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BANK FUNDING MODES

Securitization versus Deposits

Stuart I. GREENBAUM*

Northwestern University, Evanston, IL 60208, USA

Anjan V. THAKOR*

Indiana University, Bloomington, IN 47401, USA

We examine a bank's choice of whether to fund the loans it originates by emitting deposits or to sell the loans to investors. With common knowledge of loan quality and laissez faire banking, we find that the choice is irrelevant. With asymmetric information but without government intervention, we find that better quality assets will be sold (securitized) and poorer quality assets will be funded with deposits. Public regulation can influence the bank's choice; subsidies can cause a bank to favor deposit funding, but mutual funds and third-party insurers may mitigate the effects of governmental subsidies.

1. Introduction

Securitization is a neologism used to describe the transformation of illiquid financial claims, often held by depository financial intermediaries, into tradeable ones. The liquefaction enhances values, and it also permits intermediaries to sell their assets and thereby decompose the traditional lending process into more elemental activities, i.e., origination, servicing, guaranteeing and funding. The unbundling permits intermediaries to specialize in those more basic activities in which they enjoy a comparative advantage and to shift to others those that they are less adept at performing [see Greenbaum (1986)].

Securitization is achieved by pooling assets and 'credit enhancing' the pools. The securitized assets become closed-end mutual funds with partial guarantees against credit risk. The credit enhancement typically permits the newly created claims to obtain investment grade ratings from the major rating agencies. In addition, claims against these asset pools are often partitioned or stripped into tranches with differing rights to the cash flows.

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The collateralized mortgage obligation (CMO) with multiple maturity tranches is an example. Real estate mortgage investment conduits (REMICs), created by the tax legislation of 1986, facilitate a wider range of claim designs including interest only/principal only and senior/subordinated structures.[1]

While many believe that securitization is in its infancy, hundreds of billions worth of assets have already been processed, including mostly residential mortgages, but commercial mortgages, business loans, consumer receivables, auto loans and computer leases have been securitized as well. Much of the mortgage securitization has been supported by subsidized credit risk guarantees provided through the government-sponsored housing agencies, particularly the Federal National Mortgage Association (FNMA), the Government National Mortgage Association (GNMA) and the Federal Home Loan Mortgage Corporation (FHLMC). More interesting, however, is the growth of securitization not guaranteed by the agencies. The latter indicates that even without direct subsidies there are incentives to securitize. This raises two questions. Why do financial intermediaries, which in the past have found it advantageous to bundle the origination, funding, guaranteeing and servicing of loans, now find it profitable to eschew the funding? Second, if the securitization trend continues, what are the implications for public policy, and especially for monetary policy and the safety and soundness of banking?

The safety and soundness question can be framed in two ways. If a traditional deposit-funded intermediary selects assets from its portfolio to be securitized, will there be an adverse selection resulting in the retention of the poorer quality assets? Similarly, if newly originated assets can be booked or sold, will those with irregularities arising from altered states or underwriting errors tend to be booked, again giving rise to asset deterioration?

The issue of monetary policy arises when we extrapolate the securitization trend. Commercial banks and thrifts might originate, service and even guarantee loans without booking any, or emitting any deposits. Bank capital would support contingent liabilities, including letters of credit and loan

[1]It may be useful to distinguish between securitization and loan sales. The latter practice, although rapidly growing in recent years, is a traditional banking practice [see Gorton and Haubrich (1987)]. It involves the sale of a participation, or the totality of an originated loan, and the sale is usually effected without recourse. In such transactions, undertaken traditionally with correspondents on overline loans, the originating bank serves as a pure broker. In contrast, securitization involves qualitative asset transformation. By pooling assets, the originating bank provides investors with diversification services. Moreover, the asset pools are typically credit enhanced with augmented collateral or some other form of recourse. The credit enhancement, provided by the originating bank or a third party, is usually pivotal in obtaining an investment-grade rating for the new claim. Beyond this partitioning or stripping of cash flows increases the market value of the claims sold to investors. Thus, securitization enhances liquidity, reduces credit risk and restructures cash flows. Loan sales merely separate funding from origination and the asset originated is to all intents and purposes identical to the asset purchased by the investor. The latter is no more tradeable than the originated loan.

commitments, but deposits need not be a part of the process. The payments services traditionally provided by the deposit-taking intermediaries could remain with them despite the disappearance of deposits, but they could also migrate elsewhere, perhaps to the mutual funds and the credit card operators. If such a migration occurred, the Federal Reserve would presumably need to reconsider its methods of implementing monetary policy. To be sure, monetary control is feasible in a world devoid of bank deposits. However, such a regime presumably poses its own control problems. Moreover, would the public regulators still care about safety and soundness of the restructured banks, or would their concern be redirected to the new vendors of payments services?

We do not propose to answer all of these questions in the following pages. We shall, however, offer a beginning. In particular, we provide a definition of securitization and an explanation for its emergence at the present historical juncture. We also explain why assets of higher quality seem to be securitized whereas poorer quality assets tend to remain on banks' balance sheets. We start by formalizing the distinction between the traditional deposit funding mode (DFM) of intermediation and the contemporary securitized funding mode (SFM). We show that in the absence of informational asymmetries regarding loan quality, and in an environment devoid of deposit insurance and public regulation, intermediaries, borrowers and depositor/investors would be indifferent between the DFM and the SFM. This irrelevance result provides an informative base line. We then permit for asymmetric information relating to loan quality. That is, borrowers are assumed to possess private information not available to depositor/investors. In this setting, if borrowers are permitted to partially insure (enhance) their credits, as in the case of borrowers purchasing letters of credit, then the SFM may emerge as a way of resolving the informational asymmetry, since the borrower's choice of insurance coverage will signal its quality. However, we find that better quality assets will be securitized whereas poorer quality assets will be financed with deposits. Thus, in a setting with uninsured deposits and without regulation, but with asymmetric information regarding asset quality, we would expect to find banks originating loans, securitizing the better quality credits, and booking the poorer quality credits. This leaves unexplained why the DFM dominated banking practice until just recently. With appropriately underpriced deposit insurance, the value of the signaling associated with the SFM can be overwhelmed. It is suggested that this was the case until recently when increased deposit insurance fees, income taxes (particularly via taxation of mutuals and bank loan loss reserves), capital requirements and monitoring costs reduced the relative appeal of the DFM. We show that as the cost of deposit insurance or any footings-related regulatory tax increases, the bank will substitute the SFM for the DFM.

