Don't Put All Your Eggs in One Basket?
Diversification and Specialization in Lending

Andrew Winton

Finance Department
University of Minnesota

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Abstract

Should lenders diversify, as suggested by the financial intermediation literature, or specialize, as suggested by the corporate finance literature? I model a financial institution's ("bank's") choice between these two strategies in a setting where bank failure is costly and loan monitoring adds value. All else equal, diversification across loan sectors helps most when loans have moderate exposure to sector downturns ("downside") and the bank's monitoring incentives are weak; when loans have low downside, diversification has little benefit, and when loans have sufficiently high downside, diversification may actually increase the bank's chance of failure. Also, it is likely that the bank's monitoring effectiveness is lower in new sectors; in this case, diversification lowers average returns on monitored loans, is less likely to improve monitoring incentives, and is more likely to increase the bank's chance of failure. Diversified banks may sometimes need more equity capital than specialized banks, and increased competition can make diversification either more or less attractive. These results motivate actual institutions' behavior and performance in a number of cases. Key implications for regulators are that an institution's credit risk depends on its monitoring incentives as much as on its diversification, and that diversification per se is no guarantee of reduced risk of failure.

JEL Classifications: G11, G21, L20

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It is the part of a wise man...not to venture all his eggs in one basket.

– Miguel de Cervantes

Put all your eggs in the one basket and – WATCH THAT BASKET.

– Mark Twain

1. Introduction

Should lenders diversify across different geographic regions and industry sectors, or should they specialize in a few related sectors – that is, should they follow the advice of Cervantes or of Twain? Experts on financial institutions generally follow Cervantes: they argue that lenders such as banks, finance companies, and life insurers are typically highly levered, and diversification across sectors reduces their chance of costly financial distress; also, several models of intermediation suggest that diversification makes it cheaper for institutions to achieve credibility in their role as screeners or monitors of borrowers (see Diamond, 1984, Ramakrishnan and Thakor, 1984, and Boyd and Prescott, 1986). On the other hand, experts on corporate finance generally follow Twain: they argue that any firm – financial institution or other – should focus on a single line of business so as to take greatest advantage of management's expertise and reduce agency problems, leaving investors to diversify on their own (see Jensen, 1986, Berger and Ofek, 1996, Servaes, 1996, and Denis et al., 1997).

Cases can be mustered in support of either view. Supporters of diversification can cite Continental Illinois' failure in 1984, linked to a large concentration of energy-sector loans, and Bank of New England's failure in 1991, linked to a large concentration in New England real estate loans. Supporters of specialization can cite the credit problems that followed rapid diversification at many institutions during the 1980s, including Citicorp, Bank of America, Credit Lyonnais, and a number of major Japanese banks. They can also point to a number of recent cases where focus has produced superior results without excessive risk, including Comerica, a specialist in middle market and small business lending, and CapitalOne, FirstUSA, and MBNA, specialists in credit card lending.[1] Since these contrasting cases suggest that neither diversification nor specialization always dominates, which circumstances favor one strategy or the other?

I consider this question in a simple model of lending. A financial institution ("bank") issues debt (later, I allow for costly equity capital) and uses the funds to make loans to one or two different sectors of the economy. Bank failure is costly; because investors require compensation for such costs, the bank has incentive to minimize its chance of failure, all else equal. By monitoring loans, the bank is better able to catch problem loans before matters deteriorate too far, improving loan returns. Since loans to any particular sector are most likely to be in trouble when that sector is in a downturn, monitoring helps most when times

[1] See Herring (199_), Hansell (1997b), Klinkerman (1998), and the discussion in Section 7 below.

prove to be bad, which is precisely when the bank itself is most in danger of failing. This may expose the bank to a variant of the Myers (1977) underinvestment problem: if in good times problem loans are so infrequent that the ex post benefit of monitoring is less than its ex ante cost, the bank may be tempted to forego monitoring, pocketing cost savings in good times and defaulting on its debt in bad times. Because investors anticipate such "risk-shifting" behavior and demand a higher rate to compensate, the bank ends up internalizing any decrease in loan returns from not monitoring. Thus, in choosing whether to diversify, the bank weighs the impact of diversification on its incentive to monitor its loans and on its chance of failure.

First, consider the impact of diversification when the bank's ability to monitor loans is constant across different sectors. Such "pure" diversification increases the central tendency of the bank's return distribution, which generally reduces the bank's chance of failure; also, if underinvestment in monitoring is an issue, greater central tendency improves monitoring incentives. Nevertheless, if its loans have sufficiently low exposure to sector downturns ("downside"), a specialized bank has a low probability of failure, so the benefit of diversification is slight. Also, if its loans have sufficiently high downside, diversification can actually *increase* the bank's chance of failure: a downturn in one sector is enough to make a diversified bank fail, and a diversified bank is exposed to more sectors than a specialized one.[2] Thus, all else equal, diversification's benefits are greatest when the bank's loans have moderate levels of downside risk and when the bank's monitoring incentives need strengthening.

Furthermore, all else may not be equal. By definition, diversification involves moving into economic sectors or geographic regions that differ from the bank's home base. Effective loan monitoring requires that the lending institution have a thorough understanding of these differences, but building such organizational knowledge takes time and effort. Also, recent work suggests that a bank entering a sector with several established banks faces increased adverse selection in its pool of borrowers (the "Winner's Curse").[3] Thus, regardless of the bank's efforts, loans in the new sector are likely to perform worse than loans in the bank's home sector. Worse performance for new sector loans also makes diversification more likely to increase the bank's chance of failure and less likely to improve the bank's monitoring incentives; indeed, diversification may even *undermine* incentives to monitor home sector loans. Overall, diversification is more likely to be unattractive, particularly when the bank's home sector loans have either low or high downside.

Lack of knowledge about new markets is not the only way in which diversification can harm the effectiveness of loan monitoring. Some sectors simply offer lower returns to monitoring. For example, some

[2] More generally, increased central tendency in loan portfolio returns increases a bank's failure probability if the bank's debt level is sufficiently high relative to the portfolio's mean return. Since loan portfolio returns are very skewed to the left, this can occur for debt levels well below the mean return.

[3] For theoretic treatments, see Dell'Arricia, Friedman, and Marquez (1999), Marquez (1997), Dell'Arricia (1998), and Gehrig (1998). Shaffer (1998) finds supporting empirical evidence.

industries have few tangible assets, and some regions or countries have fewer creditors' rights; both reduce recoveries from troubled loans, regardless of the bank's monitoring efforts. Also, if increased diversification requires increased size, diversification may involve increased layers of management and free rider problems, which could lower monitoring effectiveness in *all* sectors.

In debating diversification's pros and cons, the features that distinguish banks and other lenders from nonfinancial firms are lenders' greater use of debt finance (leverage) and the way in which lenders' efforts affect their return distributions. With high leverage, worst-case outcomes loom large both in terms of underinvestment problems and in terms of outright failure. Loan monitoring improves returns not by increasing best-case outcomes but by reducing the frequency and severity of worst-case outcomes: after all, a loan cannot earn more than its stated principal and interest, but effective monitoring may stop a troubled loan from deteriorating too far. Although pure diversification tends to reduce the frequency of both worst-case and best-case outcomes, diversification that lessens monitoring effectiveness may *increase* the frequency and severity of worst-case outcomes, increasing failure probability and underinvestment problems.

A bank can reduce its probability of failure and alleviate any underinvestment problems by raising equity capital, but equity finance has a number of costs relative to debt finance (see Section 6). Although the conventional view is that greater diversification means less need for costly equity capital, my analysis suggests that sometimes the opposite is true: a more diversified bank may have greater relative need for capital, especially if diversification involves expansion into sectors where the bank is less effective.

Similarly, the conventional view is that greater competition has increased the need for banks to diversify: lower profits leave less margin for error, so diversification provides a necessary reduction in risk. Again, my analysis suggests that the opposite can be true. For example, increased competition may magnify the "Winner's Curse" problem faced on entry into a new sector, making diversification very costly. Banks facing greater competition may therefore find it more attractive to specialize.

As discussed in Section 7, my results help motivate a number of actual cases, including many of those mentioned at the outset. Consider Continental Illinois: upon closer examination, its downfall was due as much to lax credit standards as to lack of diversification, and indeed Continental's loans had precisely those features for which my model predicts that a specialized bank has greater incentive problems than a diversified bank. By contrast, credit card lending in the 1990s had several features which favor specialists over more diversified rivals, which is consistent with the superior performances of CapitalOne, First USA, and MBNA, and with that of Citicorp, which chose credit cards as one of a few areas of focus after rapid diversification in the 1980s produced the disastrous results mentioned earlier.

A more general point is that credit exposure on most bank loans is in large part *endogenous*; it is greatly affected by the intensity and efficacy of the bank's monitoring. Thus, the recent move at larger banks to manage portfolio-wide credit risk using quantitative products such as J.P. Morgan's CreditMetrics or

Credit Suisse's CreditRisk$^+$ must be taken with a grain of salt. In these models, loan risk is exogenous, making portfolio risk a mechanical function of allocation across various loan sectors (see Gordy, 1998). To the extent that the banks that provide the loan history data on which these products are based tend to be those which have been active in a given sector for some time, and successful enough to survive and be willing to share their history, the data may well represent above-average lending performance. An institution that uses such data to assess the pros and cons of moving into a new sector understates the risk it will face due to its lack of expertise. Similar caveats apply to regulators using such data to assess institutions' risk.

