sharing, in "Contractual Arrangements for Intertemporal Trade" (E. C. Prescott and N. Wallace, Eds.), pp. 26–47. University of Minnesota Press, Minneapolis, MN.
- JACKLIN, C. (1989). Banks and risk-sharing: Instabilities and coordination, in "Financial Markets and Incomplete Information" (S. Bhattacharya and G. M. Constantinides, Eds.), pp. 317–327. Rowman and Littlefield, Lanham, MD.

- JACKLIN, C., AND BHATTACHARYA, S. (1988). Distinguishing panics and information-based bank runs: Welfare and policy implications, *J. Polit. Econ.* **96**, 568–592.
- JAFFEE, D., AND MODIGLIANI, F. (1969). A theory and test of credit rationing, *Amer. Econ. Rev.* **59**, 850–872.
- JAMES, C. (1987). Some evidence on the uniqueness of bank loans, *J. Finan. Econ.* **19**, 217–235.
- JAMES, C. M. (1988). The use of loan sales and standby letters of credit by commercial banks, *J. Monet. Econ.* **22**, 395–422.
- KAHANE, Y. (1977). Capital adequacy and the regulation of financial intermediaries, *J. Banking Finance* **1**, 207–218.
- KANATAS, G. (1986). Deposit insurance and the discount window: Pricing under asymmetric information, *J. Finance* **41**, 437–450.
- KANATAS, G. (1987). Commercial paper, bank reserve requirements, and the informational role of loan commitments, *J. Banking Finance* **11**, 425–448.
- KANATAS, G., AND GREENBAUM, S. I. (1982). Bank reserve requirements and monetary aggregates, *J. Banking Finance* **6**, 507–520.
- KANE, E. J. (1981). Accelerating Inflation, Technological Innovation, and the Decreasing Effectiveness of Banking Regulation, *J. Finance* **36**, 355–367.
- KANE, E. J. (1984). Technological and Regulatory Forces in the Developing Fusion of Financial Services Competition, *J. Finance* **39**, 759–772.
- KANE, E. J. (1989). Changing Incentives Facing Financial–Services Regulators, *J. Financial Services Research* **2**, 263–272.
- KANE, E. J. (1990). Principal-agent problems in S&L salvage, *J. Finance* **45**, 755–764.
- KANE, E. J., AND M. YU. (1993). “How Much Did Capital Forbearance Add to the Tab for the FSLIC Mess?”, Working Paper, Boston College.
- KAREKEN, J. (1983). Deposit insurance reform or deregulation is the cart, not the horse, *Fed. Res. Bank Minneapolis Quart. Rev.* 1–9.
- KEELEY, M. C. (1990). Deposit insurance, risk, and market power in banking, *Amer. Econ. Rev.* **80**, 1183–1200.
- KEETON, W. (1979). “Equilibrium Credit Rationing,” Garland Press, New York.
- KOEHN, M., AND SANTOMERO, A. M. (1980). Regulation of bank capital and portfolio risk, *J. Finance* **35**, 1235–1250.
- KRASA, S., AND VILLAMIL, A. P. (forthcoming). Monitoring the monitor: An incentive structure for a financial intermediary, *J. Econ. Theory*.
- LANDSBERGER, M., AND ZAMIR, S. (1993). “Loan Contracts with Collateral and Credit Rationing: A Signaling Approach,” Discussion Paper 26, Center of Rationality and Interactive Decision Theory, The Hebrew University of Jerusalem.
- LELAND, H., AND PYLE, D. (1977). Informational asymmetries, financial structure, and financial intermediation, *J. Finance* **32**, 371–387.
- LOEWY, M. B. (1991). The macroeconomic effects of bank runs: An equilibrium analysis, *J. Finan. Intermediation* **1**, 242–256.
- LUMMER, S. L., AND MCCONNELL, J. J. (1989). Further evidence on the bank lending process and the capital-market response to bank loan agreements, *J. Finan. Econ.* **25**, 99–122.
- MADAN, D., AND SOUBRA, B. (1991). Design and marketing of financial products, *Rev. Finan. Stud.* **4**, 361–384.
- MATUTES, C., AND VIVES, X. (1992). “Competition for Deposits, Risk of Failure, and Regulation in Banking,” Working Paper 18, ESF Network in Financial Markets.

- MERTON, R. C. (1977). An analytic derivation of the cost of deposit insurance loan guarantees, *J. Banking Finance* **1**, 3–11.