We also show that securitization would emerge even in a laissez faire

environment. The deposit funding contract is a risky debt contract and all of the bank's capital secures the loan; the payoff to the bank's shareholders is zero if the loan defaults. By contrast, the bank does not fund the loan under the SFM and it is not liable to the investors in case the borrower defaults unless a guarantee is provided by the bank. Thus, the bank can produce information about the borrower and then design a schedule of insurance premia such that each borrower's optimal choice of coverage – where the bank uses its capital to provide (partial) insurance against loan default – signals its success probability to the investors who purchase the loan. This avoids duplication in information production as investors need not expend resources to become informed. Thus, the SFM offers greater contract design flexibility and a less costly resolution of informational asymmetries, but at the cost of less efficient risk sharing.

Although we emphasize the role of regulation in dictating the choice between securitization and deposit funding, we recognize the importance of advances in information processing technology as a pre-condition for certain contemporary manifestations of securitization. For example, the servicing and trading of securitized assets would not be feasible without state-of-the-art information systems. (However, it is quite another matter to argue that reduced information costs have trivialized borrower-lender informational asymmetries.) We will show that if information costs are sufficiently high, securitization will be unprofitable.

The paper is organized in five sections. Section 2 describes the basic model and discusses the symmetric information case, i.e., when all contract-relevant information is common knowledge. In section 3 we introduce asymmetric information. The borrower's probability of success is assumed to be known to the borrower, but to no one else. In this case, we show that the choice of funding mode depends on asset quality. Securitization is preferred for high quality assets and deposit funding is preferred for low quality assets. Thus, there is a predictable decline in the quality of assets that remain on the banks' books. In section 4, we further complicate the model by introducing public regulation and show how footings-related subsidies can subvert the SFM. We then consider the possibility of third-party participation in securitization and the possible influence of mutual funds. By augmenting credit enhancement, an outside insurer can foster securitization. Similarly in diversifying the portfolios of risk averse investors, mutual funds can enhance the attractiveness of securitization. Finally, section 5 concludes.

2. Symmetric information

Initially we consider a setting with three parties – borrowers, banks and depositor/investors. For simplicity, each bank is endowed with a fixed amount of capital, $K > 0$, and each deals with only one borrower requiring a

\$1 loan.[2] We assume that the bank and the borrower are risk neutral, but depositor/investors are risk averse. Thus, we seek to depict a credit market in which borrowers are corporations (with their owners having diversified portfolios) and depositor/investors are individuals. Nothing material changes, however, if borrowers also are assumed to be risk averse. Universal risk neutrality, on the other hand, has the effect of creating an overwhelming advantage for the SFM, as we explain in section 4.

The credit market is assumed to be perfectly competitive in the sense that banks will design credit contracts to maximize borrowers' expected utilities, subject to the constraint that depositors/investors receive their reservation utility level and that the bank will earn at least the riskless rate of return on its equity [see Besanko and Thakor (1987b)]. This assumed market structure implies that all regulatory subsidies are passed along to borrowers, and it is the borrowers who effectively choose the bank's funding mode.

This approach of maximizing borrowers' surplus makes sense in an environment where free entry precludes capture by bank shareholders of any of the surplus related to *borrower* investment projects, and a competitive liability market ensures that depositors receive no less than their (competitive) reservation return. This formulation allows us to analyze deregulation without being forced to argue that bank profits were reduced. Hence, our results are sustained even if regulation was without effect on the competitiveness of banking.

Each borrower invests its \$1 loan in a two-state, single-period project that pays off \$R with probability δ and zero with probability $1-\delta$. The probability, δ, varies cross-sectionally over the interval $[\delta_1, \delta_2]$ which is a compact subset of $[0, 1]$. The cumulative (cross-sectional) distribution function for δ is $Q(\delta)$ and we assume an associated probability density function, q, satisfying $q(\delta) > 0 \forall \delta \in [\delta_1, \delta_2]$ and $q(\delta) = 0 \forall \delta \notin [\delta_1, \delta_2]$. Each borrower's δ is potentially private information, while R is common knowledge and the same for all borrowers.

There are two ways in which the bank can fund a borrower's loan request. One is by emitting deposits. The other, securitization, involves selling, or even pre-selling, the loan to investors. From the investor's viewpoint, he can either own the loan directly by purchasing it from the bank, or indirectly by holding bank deposits.

It is often argued that securitization represents a form of regulatory arbitrage arising from increased deposit insurance fees and related regulatory taxes. However, there is a significant distinction between the DFM and the SFM that has little to do with regulation. Under the DFM, the bank's entire capital supports the integrity of the loan contract whereas with the SFM fractional coverage is a possibility. More importantly, with the SFM the coverage is occasionally an object of borrower choice.

[2]Alternatively, we can think of multiple borrowers with perfectly correlated prospects.

With the SFM, the borrower's cost of funds depends on the investor's perception of δ. We construct a signaling game in which the borrower purchases partial backing for its loan from the bank. That is, the borrower asks the bank to guarantee a fraction $\theta \in [0,1]$ of its loan, which the bank pays investors if the borrower defaults. Thus, θ serves as a signal of δ. While this scheme will be discussed in greater detail in the next section, for now we note that a key distinction between the DFM and the SFM lies in the greater flexibility of contract design possible under the latter. Note that whenever the borrower defaults under the DFM, the bank's capital is first used to repay depositors, and the remaining obligation is then shifted to the deposit insurer. By definition, the shareholders' payoff is zero. This is consistent with the idea that the bank both originates and funds the loan under the DFM, i.e., the lending functions are bundled within the bank. With the SFM, however, the bank holds no financial assets and emits no deposits. Its only possible liabilities are contingencies under recourse agreements or standby letters of credit. Selling the loans it originates and possibly guaranteeing partial repayment, the bank adopts a more limited role. The bank's shareholders need not fully expose their invested capital. Partial guarantees are most often implemented by 'over-collateralizing', but various kinds of recourse arrangements involving standby letters of credit, repurchase agreements and third-party guarantees have also been used. In our formal analysis, we will assume that the maximum guarantee issued by the bank can be satisfied with its capital.

We begin our analysis under ideal conditions. There is no deposit insurance or public regulator and every borrower's δ is common knowledge. This will help us to isolate some of the factors contributing to the recent emergence of the SFM as well as to the traditional popularity of the DFM.