For regulators seeking to control institutional moral hazard caused by deposit insurance or other government guarantees, a related point is that "risk-shifting" through lack of monitoring should be as great a concern as risk-shifting through lack of diversification. Furthermore, poor monitoring is likely to be harder to observe on a timely basis than portfolio diversification, and thus harder to control. Nor is it correct to assume that monitoring incentives always increase with diversification: aggressive diversification into new sectors can undermine monitoring incentives just as much as excessive concentration in a few risky sectors. This suggests a need for more research on the relationships between monitoring expertise, monitoring incentives, and loan portfolio composition.

Finally, while this paper focuses on the implications of diversification for lending institutions, other financial institutions face the same combination of high leverage, portfolio exposures that are greatly skewed to the left, and potential gains to specialization; examples include property and liability insurers, credit insurers, and investment banks that specialize in high yield bonds. Thus, these institutions may face similar tradeoffs between diversification and specialization.

There have been a number of papers on bank diversification incentives, but most assume that loans are uncorrelated and diversification increases automatically with bank size.[4] Similarly, although there has been some work on specialization and loan performance, these papers do not address monitoring incentives or aggregate portfolio risk.[5] A somewhat closer paper is Besanko and Thakor (1993), who model insured banks allocating loans across two uncorrelated sectors. Diversified banks forfeit gains from risk-shifting but increase their odds of surviving to collect informational rents on continuing lending relationships; free entry reduces these rents, discouraging diversification. My paper differs from all of these by incorporating banks'

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[4] See Yanelle (1989, 1997), Winton (1995, 1997), Matutes and Vives (1996), Yosha (1997), Gehrig (1995), and Daltung (1996). Hellwig (1998) differs by allowing the bank to choose the size of each loan; thus a bank can "specialize" and save on fixed monitoring costs by increasing loan size, albeit at the cost of less diversification. Shaffer (1994) points out that diversification by merging independent banks actually increases the odds that *all* banks fail simultaneously, increasing systemic risk.

[5] In addition to the previously-mentioned papers on the winner's curse problem facing new entrants, Boot and Thakor (1998) examine incentives to specialize in the face of increased competition.

role as active monitors and by examining how varying degrees of expertise, loan risk, or correlation between different sectors affect both the decision to diversify and subsequent monitoring performance.

The paper's structure is as follows. Section 2 outlines the basic model and examines the behavior of an undiversified bank. The next two sections examine the impact of diversification when the bank's monitoring incentives are not an issue; in Section 3 the bank has the same monitoring expertise in both sectors, while in Section 4 the bank has less expertise in the new sector. Section 5 examines diversification when the bank's monitoring incentives are weaker and underinvestment may be a problem. Section 6 looks at incorporating bank equity capital, competitive considerations, and unobservable allocations of loans across sectors. Section 7 applies the model to actual cases. Section 8 discusses policy implications and concludes.

2. Basic Model

A. Assumptions

A financial institution operates for a single period. At the start of the period, it raises 1 unit of funds from investors by issuing debt with face value (principal and interest) D; in Section 6 I will allow for equity to be issued as well. Investors are competitive, risk-neutral, and require a total expected return of 1 per unit invested. The funds that the institution raises are then invested in loans. At the end of the period, loan returns are realized; the institution then either repays D if it has sufficient funds, or else fails, in which case investors seize its assets. Failure results in a deadweight loss b for the investors; this represents various costs of financial distress that diminish the value of the institution's assets.

Although I will generally refer to the institution as a bank, I do not assume that its debt is insured; the institution could be an uninsured finance company or a commercial bank that pays a fair price for deposit insurance. What is critical is that the institution relies on debt for (most of) its funding, that it pays a fair price in equilibrium for its funding, and that its failure is costly. James (1991) presents evidence that direct costs of bank failure can be quite substantial (roughly 10% of assets); Slovin, Sushka, and Polonchek (1993) present evidence of significant indirect costs.

The institution (henceforth "bank") can allocate its loans across two sectors, 1 and 2. Let α indicate the fraction of Sector 1 loans in the bank's portfolio; for simplicity, I restrict α to be 0, ½ , or 1. The contractual payment (principal plus interest) per unit loaned is fixed exogenously at $R > 1$; later, in Section 6, I examine how R is determined by competitive considerations. Within a given sector, a fraction q_s of loans are repaid in full, while the rest are problem loans. The fraction q_s of successful loans depends on the sector's state s, which is either good (G) or bad (B); $q_G > q_B$. For simplicity, the bank is assumed to be perfectly diversified *within* any sector to which it lends, and so the fractions q_G and q_B perfectly represent the relative proportions by sector of good and bad loans within the bank's loan portfolio. Henceforth, when I refer to "diversification," I am referring to diversification *across* sectors, i.e., $\alpha = 1$.

Each sector has probability $p \geq ½$ of being in the good state G, and 1-p of being in the bad state B, so $\bar{q} \equiv pq_G + (1\text{-}p)q_B$ is the probability that a loan is repaid in full. The two sectors' states may be correlated. Let φ_{st} be the joint probability of Sector 1 being in state s and Sector 2 being in state t (henceforth state "st"). Because the sectors are symmetric, the "cross-probabilities" φ_{GB} and φ_{BG} are equal; henceforth, I refer to both as φ_{BG}. The following lemma establishes some useful facts about this distribution.

Lemma 2.1 (Facts about Joint Distribution of Sector Returns). (i) $\varphi_{GG} + \varphi_{BG} = p$ and $\varphi_{BG} + \varphi_{BB} = 1 - p$.
(ii) The correlation between the two sectors equals $(\varphi_{GG} - p^2)/(p - p^2)$; since $p \geq ½$, the minimum correlation is $1 - p^{-1} \leq 0$, and the maximum is 1.
(iii) Holding p constant, increasing sector correlation increases φ_{GG} and φ_{BB} and decreases φ_{BG}.

Proof: see Appendix A.

In addition to allocating loans across sectors, the bank can monitor loans at a cost of c per unit loaned. Monitoring must begin right after loans are made; it lets the bank spot troubled borrowers before their situations become hopeless, allowing the bank to increase its average recovery by invoking protective covenants, renegotiating maturing loans, forcing foreclosure, and so forth. If the bank has expertise in a loan sector, then it is always successful in spotting problem loans in that sector when it monitors. If a bank does not have such expertise, it is only successful with probability $\gamma < 1$. If successfully monitored, problem loans pay some amount $L < 1 < R$; otherwise, they pay nothing.[6] It follows that if the bank has expertise in a sector and monitors (choice "M"), then when the sector is in state s the bank's loans to that sector will yield

$$r(M,s) \equiv q_sR + (1\text{-}q_s)L - c.$$

If the bank monitors but lacks expertise because it is new to the sector (choice "N"), its loans yield

$$r(N,s) \equiv q_sR + (1\text{-}q_s)\gamma L - c.$$

Finally, if the bank does not monitor (choice "U" for "unmonitored"), its loans yield

$$r(U,s) \equiv q_sR.$$

Note that monitoring adds most value when the sector state is bad. Also, regardless of its monitoring choice,

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[6] An alternative interpretation is that successful monitoring gives the bank a probability L/R of preventing an "iffy" loan from becoming a problem.

the bank does better in the good state than in the bad (for any $\sigma \in \{M,N,U\}$, $r(\sigma,G) > r(\sigma,B)$).

Remark 1: Incidence of monitoring costs. My expressions for the return on monitored loans assume that monitoring costs are pecuniary, reducing bank assets, and that the costs occur at the end of the monitoring period. Having monitoring costs instead reduce the bank's investable funds would complicate some expressions without changing the essential results of the paper. A more critical assumption is that costs reduce bank assets *before* debtholders are paid. In reality, costs of monitoring take the form of effort on the part of the bank's management, employees, and directors; while much of these costs are compensated on an ongoing basis through salaries and directors' fees, some are compensated ex post through salary increases, bonuses, and grants of stock or stock options – compensation that may well be lost in the event the bank fails, when jobs are lost and stock becomes worthless. If monitoring costs only become pecuniary on such an ex post basis, the underinvestment problem becomes more severe: the bank's decision makers now bear the costs of monitoring regardless of outcome, whereas in the current model costs are shared with debtholders if the bank fails. I return to this issue in Remark 3 in Section 5 below.

Remark 2: Banks as loan screeners. Although most of my discussion focuses on banks monitoring existing loans, banks also screen borrowers when making loans. The model is easily adapted to cover screening. Suppose that some loans end up being good, yielding R, while some end up bad, yielding 0. If the proportion of good loans in a sector is q_s depending on the state of the sector, a bank that does not screen receives q_sR. If screening at cost c allows the bank to increase its proportion of good loans to $q_s+(1-q_s)(L/R)$, one arrives at the same revenue stream for the bank given above; L/R now reflects the bank's ability to exclude bad loans. Since the proportion of bad loans increases when the sector state is bad ($1-q_B$ exceeds $1-q_G$), screening has more value (ex post) in the bad state. Effectively, this assumes that screening reveals firm characteristics associated with greater vulnerability to negative shocks, which are more likely to occur when the sector as a whole is in bad shape.

Returning to the basic model, it follows that the expected profit of a bank that issues debt with face value D, allocates α of its loans to Sector 1, and chooses monitoring strategy σ_i for each sector $i \in \{1,2\}$ is

$$\pi(\alpha,\sigma_1,\sigma_2,D) \equiv \sum_{s\in\{G,B\}} \sum_{t\in\{G,B\}} \varphi_{st} \cdot \max\{\alpha\cdot r(\sigma_1,s) + (1-\alpha)\cdot r(\sigma_2,t) - D, 0\}.$$

The next assumption concerns the relative performance of monitored and unmonitored loans:

Assumption 1 (Loan Risk and the Value of Monitoring). The following restrictions hold:
(i) $p\cdot r(M,G) + (1-p)\cdot r(M,B) = \bar{q}R+(1-\bar{q})L - c \geq 1+(1-p)b$ (monitored loans have positive net present value);
(ii) $(1-\bar{q})L > c$ (ex ante, monitoring is more attractive than not monitoring);
(iii) $q_B R < 1 < q_G R$ (unmonitored loans create some risk of bank failure).