- MERTON, R. C. (1978). On the costs of deposit insurance when there are surveillance costs, *J. Bus.* **51**, 439–452.
- MERTON, R. C. (1989). On the application of the continuous-time theory of finance to financial intermediation and insurance, *Geneva Pap. Risk Insurance* **14**, 225–261.
- MERTON, R. C. (1993). Operation and regulation in financial intermediation: A functional perspective, in "Operation and Regulation of Financial Markets" (P. Englund, Ed.), pp. 17–68. The Economic Council, Stockholm, Sweden.
- MERTON, R. C., AND BODIE, Z. (1992). On the management of financial guarantees, *Finan. Manage.* Winter, 87–109.
- MERTON, R. C., AND BODIE, Z. (1993). Deposit insurance reform: A functional approach, *Carnegie-Rochester Conf. Ser. Public Policy* **38**.
- MESTER, L. J. (1991). Agency costs among savings and loans, *J. Finan. Intermediation* **1**, 257–278.
- MILLON, M., AND THAKOR, A. V. (1985). Moral hazard and information sharing: A model of financial information gathering agencies, *J. Finance* **40**, 1403–1422.
- MOOKHERJEE, D., AND P'NG, I. (1989). Optimal auditing, insurance and redistribution, *Quart. J. Econ.* **104**, 399–415.
- MORGAN, D. P. (1993). Financial contracts when costs and returns are private, *J. Monet. Econ.* **31**, 129–146.
- MYERS, S. C. (1977). The determinants of corporate borrowing, *J. Finan. Econ.* **5**, 147–175.
- MYERS, S. C., AND MAJLUF, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have, *J. Finan. Econ.* **13**, 187–221.
- NACHMAN, D., AND NOE, T. (forthcoming). Design of securities under asymmetric information, *Rev. Finan. Stud.*
- NIEHANS, J. (1978). "The Theory of Money," The Johns Hopkins Univ. Press. Baltimore, MD.
- NIEHANS, J., AND NEWSON, J. (1976). The Eurodollar market and monetary theory, *J. Money, Credit, Banking* **8**, 1–27.
- O'HARA, M. (1993). Real bills revisited: Market value accounting and loan maturity, *J. Finan. Intermediation* **3**.
- PENNACCHI, G. G. (1988). Loan sales and the cost of bank capital, *J. Finance* **43**, 375–396.
- POSTLEWAITE, A., AND VIVES, X. (1987). Bank runs as a equilibrium phenomenon, *J. Polit. Econ.* **95**, 485–491.
- RAJAN, R. (1992). Insiders and outsiders: The choice between informed and arm's-length debt, *J. Finance* **47**, 1367–1400.
- RAJAN, R. (1993). "Conflict of Interest and the Separation of Commercial and Investment Banking," University of Chicago.
- RAMAKRISHNAN, R. T. S., AND THAKOR, A. V. (1984). Information reliability and a theory of financial intermediation, *Rev. Econ. Stud.* **51**, 415–432.
- RAMAKRISHNAN, R. T. S., AND THAKOR, A. V. (1991). Cooperation versus competition in agency, *J. Law Econ. Organiz.* **7**, 248–283.
- ROELL, A. (1990). Dual-capacity trading and the quality of the market, *J. Finan. Intermediation* **1**, 105–124.
- ROSS, S. A. (1989). Institutional markets, financial marketing, and financial innovation, *J. Finance* **44**, 541–556.

- ROTHSCHILD, M., AND STIGLITZ, J. E. (1970). Increasing risk. I. A definition, *J. Econ. Theory* **2**, 225–243.
- ROTHSCHILD, M., AND STIGLITZ, J. E. (1976). Equilibrium in competitive insurance markets: An essay on the economics of imperfect information, *Quart. J. Econ.* **90**, 629–649.
- SANTOMERO, A. M. (1984). Modeling the banking firm: A survey, *J. Money, Credit, Banking* **16**, 576–602.
- SEWARD, J. K. (1990). Corporate financial policy and the theory of financial intermediation, *J. Finance* **45**, 351–377.
- SHARPE, S. A. (1990). Asymmetric information, bank lending, and implicit contracts: A stylized model of customer relationships, *J. Finance* **55**, 1069–1087.
- SHARPE, S. A. (1991). Credit rationing, concessionary lending and debt maturity, *J. Banking Finance* **15**, 581–604.
- SMITH, B. D. (1984). Private information, deposit interest rates, and the “stability” of the banking system, *J. Monet. Econ.* **14**, 293–317.