Let R_f be the riskless interest factor (one plus the riskless interest rate). Let $r(\delta)$ be the deposit interest factor paid by a bank holding a loan with success probability δ. We denote by $\xi(\delta)$ the spread charged by the bank on a type-δ loan. Thus, the loan interest factor will be $\tau(\delta) \equiv r(\delta) + \xi(\delta)$. Risk-averse depositors (or perhaps a single depositor) assign a value of $U(\chi)$ to a payoff of χ, where $U' > 0$, $U'' < 0$ and primes denote partial derivatives. Depositors require a minimum expected utility of $\bar{u}$ in order to hold \$1 of deposits. The bank's problem is to

$$\max_{\xi(\delta), r(\delta)} \delta[R - \xi(\delta) - r(\delta)]R_f^{-1}, \tag{1}$$

subject to

$$\delta U(r(\delta)) + [1-\delta]U(KR_f) \geqq \bar{u}, \tag{2}$$

$$\delta[\xi(\delta) + KR_f] \geqq KR_f. \tag{3}$$

In this program, expression (1) represents the borrower's expected utility that the bank maximizes by choosing its management fee and the interest rate to offer depositors, subject to constraint (2) that depositors get their reservation return, and constraint (3) that the bank's expected return on equity is at least R_f. In writing the above maximization program, we assume that $KR_f \leqq r(\delta)\ \forall\ \delta \in [\delta_1, \delta_2]$, indicating that bank deposits are risky. We make this assumption because, in its absence, any potential informational asymmetry between borrowers and depositors – such as the one we introduce in the next section – would be of no consequence. In addition, we assume that all of the bank's capital is invested in the riskless asset and \$1 is borrowed from depositors to be invested in the (risky) loan. Alternatively, the bank could invest its capital in the risky loan and borrow only $\$1 - K$ from depositors. In the setting here, these two strategies are equivalent (a formal proof is available from the authors). The intuition is that depositors, on their own account, can replicate the bank's portfolio. If the bank invests its capital in the riskless asset, it needs to obtain all of its loan funds from depositors. Thus, although depositors commit all of their funds (\$1) to the risky loan, they have a larger cushion provided by the bank's riskless asset holding. On the other hand, if the bank invests all of its capital in the risky loan, then depositors have no riskless asset safety cushion, but they invest less through the bank in the risky loan. They can therefore invest the remaining funds in the riskless asset on their personal account, should they so desire.

Henceforth, we will assume that the bank invests all of its capital in the riskless asset.[3] In the case of SFM, if the borrower insures a fraction $\theta^*(\delta)$ of its loan, then the bank's problem is to

$$\max_{\xi(\delta),\, r(\delta,\, \theta^*(\delta))} \delta[R - \xi(\delta, \theta^*(\delta)) - r(\delta, \theta^*(\delta))]R_f^{-1}, \tag{4}$$

subject to

$$\delta U(r(\delta, \theta^*(\delta)) + [1-\delta]U(\theta^*(\delta)r(\delta, \theta^*(\delta))) \geqq \bar{u}, \tag{5}$$

$$\theta^*(\delta) \in \operatorname*{argmax}_{\theta(\delta) \in [0,\, \lambda(\delta)]} \delta[R - \xi(\delta, \theta(\delta)) - r(\delta, \theta(\delta))]R_f^{-1}, \tag{6}$$

$$\delta[\xi(\delta, \theta^*(\delta)) + KR_f] + [1-\delta][KR_f - \theta^*(\delta)r(\delta, \theta^*(\delta))] \geqq KR_f \tag{7}$$

and

$$\lambda(\delta) \equiv KR_f[r(\delta, \theta(\delta))]^{-1}. \tag{8}$$

[3]There will be cases in which this investment rule will not be optimal. However, little additional insight is obtained by endogenizing the bank's allocation of K between the risky loan and the riskless asset.

Thus, we assume that investors are risk averse and have the same preferences as depositors. In this maximization program, (4) is once again the borrower's expected utility. The investors' reservation utility constraint, (5), reflects the fact that the investors' payoff is only a fraction θ^* times the promised repayment if the borrower defaults. In (6) we have stated that the type-δ borrower chooses $\theta^*(\delta)$ to maximize its expected utility, and in (7) we have stated that the bank must earn a rate of return of at least R_f on its equity. In this rate-of-return constraint, it is recognized that the bank must pay a fraction θ^* times the borrower's repayment obligation if the borrower defaults. Finally, (8) is a definitional constraint. Taken in conjunction with (6), it says that the maximum fractional guarantee that the bank can issue is limited by its capital. We now present an equivalence result.

Proposition 1. When all payoff-relevant information is common knowledge and there is no deposit insurance and bank regulation, the DFM and the SFM are Pareto equivalent.

Proof. See the appendix.

This result provides a useful starting point. If informational problems are trivial and there is no regulatory intervention, then the bank will be indifferent between the DFM and the SFM. The intuition is as follows. Absent regulatory complications, the only difference between the DFM and the SFM arises from differences in the underlying contracts. But since all relevant information is symmetric, the SFM provides no information advantage relative to the DFM. Further, since depositors are risk averse, the optimal risk sharing arrangement calls for all of the bank's capital to be made available to secure the loan. Thus, in equilibrium the borrower will set its insurance coverage on the loan at the maximum permitted by the bank's capital. And this makes the SFM contract identical to the DFM contract. In the next section, we consider the impact of informational asymmetries.

3. Asymmetric information in an unregulated environment

In this section, we continue to assume that there is no deposit insurance or governmental intervention. However, we now introduce asymmetric information by assuming that each borrower knows its own δ, but no one else does. This is a situation familiar from the contemporary literature on financial intermediary existence [see Ramakrishnan and Thakor (1984)] as well as on credit rationing [Stiglitz and Weiss (1981, 1983) and Thakor and Callaway (1983)]. There are two ways of resolving this informational asymmetry. One is for the borrower to signal its δ through its choice among credit contracts. This is the approach adopted by Besanko and Thakor (1987a, b). However,

since loan size is fixed and collateral is unavailable in our model, no such revelation is possible here. Thus, we follow Stiglitz (1975) and allow uninformed agents to screen borrowers. Let $C^{\mathrm{B}}>0$ represent the cost a bank sustains to discover a borrower's δ. Likewise, let $C^{\mathrm{n}}>0$ be the cost a non-bank agent incurs to discover a borrower's δ. In general, C^{B} and C^{n} will both be functions of the distribution function, Q. In keeping with the financial intermediary existence literature, we assume that $C^{\mathrm{B}}(Q)<C^{\mathrm{n}}(Q)$.