The critical assumptions are that monitored loans are worth funding, that the gains from monitoring when the state is bad more than outweigh any net costs of monitoring when the state is good, and that unmonitored loans create some risk of bank failure. These assumptions leave room for considerable variety: for example, unmonitored loans may be worth funding ($\bar{q}R \geq 1+(1-p)b$), monitoring may be unattractive in the good state ($(1-q_G)L < c$), or monitoring may leave the bank with a risk of default ($r(M,B) < 1$).

Finally, the ease with which investors can observe the bank's actions must be specified. Since it is difficult for outsiders to directly observe the lending process that a bank is following, I assume that the bank's monitoring choices cannot be observed by outside investors. This rules out contracting based on the bank's actual monitoring choice.[7] By contrast, since banks in many developed countries do report information on loan concentrations at regular intervals (albeit for broad groupings and with lags), and massive reallocations of existing loans are likely to be time-consuming and hard to conceal, I initially assume that the bank's loan allocation across sectors is observable. In Section 6, I consider the case where it is difficult to observe loan allocations, as might be more representative of banks in developing countries.

For simplicity, assume that the bank's debt face value is conditioned on its loan allocation.[8] In this setting, an equilibrium is a subgame perfect equilibrium of the game in which the bank first chooses its loan allocation, investors competitively set D, and the bank then makes monitoring decisions. More specifically,

Definition 1. An equilibrium consists of loan allocation $\alpha \in \{0, \frac{1}{2}, 1\}$, monitoring strategies $\sigma_1(\alpha)$ and $\sigma_2(\alpha)$ as functions of α, and debt face value $D(\alpha)$ as a function of α, such that:
(i) given any α and resulting $D(\alpha)$, the bank chooses σ_1 and σ_2 to maximize its profits $\pi(\alpha,\sigma_1,\sigma_2,D(\alpha))$;
(ii) for any α and resulting $\sigma_1(\alpha)$, and $\sigma_2(\alpha)$, investors must break even on their investment; i.e.,

$$\sum_{s\in\{G,B\}} \sum_{t\in\{G,B\}} \varphi_{st} \cdot \min\{\alpha\cdot r(\sigma_1(\alpha),s) + (1-\alpha)\cdot r(\sigma_2(\alpha),t), D(\alpha)\}$$
$$- \; b \cdot \text{Prob}\{\alpha\cdot r(\sigma_1(\alpha),s) + (1-\alpha)\cdot r(\sigma_2(\alpha),t) < D(\alpha)\} \;=\; 1;$$

(iii) the bank chooses its allocation α to maximize its expected profits $\pi(\alpha,\sigma_1(\alpha),\sigma_2(\alpha),D(\alpha))$.

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[7] Although assuming that monitoring costs reduce bank assets makes the cost observable ex post, the bank's owners could always consume c and claim it was spent on monitoring. Alternatively, monitoring costs could be nonpecuniary, as discussed in Remark 1. For simplicity, I abstract from these issues.

[8] This is equivalent to having the bank issue the debt with face value 1 and a maturity right after loans are allocated; since the bank has no cash when the debt matures, the debt must be rolled over at a rate that reflects the bank's risk based on its loan allocation and expected monitoring efforts.

Since investors have rational expectations about how the bank will behave, the debt face value that they demand compensates them for any equilibrium lack of monitoring and costs of bank failure. Thus, ex ante, the bank's expected profit equals [expected loan portfolio returns] less [1+expected failure costs], and the bank fully internalizes the impact of its monitoring choice and any costs of bank failure. It follows that the bank would like to monitor (see Assumption 1(ii)) and keep its chance of failure as low as possible; the problem, of course, is that the bank must have incentive to monitor *after* its debt has been issued.

In my analysis, I adopt the following strategy. First, I examine the equilibrium monitoring decision and failure probability of an undiversified ("specialized") bank. Then, in the three sections that follow, I explore monitoring and failure probability for a diversified bank as a function of both its degree of expertise in each sector and the strength of its monitoring incentives; comparison with the benchmark case of a specialized bank leads to the bank's optimal decision on whether to diversify or specialize.

B. Benchmark Case: Undiversified ("Specialized") Bank

Suppose that the bank has allocated all of its loans to Sector 1, and that it has expertise in that sector, so that when it monitors it always identifies problem loans.[9] It follows that $\pi(1,\sigma_1,\cdot,D) = p\cdot\max\{r(\sigma,G)-D,0\} + (1-p)\cdot\max\{r(\sigma,B)-D, 0\}$. The next proposition outlines when equilibrium monitoring ($\sigma(1) = M$) is feasible in this setting, along with associated debt face values D(1) and probabilities of bank failure.

Proposition 2.2 (Monitoring Equilibria for Specialized Bank). Suppose that the bank allocates all of its loans to Sector 1, and that the bank has expertise in that sector.
(i) Suppose $(1-q_G)L > c$. Then in equilibrium the bank always monitors. If $r(M,B) \geq 1$, then the face value of the bank's debt equals 1 and the bank never fails; otherwise, the debt's face value equals $D^M = p^{-1}\{1-(1-p)\cdot[r(M,B)-b)]\} > 1$, and the bank fails with probability $1-p$.[10]
(ii) Suppose $(1-q_G)L < c$. If $(1-\bar{q})L-c \geq (1-p)\cdot[1-r(U,B)]$ (equivalently, $r(M,B) \geq 1-[p/(1-p)][(1-q_G)L-c]$), there is an equilibrium where the bank monitors, its debt face value is 1, and it never fails. Otherwise, the bank does not monitor in equilibrium.

Proof: see Appendix A.

In part (i) of the proposition, returns from monitored loans are always higher than returns from unmonitored loans, regardless of the state of the sector, so the bank always monitors. In part (ii), monitoring is unattractive (ex post) when the sector is in the good state, leaving open the possibility of risk-shifting by

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[9] Given the assumption of symmetry between sectors, it is easy to show that $\pi(\alpha,\sigma_1,\sigma_2,D) = \pi(1-\alpha,\sigma_2,\sigma_1,D)$. Thus, results for a bank that focuses on Sector 2 are the same as those derived for a bank that focuses on Sector 1.

[10] Actually, if $1 \leq r(M,B) < 1 + (1-p)b$, both D = 1 and $D = D^M$ are consistent with equilibrium; the higher rate makes the bank fail more often, which is self-fulfilling. As noted below, I focus on the Pareto optimal equilibrium, which in this case is the one with D = 1.

the bank. At a minimum, a monitoring equilibrium requires that the bank be able to repay its debt even in the bad state ($r(M,B) \geq 1$); otherwise, the bank only receives profits in the good state, which is when not monitoring dominates. Also, the bank must prefer monitoring and repaying investors in all states over cheating investors by issuing low-priced debt ($D(1) = 1$) and then not monitoring. The expected gain from monitoring is $(1-\bar{q})L-c$; this must exceed the expected gain from risk-shifting, which is $(1-p)(1-r(U,B))$, the expected shortfall on the bank's debt payments in the bad state. The rearranged version of this condition confirms that it is more binding than the requirement that $r(M,B) \geq 1$.

As outlined in Proposition B.1 of Appendix B, other equilibria may exist; the bank may not monitor at all, failing in the bad state, or the bank may randomize between monitoring and not monitoring. The first of these equilibria can coexist with the monitoring equilibrium of Proposition 2.2(ii); the randomized equilibria only exist when the monitoring equilibrium exists. Multiple equilibria are quite common in models of banking, and it follows that investor beliefs are critical.[11] Since this paper focuses on the impact of diversification on bank failure and bank incentives to monitor, when multiple equilibria exist, I focus on the Pareto optimal equilibrium, which is the one with the most monitoring and the lowest debt face value.

To summarize, a specialized bank monitors its loans in two cases: when monitoring loans is attractive even in the good sector state, or when monitoring's effect in the bad state is powerful enough that the bank avoids default by a margin high enough to make risk-shifting unattractive. It is easy to show that increases in recoveries L from monitoring or decreases in monitoring costs c make both cases more likely. Increases in the quality q_G of loans in the good state make the first case less likely because monitoring is less attractive in the good state. Finally, increases in the quality q_B of loans in the bad state or the stated rate R on loans make the second case more likely, since they increase the return on monitored loans in the bad state.

I have thus far assumed that the bank has expertise in its sector of specialization. It is easy to extend the analysis to the case where the bank has not yet acquired such expertise; not surprisingly, since its monitoring is less effective, a bank without sector expertise is less likely to monitor and more likely to fail.

Corollary 2.3 (Equilibria for Undiversified Bank Without Sector Expertise). Suppose that the bank allocates all of its loans to Sector 1, and that the bank does not have expertise in that sector. Then all the results and conditions in Proposition 2.2 hold, with L replaced by γL. As γ decreases (sector expertise is more critical for effective monitoring), the parameter range where monitoring is an equilibrium outcome decreases, as does the range where the bank never fails.

Proof: obvious.

With these results on a specialized bank's behavior as a benchmark, I now turn to the question of

[11] See Diamond and Dybvig (1993), as well as Yanelle (1989, 1997) and Winton (1995, 1997).

whether diversification improves bank performance.