- SMITH, B. D., AND STUTZER, M. J. (1990). Adverse selection and mutuality: The case of the farm credit system, *J. Finan. Intermediation* **1**, 125–149.
- SRINIVASAN, A. (1992). Are there cost savings from bank mergers? *Fed. Res. Bank Atlanta Econ. Rev.* 17–28.
- STAHL, D. O. (1988). Bertrand competition for inputs and Walrasian outcomes, *Amer. Econ. Rev.* **78**, 189–201.
- STIGLITZ, J. E., AND WEISS, A. (1981). Credit rationing in markets with imperfect information, *Amer. Econ. Rev.* **71**, 393–410.
- STIGLITZ, J. D., AND WEISS, A. (1983). Incentive effects of terminations: Applications to the credit and labor markets, *Amer. Econ. Rev.* **73**, 912–927.
- STULZ, R. M., AND JOHNSON, H. (1985). An analysis of secured debt, *J. Finan. Econ.* **14**, 501–522.
- SUBRAHMANYAM, A. (1991). Risk aversion, market liquidity, and price efficiency, *Rev. Finan. Stud.* **4**, 417–442.
- THAKOR, A. V. (1989). Competitive equilibrium with type convergence in an asymmetrically informed market, *Rev. Finan. Stud.* **2**, 49–71.
- THAKOR, A. V. (1992). Maturity transformation, in “The New Palgrave Dictionary of Money and Finance,” pp. 678–680. MacMillan, London.
- THAKOR, A. V. (forthcoming). Information, investment choice, and price reactions, *J. Finan. Quant. Anal.*
- THAKOR, A. V., AND CALLAWAY, R. (1983). Costly information production equilibria in the bank credit market with applications to credit rationing, *J. Finan. Quant. Anal.* **18**, 229–248.
- THAKOR, A. V., HONG, H., AND GREENBAUM, S. I. (1981). Bank loan commitments and interest rate volatility, *J. Banking Finance* **5**, 497–510.
- THAKOR, A. V., AND UDELL, G. F. (1987). An economic rationale for the pricing structure of bank loan commitments, *J. Banking Finance* **11**, 271–289.
- TOWNSEND, R. M. (1979). Optimal contracts and competitive markets with costly state verification, *J. Econ. Theory* **21**, 1–29.
- VILLAMIL, J. (1991). Deposit contracts, suspension of convertibility, and optimal intermediation, *Econ. Theory* **1**, 277–288.
- VIVES, X. (1990). Banking competition and European integration, in “European Financial Integration” (A. Giovannini and C. Mayer, Eds.), pp. 9–31. Cambridge Univ. Press, Cambridge.

- VON THADDEN, E. L. (1990). "Bank Finance and Long-Term Investment," WWZ Discussion Paper 9010, University of Basel.
- WALLACE, N. (1988). Another attempt to model an illiquid banking system: the Diamond-Dybvig model with sequential service taken seriously, *Fed. Res. Bank Minneapolis Quart. Rev.* 3-15.
- WHITE, L. (1988). Market value accounting: An important part of the reform of the deposit insurance system, in "Capital Issues in Banking" (S. I. Greenbaum, Ed.), pp. 226-242. Association of Reserve City Bankers, Washington, DC.
- WILLIAMSON, O. (1975). "Markets and Hierarchies: Analysis and Antitrust Implications," The Free Press, New York.
- WILLIAMSON, S. (1987). Costly monitoring, loan contracts, and equilibrium credit rationing, *Quart. J. Econ.* 102, 134-145.
- WILSON, P. (1992). "Public Ownership, Delegated Project Selection and Corporate Financial Policy," Working Paper, School of Business, Indiana University.
- WINTON, A. J. (1990). "Three Essays of Information, Contracting, and Financial Intermediation," Doctoral Dissertation, University of Pennsylvania.
- WINTON, A. J. (1992). "Competition Among Financial Intermediaries when Diversification Matters," Working Paper 185, Banking Research Center, Kellogg School, Northwestern University.
- YANELLE, M. O. (1989a). The strategic analysis of intermediation, *Europ. Econ. Rev.* 33, 294-304.
- YANELLE, M. O. (1989b). "On The Theory of Intermediation," Ph.D. Dissertation, University of Bonn.
- YAVAS, A. (1992). Market-makers vs match-makers, *J. Finan. Intermediation* 2, 33-58.