We begin with an analysis of the DFM. In this case, depositors have two options. They can either screen a given borrower at a cost C^{n} or they can 'pool' by pricing deposits at some 'pooling' success probability, $\bar{\delta}$, and thereby avoid screening costs. This will subsidize some borrowers at the expense of others. Since all screening costs are ultimately borne by the borrowers, it is they who will choose whether to be screened or pooled. As Stiglitz (1975) has shown, screening is not always optimal.[4] For example, in a two-type model, the 'jeopardized' (good) type will prefer not to be screened if the gain from screening is exceeded by the cost. To avoid this possibility we assume that C^{B} and C^{n} are sufficiently small so that a (positive measure) subset $\Delta\subset[\delta_1,\delta_2]$ of borrowers will prefer to be screened.[5] In what follows, we will restrict our attention to $\delta\in\Delta$.[6]

With the DFM, the bank's problem is to

$$\max_{\xi(\delta),r(\delta)}\ \delta[R-\xi(\delta)-r(\delta)]R_{\mathrm{f}}^{-1}-C^{\mathrm{B}}-C^{\mathrm{n}}, \tag{9}$$

subject to

$$\delta U(r(\delta))+[1-\delta]U(KR_{\mathrm{f}})\geqq\bar{u}, \tag{10}$$

$$\delta[\xi(\delta)+KR_{\mathrm{f}}]\geqq KR_{\mathrm{f}}. \tag{11}$$

[4]Perhaps a better usage is 'quality certification', which is a term coined by Viscusi (1978). We use the Stiglitz' (1975) terminology – which has occasionally been used to refer also to the separation that takes place in self-selection models – because we utilize some of his results.

[5]With a continuum of types, there will be a subset that will prefer to be pooled under asymmetric information. That is, $\hat{\Delta}\equiv[\delta_1,\delta_2]\backslash\Delta$ has positive measure. Note that in a perfectly separating first-best equilibrium, there is a one-to-one (invertible) mapping from a given δ to an equilibrium loan price charged to a borrower with that δ (such that the depositors' break-even constraint is exactly satisfied). This mapping 'covers' every $\delta\in[q_1,q_2]$. Thus, we can take the inverse of this mapping, apply it to the common loan price charged to all of the pooled borrowers, and compute the δ corresponding to that price in the perfectly separating first-best equilibrium. Say this δ is δ_p. Then, any borrower preferring to be screened under asymmetric information will need to establish that its expected payoff net of all screening costs will be higher than it would be if it were valued as a type-δ_p borrower and no screening costs were incurred.

[6]This causes little loss in generality as far as our qualitative results are concerned. Of course, when we consider the SFM, the set $\hat{\Delta}$ has smaller measure since one benefit of securitization is that the cost of C^{n} is avoided. Thus, strictly speaking, we should analyze those types within $\hat{\Delta}$ that may have an incentive to be sorted under the SFM. We do not do that, however.

Since in equilibrium screening costs are borne by the borrower, we assume that these are paid at the outset, i.e., depositors receive C^{n} from the borrower for screening and the bank receives C^{B}.[7] It is assumed here that the bank's management fee, $\xi(\delta)$, is unobservable to depositors. If it were observable, depositors could infer δ and therefore would not need to screen. This assumption can be justified in terms of a credibility problem associated with the bank simply announcing its $\xi(\delta)$ to depositors. The bank has an obvious incentive to misrepresent in order to obtain a more favorable deposit rate. Depositors could check bank records, but to the extent that misrepresentation is feasible, cursory examinations will not suffice. Extensive verification will entail costs which one could interpret as screening costs.

The reason that borrowers would want depositors to screen rather than pool in equilibrium under the DFM is that, for every $\delta \in \Delta$, the gains from screening exceed the screening costs. Thus, there is no pooling allocation that saves on depositor screening costs and attracts even one $\delta \in \Delta$. This means that a standard (Nash type) competitive argument will lead to depositors offering banks screening contracts only.

With the SFM, the bank's problem is to

$$\max_{p(\delta,\theta^*(\delta)),\, r(\theta^*(\delta))} \quad \delta[R - r(\theta^*(\delta))]R_{\mathrm{f}}^{-1} - p(\delta, \theta^*(\delta)), \tag{12}$$

subject to

$$\theta^*(\delta) \in \operatorname*{argmax}_{\theta(\delta)\in[0,\,\hat{\lambda}]} \{\delta[R - r(\theta)]R_{\mathrm{f}}^{-1} - p(\delta, \theta)\}, \tag{13}$$

$$p(\delta, \theta^*(\delta)) \geqq C^{\mathrm{B}} + [1-\delta]\theta^*(\delta) r(\theta^*(\delta)) R_{\mathrm{f}}^{-1}, \tag{14}$$

$$\delta U(r(\theta^*(\delta))) + [1-\delta] U(\theta^*(\delta) r(\theta^*(\delta))) \geqq \bar{u}, \tag{15}$$

where $\hat{\lambda} \equiv K R_{\mathrm{f}} \{r(\theta)\}^{-1}$.

Recall that the bank invests all of its capital in the riskless asset.[8] The problem stated above is similar to that in Thakor (1982). The basic idea is as follows. The bank first produces information about the borrower's δ at a cost C^{B}. It then designs the insurance (or letter of credit) premium schedule, $p(\delta, \theta)$, so that the borrower's privately optimal choice of coverage, $\theta^*(\delta)$, correctly communicates its δ to investors. This eliminates the need for investors to duplicate the bank's information production and hence reduces total screening costs. This saving is the advantage of the SFM relative to the

[7]It makes little difference if we assume that C^{n} and C^{B} are recovered indirectly through $r(\delta)$ and $\xi(\delta)$, respectively.

[8]The bank needs only $\theta r(\theta)$ to fulfill its insurance obligation in the state in which the borrower defaults. Thus, $K - \theta r(\theta) R_{\mathrm{f}}^{-1}$ could be invested in the risky loan. However, this complicates the analysis without obvious gain.

DFM. The disadvantage of the SFM is that there are values of δ for which $\theta^*(\delta)r(\theta^*(\delta)) < KR_f$, which means that some borrowers provide investors with less insurance than they would with the DFM; recall that the bank's entire capital backs the loan under the DFM. Since investors are risk averse, there is a risk-sharing loss associated with the SFM that the borrower must pay for in equilibrium. Without regulation, the choice of funding mode will depend on the tradeoff between the screening cost C^n with the DFM and the possible loss in risk sharing with the SFM.

The SFM signaling equilibrium is defined below. It is related to the maximization program in (12)–(15).

Definition of equilibrium. An SFM signaling equilibrium is one in which:

(i) the bank becomes informed about the borrower's δ by producing costly information and then offers the borrower the choice of having a fraction of its loan insured in exchange for a fee that the borrower must immediately pay the bank;
(ii) the fee schedule is designed by the bank in such a way that the borrower's expected utility maximizing choice of coverage correctly signals its δ to a priori uninformed investors;
(iii) the fee, which depends on δ and the borrower's chosen fractional insurance coverage, permits the bank to exactly break even on the insurance it offers;
(iv) the effective yield demanded by investors, which depends only on the borrower's observable insurance coverage, gives investors exactly their reservation utility on the funds loaned; and
(v) all of the above is designed to maximize the borrower's expected utility subject to the relevant incentive compatibility and break-even constraints.