3. "Pure" Diversification and Bank Failure

My analysis of the impact of diversification begins with the case where the bank's monitoring ability is constant across sectors. The common intuition is that such "pure" diversification makes a bank safer, reducing its failure probability. My analysis shows that there are caveats to this intuition; diversification may not help much if loans' exposure to a sector downturn ("downside") is low, and it may even *increase* the bank's failure probability if loans' downside is sufficiently high.

To simplify exposition, in this section I focus on the case where the ex post gain to monitoring in the good state $(1-q_G)L$ exceeds the cost of monitoring c. I deal with the other case in Section 5. As shown in Proposition 2.2(i), $(1-q_G)L > c$ implies that, regardless of a sector's realized state, monitoring always dominates not monitoring; thus the bank always monitors, and its decision to diversify or specialize is based solely on which strategy results in a lower equilibrium probability of bank failure.

Proposition 3.1 (Pure Diversification When Monitoring Incentives Are Strong). Suppose that $(1-q_G)L > c$. Then the bank always monitors all loans. Let $D(1) = D^s$ be the debt face value investors require from a specialized bank, and let $D(½) = D^d$ be the debt face value investors require from a diversified bank.
(i) If $r(M,B) \geq 1$, then regardless of its diversification strategy the bank never fails, and $D^s = D^d = 1$. The bank is indifferent between diversifying and specializing.
(ii) If $r(M,B) < 1$, and $½[r(M,B)+r(M,G)] \geq A \equiv (1-\varphi_{BB})^{-1}\{1-\varphi_{BB}\cdot[r(M,B)-b]\}$, a diversified bank fails less often than a specialized bank (probability φ_{BB} versus $1-p$), and $D^d = A$. Also, $1 < A < D^s = D^M$ from Proposition 2.2. The bank prefers to diversify.
(iii) If $r(M,B) < 1$, and $½[r(M,B)+r(M,G)] < A$, a diversified bank fails more often than a specialized bank (probability $1-\varphi_{GG}$ versus $1-p$), and $D^d > A$. The bank prefers to specialize.

Proof: see Appendix A.

In part (i) of the proposition, a sector downturn is not too risky (r(M,B) exceeds 1), so even a specialized bank is relatively safe, and diversification has little value in reducing expected costs of bank failure. Conversely, in part (iii), the downside risk of loans is so high that a downturn in even one out of two sectors is enough to cause a diversified bank to fail; in this case, diversification exposes the bank to more potential sector downturns, increasing its chance of failure. The greatest gains from diversification come when the downside risk of loans is moderate: high enough to expose the bank to significant threat of failure if it specializes, but not so high that a single sector downturn can bring down the whole diversified bank.

Though it may seem counterintuitive, the result that pure diversification may increase failure probability is a simple consequence of the fact that diversification increases the loan return distribution's central tendency. If the face value of the bank's debt is high enough, this means that diversification *increases* the odds that loan returns will be below this value. There is some offset in that pure diversification increases investors' share of bank portfolio returns for any given face value of bank debt, lowering the face value that they require.[12] Nevertheless, expected returns in failure and the probability of failure are not perfectly correlated; in part (iii) of the proposition, a diversified bank may have a lower face value of debt than a specialized bank yet fail more often.[13]

The "counterintuitive" case is most likely when the bank's loan returns have significant downside risk, since this both increases the face value of the bank's debt *and* increases the damage from any one sector being a downturn. This result is also made more likely by the fact that the distribution of loan returns tends to be heavily skewed to the left; there is a high chance that loans are repaid in full, but default leads to a wide range of possible low outcomes. In this model, skewness of loan returns means $1-p$ is well below 50%, so the bank's expected return $p \cdot r(M,G)+(1-p)r(M,B)$ exceeds $\frac{1}{2}[r(M,B)+r(M,G)]$ by a difference that increases as the difference between good and bad sector returns increases. Since a diversified bank's return when one sector is in a downturn is $\frac{1}{2}[r(M,B)+r(M,G)]$, it follows that if average loan returns are not too much greater than the face value of the bank's debt, a downturn in one sector may be enough to cause the bank to fail, especially if sectors show high cyclical risk.[14]

Example: suppose that $p = 95\%$ and $\varphi_{GG} = 92\%$. Then $\varphi_{BG} = 3\%$, $\varphi_{BB} = 2\%$, and correlation between sectors is .368. Suppose also that $R = 1.02$, $L = .70$, $q_G = 99\%$, $q_B = 80\%$, $c = .005$, and $b = .10$. Then $(1-q_G)L$ exceeds c, and $(1-\bar{q})L-c = .0087 > 0$; also, $r(M,B) = .951$, $r(M,G) = 1.012$ and the expected return on monitored loans is $1.009 > 1 + (1-p)b = 1.005$. Since $\frac{1}{2}[r(M,B)+r(M,G)] = .981 < 1 < A = 1.003$, a diversified bank fails 8% of the time, while a specialized bank fails only 5% of the time.

The discreteness of the binomial setting does play a role here; since a given sector's risk is "all or nothing," the increase in central tendency shows up in the two "cross-states" where one sector is good and one is bad. If returns in these cross-states are below the face value of the bank's debt, diversification causes a large increase in failure probability. Simulations using more realistic continuous distributions show more

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[12] Pure diversification induces a mean-preserving contraction in the bank's portfolio returns; since debtholders' returns are a concave function of the bank's loan portfolio return, this increases their expected payments. See Rothschild and Stiglitz (1970).

[13] Diversification may even *increase* the face value that investors require, although this requires both that diversification increase the bank's chance of failure (holding debt face value constant) and that deadweight costs of bank failure b are sufficiently high. In this model, D^d exceeds D^s if case (iii) of Proposition 3.1 applies *and* b exceeds $(\bar{q}R+(1-\bar{q})L-c)-1$; the proof is available upon request.

[14] By contrast, if loan returns were normally distributed, an increase in bank failure from diversification would require that the face value of the bank's debt exceeded the mean loan return. This would in turn imply a base failure probability of over 50%, which would be rather implausible.

muted effects, as one would expect. Nevertheless, substantial skewness does persist in large portfolios (see Brealey et al., 1983), and even when failure probabilities do not increase with diversification, they can be a "flatter" function of diversification than intuition based on normal distributions might suggest (see Carey, 1998). This in turn suggests that if diversification has other negative effects (as discussed in the next section), it is more likely to be harmful overall.

Since the three cases of Proposition 3.1 play an important role throughout my analysis, it is useful to label them as follows:

Definition 2. Recall that r(M,B) is the return on monitored loans when the sector is in its bad state.
(i) If $r(M,B) \geq 1$, monitored loans have *low downside.*
(ii) If $r(M,B) < 1$, and $\frac{1}{2}[r(M,B)+r(M,G)] \geq A \equiv (1-\varphi_{BB})^{-1}\{1-\varphi_{BB}\cdot[r(M,B)-b]\}$, monitored loans have *moderate downside.*
(iii) If $r(M,B) < 1$, and $\frac{1}{2}[r(M,B)+r(M,G)] < A$, monitored loans have *high downside.*

One consequence of Proposition 3.1 is that changes in loan risk and other parameters have nonmonotonic effects on the value of diversification across sectors. The following corollary illustrates this.

Corollary 3.2 (Comparative Statics When Monitoring Incentives Are Strong). Suppose $(1-q_G)L > c$.
(i) Suppose a bank's loans have moderate downside, so that diversification reduces bank failure probability. The following changes make it more likely that bank loans have high downside, so that diversification *increases* bank failure probability:(a) decreases in the bank's loan returns r(M,B) or r(M,G) (from decreases in R, L, q_G , or q_B); (b) a mean-preserving increase in sector risk (e.g., q_G rises and q_B falls in such a way that $\bar{q}$ is unchanged); (c) increases in the cost of bank failure b; (d) increases in sector correlation. Increases in sector correlation also diminish the impact of diversification on expected costs of bank failure.
(ii) Suppose a bank's loans have low downside, so that diversification does not affect the bank's failure probability. The following changes make it more likely that loans have moderate downside, so that diversification *reduces* bank failure probability: (a) decreases in loan returns r(M,B) in a sector downturn (from decreases in R, L or q_B); (b) a mean-preserving increase in sector risk as per (i.b).

Proof: see Appendix A.

Figure 1 illustrates some of these results. It shows the impact of diversification in bank failure as a function of the stated rate R on loans and the degree of sectoral risk (measured by q_G-q_B, holding average loan quality $\bar{q}$ constant); all other parameters are as in the example just given, and $(1-q_G)L > c$ for all values in the graph. Increases in loan returns (here, from increases in R) make the bank safer, but this can either lead to the situation where diversification reduces the chance of bank failure or the situation where diversification has no effect. Also, as the sectoral risk of loans increases, the size of the regions where diversification either reduces or increases the bank's chance of failure increase.

Although I have been assuming that the bank has expertise in both sectors, it is easy to extend the results of this section to the case where the bank lacks expertise in *both* sectors. The only question is whether loans monitored by a bank without expertise have low, moderate, or high downside risk, defined in analogy to Definition 2. Clearly, lower efficiency γ makes loans have greater downside; however, if lower efficiency causes loans to have moderate rather than low downside, diversification becomes more attractive, while if lower efficiency causes loans to have high downside, diversification becomes less attractive.

To summarize the results of this section, diversification that does not impair the bank's monitoring ability may reduce a bank's probability of failure. On the other hand, if loans have relatively low downside, a specialized bank is already safe, while if loans have sufficiently high downside, a diversified bank may fail more often than a specialized bank. Thus, diversification's benefits are greatest when loans have moderate downside. Increasing the correlation between sectors diminishes gains from diversification, and high costs of bank failure can have a similar effect. Other comparative statics depend critically on whether loans begin with low, moderate, or high downside risk.

4. Diversifying into Sectors Where Monitoring Is Less Effective

I now turn to the case where the bank diversifies from a sector where it has expertise into a sector in which its monitoring is less effective ($\gamma < 1$). By definition, such a move must be less attractive than the pure diversification analyzed in the previous section; returns to monitored loans in the new sector are worse in any state, reducing the bank's average loan returns and increasing the probability of bank failure. On the other hand, the bank may not have many pure diversification opportunities: each sector has nuances that take time to learn, and even if experienced lenders from other institutions are available, the bank's management has to learn some details of the new sector in order to do a good job of monitoring these lenders. Furthermore, sectors that are less correlated with those in which the bank is already established are likely to be less correlated because of differences in business environment and culture. Finally, if the new sector is a developing economy or a new industry with many intangible assets (such as growth opportunities), monitoring may be less effective due to lack of legal safeguards or good collateral; in this simple model, lower recoveries L from monitoring troubled loans have the same effect as a decrease in efficiency γ.

As in the previous section, I assume that $(1-q_G)L > c$, so that the bank always monitors loans in its home sector (Sector 1); in Section 5 I deal with the case where monitoring incentives are weaker. I also begin by assuming that r(N,G) > r(U.G), so that monitoring new sector loans is attractive even when the new sector (Sector 2) is in its good state. This is equivalent to requiring that $(1-q_G)\gamma L > c$; it implies that the bank always monitors new sector loans, which slightly simplifies analysis without changing the key results. I will discuss weakening this assumption later on.

In analogy with Definition 2, it is useful to categorize loans in the new sector by their returns in the bad state, r(N,B), as follows:

Definition 3. (i) If $\frac{1}{2}[r(M,B)+r(N,B)] \geq 1$, new sector loans are said to have *low downside.*
(ii) If $\frac{1}{2}[r(M,B)+r(N,B)] < 1$, and $\frac{1}{2}[r(M,G)+r(N,B)] \geq A' \equiv (1-\varphi_{BB})^{-1}\{1+\varphi_{BB}\cdot b-\frac{1}{2}\varphi_{BB}[r(M,B)+r(N,B)]\}$, new sector loans are said to have *moderate downside.*
(iii) If $\frac{1}{2}[r(M,B)+r(N,B)] < 1$, and $\frac{1}{2}[r(M,G)+r(N,B)] < A'$, new sector loans are said to have *high downside.*

Analogous to Definition 2, a diversified bank never fails if new sector loans have low downside, fails only when both sectors are in bad states if loans have moderate downside, and fails whenever the new sector is in a bad state if new sector loans have high downside. A' is the face value of a diversified bank's debt when new sector loans have moderate downside. Since $r(N,B) < r(M,B)$, it is immediate from Definition 2 that new sector loans always have weakly worse downside than home sector loans and that $A' > A$.

The analysis of the previous section suggests that the benefits of pure diversification are greatest when loans' downside is moderate. By extension, diversification into areas where monitoring is less effective should be most attractive when loans in the bank's home sector have moderate downside: such diversification may reduce the bank's probability of failure, possibly offsetting worse average performance on new sector loans. By contrast, if home sector loans have high downside, pure diversification is unattractive, and diversification into a new sector with even greater downside and worse average performance should be even less attractive. At the other extreme, if home sector loans have low downside, a specialized bank is safe, and diversification into new sectors can only worsen average performance and perhaps increase the bank's probability of failure. The following proposition shows that this intuition is correct.

Proposition 4.1 (New Sector Diversification When Monitoring Incentives Are Stronger.) Suppose that a bank has expertise only in Sector 1, and that $(1-q_G)\gamma L > c$. Then the bank always monitors all loans.
(i) Suppose Sector 1 loans have low downside. The bank prefers to specialize: a diversified bank has lower average loan returns and may have a higher probability of failure.
(ii) Suppose Sector 1 loans and Sector 2 loans *both* have moderate downside. The bank prefers to diversify if and only if $\frac{1}{2}(1-\bar{q})(1-\gamma)L < \varphi_{BG}\cdot b$. Otherwise, it prefers to specialize.
(iii) Suppose Sector 2 loans have high downside. The bank prefers to specialize: a diversified bank has lower average loan returns and fails with weakly higher probability.

Proof: see Appendix A.

When the bank's incentive to monitor loans is not in doubt, diversification reduces average loan returns: it does not affect the performance of home sector loans, and new sector loans perform worse than home sector loans. Thus, for diversification to be at all attractive, it must reduce the bank's probability of failure. This cannot occur if home sector loans have low downside (part (i) of the proposition), since a specialized bank never fails; indeed, since new sector loans have greater downside, the bank may fail more often if it diversifies (specifically, if new sector loans have moderate or high downside). Similarly, if new sector loans have high downside (part (iii)), a diversified bank fails whenever the new sector is in its bad state, so the bank's failure probability is *at least* $1-p$, the failure probability of a specialized bank. Since new sector loans have high downside whenever home sector loans do, the range where diversification is attractive is smaller now than in the case of pure diversification.

It is only when new sector loans have moderate downside that diversification has a chance of decreasing the bank's failure probability. Furthermore, if diversification is to be preferred, the reduction in expected costs of bank failure must outweigh the loss in average loan returns, which is the condition given in part (ii) of the proposition. This condition is less likely to hold either as sector correlation increases (reducing φ_{BG}) or as the effectiveness γ of monitoring new sector loans decreases.

Now suppose that $r(N,G) < r(U,G)$, so that monitoring new sector loans is not attractive if the new sector ends up in its good state. This may undermine the bank's incentive to monitor new sector loans. Nevertheless, the results of Proposition 4.1 are largely unchanged; indeed, if a diversified bank has sufficient incentive to monitor new sector loans, the results are completely unchanged. Even if new sector loans are not monitored, their average return is still lower and their downside is still higher than that of home sector loans, and it follows that diversification is still unattractive if home sector loans have either low or high downside. If home sector loans have moderate downside, and the downside of new sector loans is not too high, diversification may reduce the bank's failure probability by φ_{BG}; once more, if the bank is to prefer diversification, the gain from lower expected failure costs must outweigh the reduction in average loan return, which is now $\frac{1}{2}[(1-\bar{q})L-c]$.[15] Comparative statics are qualitatively unchanged.

Thus, when diversification requires expansion into a sector where the bank's monitoring is less effective (either through lack of expertise or environmental factors) but monitoring incentives are not in doubt, diversification is less attractive. Diversification must reduce the bank's average loan returns, so the only possible gain is a decrease in bank failure probability; because new sector loans have greater downside than home sector loans, it is less likely that diversification reduces the probability of bank failure, and more likely that it increases this probability. Indeed, diversification may increase the probability of failure even when a bank that specializes in home sector loans is failure-free. Higher correlation between sectors or lower monitoring effectiveness in the new sector increase the likelihood that diversification is unattractive.

[15] As shown in the next section, if home sector loans have moderate downside, a diversified bank monitors new sector loans if and only if $p[(1-q_G)\gamma L-c]+\varphi_{BG}[(1-q_B)\gamma L-c] \geq 2\varphi_{BG} \cdot \max\{A' - \frac{1}{2}[r(U,B)+r(M,G)], 0\}$, which is less likely to hold as sector correlation increases or monitoring efficiency decreases. If the bank does not monitor new sector loans, it prefers to diversify if and only if $\frac{1}{2}[(1-\bar{q})L-c] < \varphi_{BG}\cdot b$ and $\frac{1}{2}[r(M,G)+r(U,B)] \geq A'' \equiv (1-\varphi_{BB})^{-1}\{1+\varphi_{BB}\cdot b-\frac{1}{2}\varphi_{BB}[r(M,B)+r(U,B)]\}$; the second condition essentially requires that *unmonitored* loans in the new sector have moderate downside.

5. Diversification and Monitoring Incentives

I now turn to the case where $(1-q_G)L < c$, so that the benefit of monitoring in the good sector state is less than its cost, and a specialized bank may underinvest in monitoring. In choosing whether to diversify or specialize, a bank must now weigh the impact that diversification has on its monitoring incentives as well as on its failure probability. As I show, diversification may improve monitoring incentives, which produces two benefits: average loan returns increase, and monitoring reduces loans' downside, decreasing the bank's chance of failure. It follows that the range where diversification is preferred over specialization tends to increase when monitoring incentives are weaker. Nevertheless, it is still true that diversification tends to be unattractive when loans have either very low downside or high downside. Moreover, if the bank's diversification opportunity involves worse monitoring efficacy, it is possible that diversification can actually *impair* monitoring incentives in the bank's home sector.

I begin with the case of pure diversification, where the diversification opportunity involves no change in monitoring efficacy. In this setting, a diversified bank is more likely to monitor than a specialized bank: pure diversification increases the central tendency of the bank's loan return distribution, reducing the bank's risk-shifting gains by switching from monitoring to not monitoring, and thus making monitoring more "incentive compatible." (This result is weakened if some costs of monitoring are nonpecuniary – see Remark 3 below.) Because an increase in sector correlation lessens this increase in central tendency, it reduces the gain in monitoring incentives. Also, as loan downside increases and the bank faces more risk of failure even if it monitors, stronger conditions are needed to give the bank an incentive to monitor: increased risk of failure means that the bank captures less of the benefit of monitoring, which only accrues in bad sector states. These results can be seen in the next proposition.