This analysis requires that C^B be low enough to make screening beneficial. If C^B is too high, loans will be pooled and there will be no securitization. Thus, one interpretation of recent securitization stresses the decline in information processing costs. However, this decline relates to electronic data processing rather than to any fundamental change in the nature of informational asymmetries between borrowers and lenders. Thus, it seems easier to understand how declining information costs may have supported the growth of CMOs, credit card and auto receivable securities, but less clear how such advances might have led to the diversion of traditional bank customers to the commercial paper and junk bond markets.

Although equilibrium in this class of models can be either separating or pooling, we now present the necessary and sufficient conditions for global incentive compatibility in a fully separating equilibrium. We show later that

when these conditions are satisfied, a separating equilibrium exists in the signaling game under the SFM.

Lemma 1. The necessary condition for global incentive compatibility in a separating (signaling) equilibrium in which borrowers with different δ's choose different $\theta^*(\delta)$'s and thereby truthfully reveal their δ's to investors is that, along $\theta^*(\delta)$, for every $\delta \in \Delta$,

$$U(r(\theta^*(\delta))) - U(\theta^*(\delta)r(\theta^*(\delta))) + \Gamma + p_\delta R_f + \theta^*(\delta)r(\theta^*(\delta)) = 0, \tag{16}$$

where

$$\Gamma \equiv [\mathrm{d}\theta^*/\mathrm{d}\delta]\{-\tau_1 p_\theta R_f + \tau_2[1-\delta]r(\theta^*(\delta)) + \tau_2[1-\delta]\theta^*(\delta)r'(\theta^*(\delta))\}, \tag{17}$$

$$\tau_1 \equiv U'(r(\theta^*(\delta))) - 1, \tag{18}$$

$$\tau_2 \equiv U'(\theta^*(\delta)r(\theta^*(\delta))) - 1, \tag{19}$$

$$p_\delta \equiv p_\delta(\delta, \theta^*(\delta)), \tag{20}$$

$$p_\theta \equiv p_\theta(\delta, \theta^*(\delta)). \tag{21}$$

Sufficient conditions for global incentive compatibility in a separating equilibrium are that, along $\theta^*(\delta)$, for every $\delta \in \Delta$, (16) *must hold* and *the following must hold:*

$$\delta r''(\theta^*(\delta))R_f^{-1} + p_{\theta\theta}(\delta, \theta^*(\delta)) > 0, \tag{22}$$

$$p_\theta \delta \neq -r'(\theta^*(\delta))R_f^{-1}. \tag{23}$$

Proof. See the appendix.

We would like to know about the equilibrium behavior of borrowers. Is there a systematic relationship between the choice of insurance coverage under the SFM and the borrower's success probability? If so, what is it? Answers to these questions are provided by our next result.

Proposition 2. In equilibrium, borrowers with higher success probabilities choose strictly higher levels of insurance coverage under the SFM.

Proof. See the appendix.

The intuition is as follows. To the borrower, the cost of insurance is the premium that must be paid at the outset, whereas the benefit is the reduced

interest to be paid one period hence. Since the borrower pays this interest only if its project is successful, a given interest reduction is more valuable to a borrower with a higher success probability. Hence, borrowers with higher δ's are more willing to buy higher levels of coveage, pay higher premia and obtain lower interest rates than those with lower δ's.

This result, which holds for our general model without further parametric restrictions, will prove useful in comparing the SFM with the DFM.[9] Before we get to that, however, we observe that a separating equilibrium does exist in our model. This is particularly important since Lemma 1 only states the necessary and sufficient conditions for global incentive compatibility leading to the viability of full separation.[10] We know from Rothschild and Stiglitz (1976) and others that this is sometimes not enough to guarantee the existence of equilibrium.

Proposition 3. Given that the relevant schedules satisfy the conditions in Lemma 1, a completely separating equilibrium exists in the SFM signaling game.

Proof. See the appendix.

Thus, what is needed for the existence of a separating equilibrium is that the insurance premium and the yield demanded by investors as a function of the observable insurance coverage are both 'appropriately' designed. Lemma 1 formalizes what is meant by 'appropriate'. Note that one key difference between our model and those of Rothschild and Stiglitz (1976) and Riley (1979) is that we have informed agents (banks) moving first. As is well known, in games in which the informed moves first, the 'problem' usually is multiplicity of equilibria rather than non-existence of equilibrium [Stiglitz and Weiss (1984)]. Cho and Kreps (1986) propose an intuitive criterion which selects a single equilibrium from the many sequential equilibria in the example they consider. This equilibrium is the Pareto dominant, perfectly separating, zero profit one, which coincides with the equilibrium in our model.

Next, we need to define

$$V(\delta,\theta) \equiv \delta[R - r(\theta)]R_f^{-1} - p(\delta,\theta),$$

the expected utility (net payoff) of a type-δ borrower choosing a coverage of θ under the SFM.

[9]A similar result is obtained in Thakor (1982), but only at the cost of specifying preferences.

[10]The equilibrium conditions in Lemma 1 are not particularly intuitive. To the reader interested in knowing why alternative (partially) pooling equilibria are not possible here, we recommend the proof of Proposition 3 in the appendix.

Lemma 2. For R sufficiently large, $V(\delta, \theta^*(\delta))$ is strictly increasing in δ.

Proof. See the appendix.

Thus, in equilibrium, higher quality borrowers enjoy higher expected utilities. There are two reasons. First, a higher success probability leads directly to a higher expected utility. Second, a higher quality borrower chooses greater insurance coverage in equilibrium, providing risk averse investors with better risk sharing and thus lowering the yield on the securitized loan.

The results thus far indicate that the highest quality borrowers suffer the least due to the incompleteness of insurance under the SFM. From Proposition 2, we know that the coverage obtained by the highest quality borrowers will approach the maximum feasible with the bank's capital. Clearly, a borrower that obtains as much coverage under the SFM as under the DFM would prefer the former since it avoids investor screening costs. On the other hand, a borrower of sufficiently low quality may choose such a small coverage under the SFM that it would experience a large risk-sharing loss relative to the DFM. Unless the investor screening cost is prohibitive, such borrowers will prefer the DFM. This reasoning is formalized in our next result.