Proposition 5.1 (Pure Diversification When Monitoring Incentives Are Weak). Suppose that $(1-q_G)L < c$.
(i) If monitored loans have low downside (as per Definition 2), and $(1-\bar{q})L-c \geq (1-p)\cdot[1-r(U,B)] - h$ (where $h \geq 0$ is defined in Appendix A), a diversified bank monitors all loans and never fails ($D^d = 1$). This condition is less likely to hold as sector correlation increases. If $(1-\bar{q})L-c \geq (1-p)\cdot[1-r(U,B)]$, the bank is indifferent between specializing and diversifying. Otherwise, the bank prefers to diversify.
(ii) If monitored loans have moderate downside and $p[(1-q_G)L-c]+\varphi_{BG}[(1-q_B)L-c] \geq 2\varphi_{BG}\cdot\max\{A - ½[r(U,B)+r(M,G)], 0\}$, a diversified bank monitors all loans and fails with probability φ_{BB} ($D^d = A$). The bank prefers to diversify. This condition is less likely to hold as sector correlation increases; also, a diversified bank will *not* monitor all loans if $p/(p+\varphi_{BG}) > \hat{p} \equiv (1-q_B-c/L)/(q_G-q_B) \in (p,1)$.
(iii) If monitored loans have either low or moderate downside, but (i) and (ii) do not hold, a diversified bank will *not* monitor all loans. A diversified bank may monitor loans in one sector, in which case it fails with probability $1-p$; if so, the bank prefers to diversify. A diversified bank monitors *no* loans if $\varphi_{GG}/p > \hat{p}$, which is more likely as sector correlation increases.
(iv) If monitored loans have high downside, a diversified bank monitors *no* loans. The bank prefers to specialize unless $\bar{q}R < 1+(1-p)b$, in which case banking is infeasible.

Proof: see Appendix A.

In part (i), monitored loans have low downside, and a bank that monitors never fails. The only question is whether the overall gains from monitoring, $(1-\bar{q})L-c$, exceed the gains from risk-shifting (the right-hand side of the condition). This condition is less stringent than that faced by a specialized bank (see Proposition 2.2(ii)). Thus, if loans have somewhat low downside, the bank may prefer diversification as a means of committing to monitor: a specialized bank would not monitor and would fail when its sector was in the bad state, while the diversified bank monitors all loans and never fails.

In part (ii), monitored loans have moderate downside, so even if it monitors all loans, the bank fails when both sectors are in bad states. In choosing whether to monitor, the bank knows that its expected benefit from monitoring is less than $(1-\bar{q})L-c$ because it is more likely to survive when sectors are in good states and monitoring is (ex post) unattractive. Again, this expected benefit must exceed potential gains from risk-shifting by monitoring fewer loans. If this condition is met, diversification has two benefits: the bank monitors where a specialized bank does not, and its probability of failure falls from $1-p$ to φ_{BB}.

In the final condition in part (ii), $\hat{p}$ is the probability of the good sector state for which expected gains to monitoring $\hat{p}[(1-q_G)L-c]+(1-\hat{p})[(1-q_B)L-c]$ are zero. If the probability of good sector states conditional on the bank not failing exceeds $\hat{p}$, the bank's ex post benefit from monitoring both sectors (after investors have set the debt's face value at A) is negative, so monitoring all loans is not an equilibrium outcome.

Part (iii) of the proposition shows that, even if a diversified bank does not have incentive to monitor all of its loans, it is possible that it monitors loans in just one sector. As shown in Appendix A, this requires that the bank fails whenever the unmonitored sector is in its bad state and survives whenever the unmonitored sector is in its good state; if not, either gains to monitoring are so high that the bank monitors both sectors, or else risk-shifting is so attractive that the bank does not monitor at all. In this case, a diversified bank fails just as often as a specialized bank, but since a diversified bank monitors some loans and a specialized bank does not, the bank prefers to diversify. Once more, if the probability of good sector states conditional on the bank not failing (now φ_{GG}/p) exceeds $\hat{p}$, even such limited monitoring is not incentive compatible.[16]

Finally, in part (iv), loans have high downside. Even if it monitors all loans, a diversified bank fails unless both sectors are in their good states, which is when monitoring is most unattractive. The same is true if the bank monitors only one sector. Thus, the bank will not monitor any loans in equilibrium. Since in this case a diversified bank fails more often than a specialized bank (probability $1-\varphi_{BG}$ versus $1-p$), and neither strategy leads to monitoring, the bank is better off specializing.

Clearly, the comparative statics on the boundaries of the three regions of loan downside (low, moderate, and high) are unchanged from Corollary 3.2. Results on monitoring incentives are somewhat more

[16] If a diversified bank does not monitor any loans, diversification may increase the bank's failure probability; even though monitored loans have low or moderate downside, *unmonitored* loans have high downside if $\frac{1}{2}[r(U,B)+r(U,G)] < (1-\varphi_{BB})^{-1}\{1-\varphi_{BB}\cdot[r(U,B)-b]\}$. In this case, the bank prefers to specialize.

complex. As already noted, increased correlation between sectors lessens any gain in monitoring incentives from diversification. If the sector risk of loans undergoes a mean-preserving spread, monitoring incentives worsen: higher loan quality in good states makes monitoring even more unattractive in those states, while lower quality in bad states increases losses to debtholders, making risk-shifting by not monitoring more attractive. Increases in the loan rate R and recoveries from monitored loans L reduce risk-shifting incentives, and increases in L also increase the benefits of monitoring.

As in Corollary 3.2, these changes may or may not make diversification more attractive. If monitored loans start with low downside, a mean-preserving increase in sector risk can cause incentive problems for specialized banks which diversification can still overcome; conversely, if loans start with moderate downside, such an increase in risk may destroy incentive gains from diversification. Similarly, if loans have low downside, increases in R or L can lessen incentive problems for a specialized bank to the point where diversification adds little value, while the opposite may be true when loans have moderate downside.

Figure 2 illustrates some of these results: it shows the impact of diversification on monitoring as a function of the stated rate R on loans and the degree of sectoral risk (again measured by $q_G - q_B$, holding average loan quality $\bar{q}$ constant). All other parameter values are as in the previous numerical example, except that the cost of monitoring has been increased from .005 to .011; this increase makes monitoring unattractive in the good sector state, so that monitoring incentives are an issue. For this example, a diversified bank either monitors both sectors or none; the case where only one sector is monitored does not occur.

Remark 3: Nonpecuniary costs and monitoring incentives. As noted in Remark 1, underinvestment in monitoring increases if some monitoring costs are nonpecuniary and thus are *not* passed through to debtholders when the bank fails. If all monitoring costs take this form, $(1-q_G)L > c$ is no longer sufficient for the bank to monitor: the bank bears monitoring costs in all states, but only recoups these costs when it does not fail. A specialized bank always monitors if $p(1-q_G)L > c$, since the good sector state alone provides enough returns to justify monitoring; similarly, a diversified bank always monitors if $\varphi_{GG}(1-q_G)L > c$. Since $p > \varphi_{GG}$, it is now possible that a specialized bank that fails in the bad sector state would monitor while a diversified bank would not. (Proof available on request.)

Now suppose as in Section 4 that the bank has expertise in Sector 1, its home sector, but not in Sector 2, the new sector. Since $(1-q_G)\gamma L < (1-q_G)L < c$, monitoring incentives are an issue for new sector loans as well as home sector loans. Indeed, it is possible that the overall gain to monitoring new sector loans is negative, in which case they are not monitored, and any occurrence of strategy "N" (monitoring new sector loans) in what follows would be replaced by "U" (do not monitor).[17] Since this would not alter my qualitative results, I focus on the case where it is *possible* that the bank may monitor loans in its new sector:

Assumption 2 (Value of Monitoring When the Bank Lacks Expertise). $(1-\bar{q})\gamma L \geq c$; i.e., even if the bank lacks expertise in a sector, unmonitored loans do not produce higher overall net returns than monitored loans.

An immediate consequence of Assumption 2 is that $(1-q_B)\gamma L > c$, so that $r(N,B) > r(U,B)$; i.e., new sector loans have less downside if they are monitored than if they are not monitored.[18]

Proposition 5.2 below gives detailed results on the choice between specialization and diversification in this setting. Although the details are lengthy, the intuition largely combines the gist of Proposition 4.1 (diversification into a new sector) with that of Proposition 5.1 (pure diversification when monitoring incentives are weaker).