Proposition 4. Let δ_m be the smallest element of Δ. Then, if

$$\delta_m[R - r(\theta^*(\delta_m))]R_f^{-1} - [1-\delta]\theta^*(\delta_m)r(\theta^*(\delta_m))R_f^{-1}$$
$$< \delta_m[R - \delta_m^{-1}R_f K[1-\delta_m] - r(\delta_m)]R_f^{-1} - C^n, \tag{24}$$

then $\exists \hat{\delta} \in \Delta$ such that every borrower with $\delta \in \Delta_s \equiv \{\delta \geqq \hat{\delta} | \delta \in \Delta\}$ prefers the SFM and every borrower with $\delta \in \Delta_D \equiv \{\delta < \hat{\delta} | \delta \in \Delta\}$ prefers the DFM.

Proof. See the appendix.

This result asserts that with asymmetric information the best assets are securitized and the worst are funded with deposits. Provided with an incentive to securitize, banks will sell their better assets and retain those of poorer quality. Note that this proposition refers only to the δ's that lie in Δ, i.e., all borrowers are screened by depositors with the DFM. It is easy to see that all borrowers with $\delta \in \hat{\Delta}$ will also seek the DFM, but will be pooled. In the next section, we examine how bank regulation affects our findings.

4. Asymmetric information in a regulated environment

Suppose deposit insurance is complete. We will assume that for each bank

there is a flat (risk-insensitive) deposit insurance premium and a tax (subsidy) that is a function of the bank's footings. These might include reserve and capital requirements and monitoring costs absorbed by the bank. Subsidies might include underpriced central bank services, such as the discount window and special provisions of the tax code. The sum of these is $\alpha \gtrless 0$.

Now the bank's problem is to

$$\max_{\xi(\delta),\hat{r}} \delta[R-\xi(\delta)-\hat{r}]R_f^{-1}-C^B, \tag{25}$$

subject to

$$U(\hat{r}) \geqq \bar{u}, \tag{26}$$

$$\delta[\xi(\delta)+R_f\{K-\alpha\}]R_f^{-1} \geqq KR_f. \tag{27}$$

It is assumed that the regulatory tax and the deposit insurance premium are paid out of the bank's initial capital. Since deposit insurance is complete, it thereby provides first-best risk sharing and makes the deposit interest rate independent of δ. This is reflected in (26). Second, by making the deposits riskless, insurance obviates the need for the depositors to screen borrowers. Note also that there is no screening done by the regulator since it would serve no clear purpose with the insurance premium insensitive to risk.

The formulation of the SFM is the same as in (12)–(15). The lowest quality assets will continue to prefer the DFM. However, it may no longer be true that the best assets will be securitized. The issues hinges on (i) the size of α and (ii) the size of K. Although we have taken K to be exogenous, regulation clearly affects both α and K. Thus, if K is low enough so that even the best assets have low insurance under the SFM, and if α is low, then the DFM will be preferred. This is particularly true if α is a net subsidy. This discussion is summarized below (no formal proof required).

Proposition 5. *There exists $\hat{\alpha}$ and $\hat{K}$ such that if $\alpha \leqq \hat{\alpha}$ and $K \leqq \hat{K}$, then all borrowers will prefer the DFM. On the other hand, if $\alpha > 0$ and sufficiently large, then the best quality borrowers will still prefer the SFM.*

We see, therefore, that regulation can affect the tradeoff between securitization and deposit funding. Thus, regulatory subsidies may explain why loan origination and funding were bundled in the past, and how the recent emergence of securitization could be due to a diminution of regulatory and tax subsidies.

Third party participation. One limitation of the SFM – particularly in a regulated banking environment – is that it results in losses due to suboptimal risk sharing. One solution is to introduce a third party, such as a private

mortgage insurance company, to augment the bank's insurance capability. Now, suppose that the bank's capital is the primary source of insurance coverage chosen by the borrower, and if the coverage is insufficient a third party provides the rest. If the third-party insurer must expend resources in screening, then the formal analysis of this case is difficult because the screening cost includes a 'jump' at $\theta^*(\delta)r(\theta^*(\delta)) = KR_f$, which is the point at which the third-party intervenes. However, if the bank can costlessly provide credible information to the outside insurer, then the analysis is exactly the same as for the problem in (12)–(15). Thus, although we do not analyze this case formally, it appears that the availability of third-party insurance can facilitate securitization in a regulated environment. Of course, if the regulator provides banks with a sufficiently large subsidy, then once again banks will gravitate towards the DFM.

Mutual funds. A dissipative loss is incurred under the SFM because investors are risk averse. This suggests a role for mutual funds.[11] If mutual funds provide diversification services, then we can view securitized loans as being purchased by risk neutral investors. In this case, the problem with the SFM (without third party involvement) becomes the same as (12)–(15), except that risk neutrality is reflected in (15). Details of the analysis are not presented because of the similarity to (12)–(15). The result, $d\theta^*/d\delta > 0$, obtains here too, but mutual funds make deposit insurance redundant, and there is no additional dissipative loss with the SFM. Thus, in the absence of a regulatory subsidy, the only borrowers that will seek the DFM are those of the lowest quality with $\theta^*(\delta) = 0$. The reason is that competition precludes pooling of these assets. Thus, a mutual fund encourages the SFM. Of course, a sufficiently large regulatory subsidy can, once again, make the DFM attractive.

Since mutual funds are never perfectly diversified, they will not enable the SFM to completely displace the DFM. The point is that there are many institutions and market mechanisms – such as third-party insurers and mutual funds – that encourage securitization, but the extent to which the SFM will displace the DFM is still affected by regulatory taxes and subsidies.

In our model, we have viewed each bank as having just one loan. In practice, securitized assets are typically claims against portfolios of loans and some diversification is therefore provided via the SFM. Moreover, the partitioning or stripping of claims improves the risk-sharing opportunities. Thus, our comments regarding mutual funds are merely meant to indicate

[11]This would be particularly relevant if transactions costs prevented investors from achieving the unconstrained optimal level of personal diversification [see Levy (1978)].

that the risk dissipation opportunities available to capital market participants affect banks' securitization incentives; the less risk aversion investors manifest in pricing risky securities, the greater is the relative benefit of securitization.

This also clarifies the role of preferences in our model. With universal risk neutrality, deposit insurance becomes redundant and the SFM will involve no risk sharing loss relative to the DFM. Since no information is conveyed to depositors with the DFM, there will be 'pooled' pricing leading to an Akerlof-type market failure in the deposit market as successive groups of borrowers with qualities exceeding that corresponding to the 'pooled' quality migrate to the SFM. Thus, with universal risk neutrality, the SFM will be the dominant funding mode for all assets, assuming the absence of net regulatory subsidies. In this case, if any borrower displays a preference for the DFM, it would be driven exclusively by the regulatory subsidies.