Proposition 5.2 (New Sector Diversification When Monitoring Incentives Are Weaker.) Suppose that a bank has expertise only in Sector 1, and that $(1-q_G)L < c$.
(i) If Sector 1 loans have low downside and $(1-\bar{q})L-c \geq (1-p)\cdot[1-r(U,B)]$, the bank prefers to specialize: diversification reduces average loan returns, may increase the bank's failure probability, and may destroy the bank's incentive to monitor Sector 1 loans. Negative effects are more likely as sector correlation increases or as monitoring effectiveness γ decreases.
(ii) If Sector 2 loans have low downside but $(1-\bar{q})L-c < (1-p)\cdot[1-r(U,B)]$ and $(1-\bar{q})\gamma L-c \geq (1-p)\cdot[1-r(U,B)]-h'$ (where $h' \geq 0$ is given in Appendix A), a diversified bank monitors all loans and never fails. The bank prefers to diversify. This case is less likely as sector correlation increases or as γ decreases.
(iii) If Sector 2 loans have moderate downside, (i) does not hold, and $p[(1-q_G)\gamma L-c]+\varphi_{BG}[(1-q_B)\gamma L-c] \geq 2\varphi_{BG}\cdot\max\{A' - ½[r(U,B)+r(M,G)], 0\}$, a diversified bank monitors all loans and fails with probability φ_{BB}. The bank prefers to diversify. This condition is less likely to hold as sector correlation increases or as γ decreases. A diversified bank will *not* monitor all loans if $p/(p+\varphi_{BG}) > \tilde{p} \equiv [1-q_B-c/(\gamma L)]/(q_G-q_B) \in (p,\hat{p})$.
(iv) If (i) does not hold, and either (a) Sector 2 loans have low or moderate downside, but conditions (ii-iii) do not hold, or (b) Sector 2 loans have high downside but Sector 1 loans do not, then a diversified bank will not monitor all loans. It may monitor Sector 1 loans, in which case it fails with probability $1-p$; if so, the bank prefers to diversify. A diversified bank monitors *no* loans if $\varphi_{GG}/p > \hat{p}$, which is more likely as sector correlation increases.
(v) Suppose Sector 1 loans have high downside. Then a diversified bank monitors *no* loans, and the bank prefers to specialize unless $\bar{q}R < 1+(1-p)b$, in which case banking is infeasible.

Proof: see Appendix A.

Intuitively, if home sector loans have sufficiently low downside, (part (i) of the proposition), a

[17] Intuitively, monitoring new sector loans hurts average returns and reduces loans' upside potential (since $r(N,G) < r(U,G)$), so not monitoring always increases bank profits; the proof is available on request.

[18] Also, Assumption 1 implies that $r(U,G) > r(M,G) > r(N,G)$, $r(M,B) > \max\{r(N,B), r(U,B)\}$, and $½[r(M,B)+r(N,G)] > ½[r(M,G)+r(N,B)]$.

specialized bank monitors its loans and never fails. Here, diversification can only be harmful: if new sector monitoring effectiveness γ is low, a diversified bank may fail more often; if sector correlation is high or monitoring effectiveness is low, a diversified bank may not monitor either sector.

In parts (ii) and (iii), the risk of new sector loans (and thus of home sector loans) is low or moderate, but home sector loans are risky enough that a specialized bank does not monitor and so fails with probability $1-p$. If sector correlation is not too high and monitoring effectiveness is not too low, a diversified bank may monitor all of its loans, in which case the bank prefers to diversify: diversification improves average loan returns and reduces the chance of bank failure to either zero or φ_{BB}. In both (ii) and (iii), the requirements for monitoring all loans are stronger than those in the case of pure diversification with low or moderate downside (Proposition 5.1(i) and (ii), respectively): gains from monitoring all loans are lower, and potential gains from risk-shifting are higher.

In part (iv) of the proposition, a diversified bank does not monitor all loans, but it is still possible that a diversified bank monitors only home sector loans even though a specialized bank does not, in which case the bank prefers to diversify. The intuition and requirements are similar to those of Proposition 5.1(iii).

Finally, if home sector loans have high downside (part (v) of the proposition), no monitoring occurs, and the bank prefers to specialize. The intuition is identical to that of Proposition 5.1(iv): diversification only increases the bank's chance of failure.

In comparison with diversification into a new sector when monitoring incentives are not in doubt (Proposition 4.1), the range where diversification is attractive is expanded: because diversification can improve monitoring incentives, there are cases where diversification is attractive even though home sector loans have low downside, or new sector loans have high downside – neither of which is true when monitoring incentives are stronger. Still, compared with the case of pure diversification (Proposition 5.1), diversification into a new sector is less likely to be attractive. Furthermore, diversification can *harm* monitoring incentives if the home sector's loans have low downside.

With regard to comparative statics, a decrease in the effectiveness of monitoring new sector loans makes diversification less attractive: the bank is more likely to experience an increase in failure probability from diversification, less likely to monitor new sector loans, and less likely to monitor loans. Increases in sector correlation also make diversification less attractive: any decrease in failure probability is lessened, and monitoring incentives are less likely to improve.

6. Extensions: Bank Capital, Competition, and Unobservable Loan Allocations

Thus far, I have used a number of simplifying assumptions: the bank finances itself entirely with debt; the bank's loan terms are exogenously given, ignoring competitive considerations; the bank's allocation of loans across sectors is fully observable. In this section, I analyze the effects of relaxing these assumptions.

A. Bank Equity Capital

Although banks do use debt for much of their financing, they also have equity capital, which serves as a buffer to absorb losses and reduce the probability of financial distress. In addition, by reducing possible shortfalls on payments to debtholders, equity capital reduces the bank's incentive to engage in risk-shifting by not monitoring. Nevertheless, despite equity's virtues, banks and other lending institutions greatly favor debt (deposits, commercial paper, medium-term notes, etc.) in their financing mix; equity is costly. Sources of this cost include tax shield advantages of debt (Orgler and Taggart, 1983), agency problems between bank managers and outside shareholders (Besanko and Kanatas, 1996), and information asymmetries that make equity especially difficult to issue and costly to hold (Bolton and Freixas, 1996, Gorton and Winton, 1998). As a result, when financing themselves, banks trade off the costs of debt against the costs of increasing the amount of equity in their capital structure.

In my model, any cost of capital guarantees that, all else equal, the bank prefers less capital to more. Thus, even if the bank can raise enough capital to rule out failure and ensure that its incentive to monitor is positive, it will prefer diversification strategies that can achieve these ends with less capital. The bank may even prefer some risk of failure if the amount of capital needed to prevent failure is sufficiently great.

Let k indicate the fraction of bank financing that takes the form of equity capital; then the bank must issue debt with face value D such that expected payments on debt equal $1-k+b\cdot\Pr(\text{failure})$. The three critical cases from Definition 2 still occur, but now depend on k: low downside risk corresponds to $r(M,B) \geq 1-k$, moderate downside risk to $r(M,B) < 1-k$ and $\frac{1}{2}[r(M,B)+r(M,G)] \geq A-k(1-\varphi_{BB})^{-1}$, and high downside risk to $r(M,B) < 1-k$ and $\frac{1}{2}[r(M,B)+r(M,G)] < A-k(1-\varphi_{BB})^{-1}$. Conditions for the bank to monitor when monitoring incentives are weaker (i.e.,$(1-q_G)L-c < 0$) are affected in similar fashion; for example, the condition from Proposition 2.2(ii) guaranteeing that a specialized bank monitors is now $(1-\bar{q})L-c \geq (1-p)\cdot[1-k-r(U,B)]$. Thus, increasing k has effects similar to decreasing the downside risk of loans: it reduces the bank's probability of failure and alleviates any underinvestment problem.

The common view is that diversified banks need less capital than specialized banks because, all else equal, diversified banks have lower failure probabilities and better monitoring incentives. The analysis from the preceding two sections shows that this is too simple a view. First, consider the case of pure diversification (no decrease in monitoring ability). Suppose that loans' downside risk is low, so that either r(M,B) exceeds 1 or else the cost of raising $1-r(M,B)$ of equity capital is relatively small. In this case, both specialized and diversified banks can achieve freedom from failure with the same amount of capital; however, if monitoring incentives are weaker, a specialized bank may require somewhat more capital than a diversified bank to maintain its monitoring incentives. Thus, if capital is relatively inexpensive and loan risk is sufficiently low, the capital advantage of diversified banks is relatively small.

Suppose instead capital is more expensive and loans' downside risk is somewhat higher, so that

$1-r(M,B)$ of equity capital is significantly expensive to raise, but $\frac{1}{2}[r(M,B)+r(M,G)]$ still exceeds A. A diversified bank that does not raise capital fails less often than a specialized bank and may have better monitoring incentives. In this case, the specialized bank does have a greater need for capital, especially when monitoring incentives are an issue; the common wisdom is correct.

Finally, if loans' downside risk is higher still, a diversified bank without capital fails more often than a specialized bank. In this case, the diversified bank gains more from additional capital than does the specialized bank; $(1-\varphi_{BB})\{A-\frac{1}{2}[r(M,B)+r(M,G)]\}$ of equity capital reduces the diversified bank's chance of failure by $2\varphi_{BG}$, but does not help the specialized bank; $1-r(M,B)$ of equity capital reduces the diversified bank's failure probability by $1-\varphi_{GG}$ and only reduces the specialized bank's failure probability by $1-p$.[19]

The bottom line is that, even with pure diversification, the marginal value of capital depends on the relative downside risk of loans. The same reasoning can be applied to the case where banks start with a certain amount of capital k_0 and then face an increase in loan risk; while diversified banks may have less need to raise additional capital than specialized banks, matters can go the other way. I will return to this issue in Section 7 when I discuss applications of the model.

Now consider the case where diversification forces the bank to move into a sector where its monitoring is less effective. From Sections 4 and 5, in the absence of equity capital, such diversification is more likely to have harmful effects, and these harmful effects are most likely to win out when the downside risk of home sector loans is either low or high. It follows that it is more likely that a diversified bank benefits more from additional capital than a specialized bank, particularly if the downside risk of home sector loans is either low or high. Low monitoring effectiveness in the new sector, stronger monitoring incentives in the home sector, and high sector correlation all have similar effect. Conversely, a diversified bank is most likely to require less capital if the downside risk of home sector loans is moderate, sector correlation is low, and monitoring incentives for home sector loans are weaker. Similar results apply if the bank begins with a certain amount of capital k_0.