5. Concluding remarks

We have explained the bank's choice of funding modes. We view the bank as an institution with a cost advantage in screening borrowers. Hence, it is able to perform the loan origination function more efficiently than others. We have shown that the bank's decision to fund a loan is affected by credit market informational asymmetries, the information processing technology, and by governmental intervention.[12]

Our principal findings can be summarized as follows:

(1) With symmetric information regarding borrowers' payoff distributions and without governmental intervention, the bank is indifferent between deposit funding and securitization.
(2) With asymmetric information about borrowers' payoff distributions, and without governmental intervention, banks will prefer securitization for their best assets and deposit funding for their worst.
(3) Governmental deposit insurance and regulation will affect the bank's choice of funding mode under asymmetric information. Sufficiently low bank capital requirements in combination with sufficiently generous regulatory subsidies linked to footings will lead to the choice of the DFM, regardless of the quality of borrowers.

[12]Two caveats deserve mention. First, we have not endogenized the existence of the bank itself. Instead of assuming that the bank has an advantage in screening borrowers, we could have started with more primitive assumptions that would have led to a screening advantage for banks. Second, we have taken the bank's capital as exogenous. Clearly, it would be more satisfying to address the bank's choice of capital structure, perhaps along the lines of Greenbaum and Taggart (1978). However, a model that rationalizes intermediary existence along with the capital decision, and also explains the choice between securitization and deposit funding seems a bit daunting at this point.

(4) The incentive to securitize can be enhanced by third-party insurers and mutual funds. However, once again a sufficiently large footings-related regulatory subsidy can result in a preference for deposit funding.
(5) The choice of funding mode will also be affected by information processing costs. For securitization to be preferred these costs must be low enough.

Thus, we find that in an unregulated environment with asymmetric information banks will securitize as well as fund some of their loans. That banks and thrifts did so little securitizing in the past may have been due to deposit insurance and the welter of subsidies linked to bank loan losses, housing, mutuality and agriculture. Depository financial institutions enjoyed tax subsidies, subsidized access to a lender-of-last-resort and also underpriced deposit insurance, all of which were linked to the booking of assets. These footings-related subsidies may explain the earlier dominance of the DFM. A possible justification for the subsidies is that they led banks and thrifts to hold assets of higher average quality.[13] A corollary is that the erosion of these subsidies in recent years may have prompted the growth of securitization, and also may have led to a deterioration in bank and thrift asset quality along with the growth of contingent liabilities at these institutions.

Finally, a word on regulatory subsidies/taxes versus information costs as competing explanations for the recent securitization trend. Without contemporary information systems that support the servicing of large and complex asset pools and the trading of partitioned (stripped) claims against these pools, securitization would be impossible. Thus, the information cost argument is facilitating and even indispensible. Technological advances have undeniably reduced the cost of producing liquidity. But this argument alone would lead to the liquefaction of intermediary assets without their necessary sale. Thus, with sufficiently low costs of liquefying assets, banks and thrifts could be expected to do so without disposing of them. Note that thrifts are large holders of mortgage-backed securities, and liquefaction facilitates diversification within bank and thrift portfolios. The liquefaction of assets as a precedent to their sale must be linked to some change in the relative advantage of these assets being *held* by banks versus others. Herein lies the

[13]In addition, the unification of lending functions solved a moral hazard problem associated with originating and underwriting. This problem is addressed under SFM by having the bank insure part of the loan, but it remains when loans are sold without recourse.

Yet another moral hazard is related to the bank's choice of screening expenditure. A bank might have an incentive to avoid the screening cost by assigning the borrower a randomly chosen δ. The bank would profit since the borrower would pay C^B as part of the management fee. Note, however, that a competitive credit market precludes this. If a bank does not screen, it will either overestimate a borrower's δ or underestimate it. If overestimated, the borrower will stay with the bank and thereby impose losses. If underestimated, the borrower will seek another bank that will screen. (Remember that our focus on $\delta \in \Delta$ implies that all borrowers prefer screening to pooling.) Hence, the policy of not screening is always suboptimal.

importance of the regulatory subsidy/tax argument. It is not clear why information cost reductions would change the attractiveness of direct versus indirect asset ownership, unless information costs are trivialized, in which case the logic of having banks of the type described herein is brought into question. Note that the screening cost advantage of banks can be explained in terms of the reusability of costly information [see Chan, Greenbaum and Thakor (1986)]. Hence, whether banks retain their originated claims in the primitive illiquid form or transform them into tradeable securities seems to have a great deal to do with the decline of information costs. Whether the transformed tradeable claims are held by banks or sold to others would appear to have less to do with information costs, and more to do with cost of capital considerations of various agents in society.

Appendix

Proof of Proposition 1. Because investors are risk averse, the borrower's expected utility is maximized in the problem in (4)–(8) by setting $\theta(\delta)=\lambda(\delta)$. Further, (4) is maximized with (5) and (7) holding as equalities. It is easy to see now that the maximized values of (1) and (4) are equal. Q.E.D.

Proof of Lemma 1. The first-order condition corresponding to (13) is (we will drop the argument of $\theta(\cdot)$ for notational convenience)

$$-\delta r'(\theta^*)R_f^{-1}-p_\theta=0. \tag{A.1}$$

Note now that (12) is maximized when (14) and (15) hold as equalities. Taking a total derivative in (14) and rearranging yields

$$\{[1-\delta]r(\theta^*)+[1-\delta]\theta^* r'(\theta^*)-p_\theta R_f\}\{\mathrm{d}\theta^*/\mathrm{d}\delta\}-R_f p_\delta-\theta^* r(\theta^*)=0. \tag{A.2}$$

Similarly, taking a total derivative in (15) and rearranging gives

$$\begin{aligned}&U(r(\theta^*))-U(r(\theta^*)\theta^*)\\&\quad+[\delta r'(\theta^*)U'(r(\theta^*))+\{1-\delta\}U'(r(\theta^*)\theta^*)\{\theta^* r'(\theta^*)+r(\theta^*)\}]\\&\quad\times[\mathrm{d}\theta^*/\mathrm{d}\delta]=0.\end{aligned} \tag{A.3}$$

Substituting (A.1) in (A.3) yields

$$U(r(\theta^*)) - U(r(\theta^*)\theta^*)$$
$$+[-p_\theta R_f U'(r(\theta^*)) + \{1-\delta\} U'(r(\theta^*)\theta^*)\{\theta^* r'(\theta^*) + r(\theta^*)\}]$$
$$\times [\mathrm{d}\theta^*/\mathrm{d}\delta] = 0. \tag{A.4}$$

Now combining (A.2) and (A.4) produces (16).

To obtain the sufficiency conditions, differentiate (A.1) partially with respect to θ to see that

$$-\delta r''(\theta^*) R_f^{-1} - p_{\theta\theta} < 0$$

must hold for an interior maximum, and this implies (22). Next, totally differentiating (A.1) gives us

$$\mathrm{d}\theta^*/\mathrm{d}\delta = [-p_{\theta\delta} - r'(\theta^*) R_f^{-1}][\delta r''(\theta^*) R_f^{-1} + p_{\theta\theta}]^{-1}. \tag{A.5}$$

From (22) we know that the denominator is non-zero. For a separating equilibrium, we need $\mathrm{d}\theta^*/\mathrm{d}\delta \neq 0$. This requires that (23) should hold. Q.E.D.

Proof of Proposition 2. Using (14) as an equality, we see that

$$p_\theta = [1-\delta]\{r(\theta^*) R_f^{-1} + \theta^* r'(\theta^*) R_f^{-1}\}. \tag{A.6}$$

Substituting (A.6) in (A.1) and rearranging yields

$$r'(\theta^*)[\delta + \{1-\delta\}\theta] R_f^{-1} = -[1-\delta] R_f^{-1} r(\theta^*). \tag{A.7}$$

The right-hand side of (A.7) is negative. Hence, $r'(\theta^*) < 0$. Now, partially differentiating (A.6) with respect to δ gives

$$p_{\theta\delta} = -[r(\theta^*) + \theta^* r'(\theta^*)] R_f^{-1}. \tag{A.8}$$

Thus, the numerator in (A.5) is

$$-\{p_{\theta\delta} + r'(\theta^*) R_f^{-1}\} = \{r(\theta^*) - [1-\theta] r'(\theta^*)\} R_f^{-1}$$
$$> 0 \quad \text{since } r'(\theta^*) < 0 \text{ and } \theta^* \in [0, 1].$$

In (A.5), we have already established that the denominator is strictly positive. Having established now that the numerator too is positive completes the proof. Q.E.D.

Proof of Lemma 2. Since $r'(\theta^*)<0$, from (A.1) we know that $p_\theta>0$. Now totally differentiating V and rearranging gives

$$\mathrm{d}V/\mathrm{d}\delta=[R-r(\theta^*)]R_\mathrm{f}^{-1}-\delta R_\mathrm{f}^{-1}r'(\theta^*)[\mathrm{d}\theta^*/\mathrm{d}\delta]$$
$$+\theta^* r(\theta^*)R_\mathrm{f}^{-1}-[1-\delta]R_\mathrm{f}^{-1}[r(\theta^*)+\theta^* r'(\theta^*)][\mathrm{d}\theta^*/\mathrm{d}\delta].$$

Now the first three terms on the right-hand side are clearly positive and the last term is $-p_\theta[\mathrm{d}\theta^*/\mathrm{d}\delta]$. Since $p_\theta>0$ and $\mathrm{d}\theta^*/\mathrm{d}\delta>0$, the last term is negative. However, it does not contain R. Thus, for R sufficiently large, $\mathrm{d}V/\mathrm{d}\delta>0$. Q.E.D.

Proof of Proposition 3. All that needs to be shown is that there is no pooling allocation that can disturb the separating equilibrium. We begin by noting that the informed agents (banks) move first in this game. Recall that Δ_s is the set of δ's which are securitized. So suppose defection from equilibrium takes the form of a bank pooling a subset $[\delta',\delta_2]\subset\Delta_\mathrm{s}$ of the highest δ's by offering them the same interest rate, insurance coverage and insurance premium. Further, assume that this is the best pooling contract possible, i.e., the bank's and investor's reservation constraints hold tightly. By Proposition 2 we know that the equilibrium insurance coverage is increasing in δ. Thus, the type-δ_2 borrowers have the maximum possible coverage permitted by the bank's capital. Since the relevant break-even conditions for the bank and the investors hold tightly in equilibrium, we can conclude that the type-δ_2 borrowers obtain in equilibrium the highest expected utility that they can, conditional on the bank producing information. Now, returning to the pooling defection from equilibrium, it is clear that pooling can occur in one of two ways. Either all δ's in $[\delta',\delta_2]$ are offered the same coverage as δ_2, or they are all offered a lower coverage. Suppose first that all δ's in $[\delta',\delta_2]$ are offered the same coverage as δ_2. Then, it must be true that the pooling insurance premium and the pooling interest rate are both higher than the respective values of the premium and interest rate for the type-δ_2 borrower. Thus, the type-δ_2 borrower is made worse off by pooling and cannot be enticed away. This argument works for every δ at the top of the types being pooled and hence there is unraveling from the top down. Now suppose pooling involves all δ's in $[\delta',\delta_2]$ being offered a lower coverage than that offered in equilibrium to the type-δ_2 borrower. In this case, the type-δ_2 borrower enjoys a lower expected utility than it would if it had chosen this lower coverage in the first place without any other type doing so. (This is because, holding the coverage fixed, pooling raises the premium and loan interest rate for the type-δ_2 borrower.) And its expected utility from choosing this lower coverage, even in isolation, is less than its equilibrium expected utility since the latter is the best it can do, conditional on the bank

producing information. Thus, this kind of pooling also worsens the lot of the type-δ_2 borrower, relative to the (separating) equilibrium. Working down, this argument can now be repeated for every δ at the top of the types being pooled. Thus, no pooling defection can threaten the equilibrium. Q.E.D.

Proof of Proposition 4. We begin by noting that $\theta^*(\delta_2)r(\theta^*(\delta_2)) = R_f K$. That is, since $d\theta^*/d\delta > 0$, the maximum insurance coverage under the SFM is provided to the borrower with $\delta = \delta_2$. And the maximum coverage the bank can provide equals $R_f K$. Thus, for $\delta = \delta_2$, the expected utility of the borrower under the SFM is

$$\delta[R - r(\theta^*(\delta_2))]R_f^{\ 1} - C^B - [1-\delta]K, \tag{A.9}$$

and under the DFM it is

$$\delta[R - r(\delta_2)]R_f^{-1} - C^B - [1-\delta]K. \tag{A.10}$$

From the constraints in the respective maximization programs, it is clear that $r(\theta^*(\delta_2)) < r(\delta_2)$. Thus, for $\delta = \delta_2$, the SFM strictly dominates the DFM. Next, it is easy to establish that the difference between a borrower's expected utility with the SFM and that with the DFM declines monotonically as δ decreases. Given (24), we also know that, for $\delta = \delta_m$, the DFM strictly dominates the SFM. Thus, $\exists \hat{\delta} \in \Delta$ such that all $\delta \in \Delta_s \equiv \{\delta \geqq \hat{\delta} | \delta \in \Delta\}$ prefer the SFM and all $\delta \in \Delta_D \equiv \{\delta < \hat{\delta} | \delta \in \Delta\}$ prefer the DFM. Q.E.D.

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