B. Competitive Considerations

Although I have taken the bank's lending terms as exogenous, these terms are clearly influenced by the bank's competitive environment. To discuss this, consider the following simple model of borrower-lender interaction. Suppose that borrowers have projects whose returns per dollar borrowed are either X with probability q_s, or zero with probability $1-q_s$, where again s refers to the state of the borrower's sector. In addition, the project itself is an asset that can be liquidated at some interim date for an amount $K < 1$, but depreciates to zero value at the end of the period. The borrower has some nontransferable benefit of control that is lost if the project is liquidated, so that, ex post, the borrower will not liquidate unless forced to do so.

[19] If $1-r(M,B) < (1-\varphi_{BB})\{A-\frac{1}{2}[r(M,B)+r(M,G)]\}$, then only the second statement applies.

A bank loan contract with face value $R \leq X$ and collateral requirement $L \leq K$ gives the bank the right to collect R or liquidate and collect L otherwise. Given the borrower's preference for continuation, the bank must force liquidation before the end of the period, when the collateral is worthless. This in turn requires that the bank must monitor so that it gets notice of the borrower's situation before the end of the period.

If the bank faces no competition at all, it can increase R up to X and demand full collateral K, giving it expected revenue of $\bar{q}X+(1-\bar{q})K-c$ if it monitors and $\bar{q}X$ otherwise. Conversely, if competition is fierce and all banks are expected to monitor, then R and L are chosen such that $\bar{q}R+(1-\bar{q})L-c = 1$ + (expected failure costs and costs of capital).

What does competition do to the bank's incentive to diversify? To the extent that R and L fall, the analysis of Corollary 3.2 applies. If loans begin with low downside, lower R and L make it more likely that loan downside becomes moderate and diversification becomes more attractive. If loans begin with moderate downside, it is more likely that loan downside becomes high and diversification becomes unattractive.[20]

This discussion assumes that all banks are identical. If banks differ in their monitoring ability, there are two complicating effects. First, to the extent borrowers want ex ante to commit to efficient liquidation (even though ex post they would like to renege), they will prefer banks that are more effective monitors. Thus, to get business, a bank that is relatively ineffective must offer borrowers lower *expected* payments. Second, if borrowers vary, a bank that is a relatively ineffective may get a worse mix of borrowers through adverse selection. For example, in the screening version of the model, more risky borrowers are more likely to come to a less effective bank because they are less likely to be discovered. In the monitoring version, borrowers with greater preference for continuation will prefer the less effective bank; such borrowers may prefer a higher rate R in return for lower collateral requirements L, worsening the spread between the bank's returns in good and bad states. Both effects increase the downside of the bank's loans, increasing its probability of failure and possibly worsening its monitoring incentives.

One immediate consequence is that expansion into an unfamiliar sector is even less attractive if that sector is already served by experienced incumbent banks. As noted in the introduction, several recent papers have investigated how the entry barrier raised by local knowledge and relationships affects lending market structure when banks screen potential borrowers. In the context of the current paper, the local banks' information advantage worsens the quality of the expanding bank's new sector loans; by Proposition 4.1, this in turn increases the expanding bank's risk of failure and diminishes its monitoring incentives.[21]

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[20] A decrease in L lowers monitoring incentives, which may make diversification more attractive. This assumes collateral loses much of its value if the bank does not monitor and seize it in timely fashion. Otherwise, too much collateral can actually undermine monitoring incentives; see Rajan and Winton (1995).

[21]Conversely, if faced with increased competition from diversified banks, a bank may gain by focusing on a single sector and building specialized lending expertise that outstrips that of less-focused

On the other hand, if a bank is able to acquire expertise in a new sector at relatively low cost – perhaps through acquisition – this might increase its monitoring incentives and reduce its risk of failure, giving it advantages over less diversified rivals. This is most likely if loans have moderate downside, so that diversification's effect is likely to be positive and specialized rivals are faced with weak monitoring incentives or relatively high levels of costly capital. If loan downside is too high, diversification is less likely to improve monitoring incentives or reduce the bank's risk of failure, and any additional reduction in performance from the possible diseconomies of scale mentioned in Section 2 only worsens matters.

Finally, my paper focuses on a single-period setting. Clearly, a bank can acquire expertise in new sectors over time, albeit at the cost of making mistakes along the way. Nevertheless, if the short-run impact of diversification is likely to be negative, then even if it believes that long-run benefits outweigh short-run costs, a bank moving into new sectors should temporarily boost capital to cope with increased risk.

C. Unobservable Loan Allocations

Although I have assumed that investors can freely observe the bank's loan allocation when pricing the bank's debt accordingly, this is clearly a simplification. The portfolios of smaller institutions or banks in emerging markets may be especially difficult to observe. On the other hand, such institutions tend to make loans in their own back yard, so the general types of borrowers may be known even if precise details are not; this again suggests that loan quality (monitoring) is less observable than general sector allocations.

To the extent that sector allocations are known only imprecisely at any given time, it is well-known that banks may have incentive to engage in risk-shifting by concentrating their loan portfolios and that they may be less likely to do this if future rents ("charter value") are jeopardized by bank failure (see Marcus, 1984, and Besanko and Thakor, 1993). Nevertheless, my model suggests additional complications, both because diversification may affect monitoring incentives and thus bank performance, and because I emphasize that diversification does not always increase the probability of costly bank failure.

Suppose the bank is considering pure diversification. If the bank's loan allocation is completely unobservable and no future rents are at stake, it never diversifies: if investors thought it would diversify, it could always specialize, inducing a mean-preserving spread in its loan portfolio returns and creating risk-shifting gains. By extension, if loan allocations are partially observable, a decrease in observability makes specialization relatively more attractive. This effect is less pronounced if bank monitoring incentives are weaker, since diversification (to the extent it *is* observable) increases monitoring incentives, lowering the face value of the bank's debt and reducing risk-shifting incentives. If future rents are at stake, and loans have moderate downside, higher future rents make diversification more attractive; however, if loans have high downside, a specialized strategy reduces the bank's probability of failure, and higher future rents make

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rivals. See Boot and Thakor (1998).

specialization *more* attractive.

When diversification involves moving into sectors where the bank lacks expertise, matters are more complicated: now, moving into a new sector may itself be a form of risk-shifting, particularly if the downside of monitored home sector loans is low and monitoring effectiveness in the new sector is poor. In this case, a bank that is expected to specialize and exploit its monitoring expertise may instead be tempted to diversify and spend relatively little effort monitoring its loans.

More generally, although earlier research has often focused on under-diversification as a means of risk-shifting in banking, risk-shifting involves actions that are difficult for investors (and regulators) to observe and control in a timely fashion. Major loan portfolio concentrations are likely to be more easily observed in timely fashion than is the effort put into screening and monitoring loans. Thus, risk-shifting in lending is harder to control if it takes the form of making bad loans or letting deteriorating loans continue, and this type of risk-shifting can be associated with diversification as well as with lack of diversification.

7. Applications

I have argued that, in contrast to the common view, diversification is not always the best strategy for banks and other lending intermediaries: while diversification may reduce failure probability and increase monitoring incentives, there are circumstances where one or both of these results are reversed. In this section, I apply these results to a number of real examples of intermediary behavior.

Diversification, failure probability, and equity capital: money center banks in the 1980s. During the 1970s and early 1980s, U.S. money center banks were generally more diversified than U.S. regional banks, lending to a wide variety of firms and institutions both nationally and internationally whereas the regionals tended to focus more on the geographic regions in which they were headquartered. Consistent with common wisdom, money center banks operated with lower capital levels during this period. In the late 1970s and early 1980s loan risk increased as price levels became more volatile and competition among banks eroded their margins. Although banks specializing in the energy sector were hit particularly hard, throughout most of the 1980s money center banks performed worse on average than did regional banks (see Boyd and Graham, 1991), facing continued weakness in LDC loans which in turn led to increased financial difficulties.

Even if both money center and regional banks were adequately capitalized in the mid 1970s, an increase in loans' downside risk later in the decade may have resulted in a situation where a downturn in even one sector (such as LDC loans) was sufficient to cause difficulties for a diversified bank – the situation of Proposition 3.1(iii).[22] If so, the money centers would have had the most to gain from additional capital;

[22] Again, this is not to say that regional banks whose regions were hit by downturns had no problems; consider the failures of most major commercial banks in Texas in the 1980s and of Bank of New England in 1991. The point is that regional banks were only exposed to downturns in their respective regions, whereas

but of course, given the combination of flat-rate deposit insurance and limited capital adequacy guidelines in force at the time, the banks did not voluntarily increase capital. The result was that a number of money-center banks were hobbled by the LDC crisis for much of the 1980s. Indeed, it is likely that some (such as Bank of America or Citicorp) would have failed if the government's safety net (deposit insurance and the "too-big-to-fail" policy of the 1980s) had not been in place.

Impact of reduced monitoring costs on diversification incentives: securitization. Improved monitoring incentives are one *potential* gain from diversification, but all else equal, lower monitoring costs decrease the extent of the underinvestment problem. Thus, if technological improvements have lowered costs of screening and monitoring borrowers, gains from diversification are less than before. This may help account for the growth of securitization, where a bank or other lending institution spins off related loans into a separate "special purpose vehicle" (SPV) which issues debt backed by the loans.[23] By doing this, the bank gives up the financing benefit of diversification across multiple sectors: debt issued by the SPV does not have a claim on the bank's total loan portfolio.

My model suggests that an undiversified strategy is most attractive for loans with either limited risk (low downside) or severe cyclicality (high downside), and for loans where monitoring costs are relatively low. This is consistent with some of the most active areas of securitization. Loans to individuals can be dealt with through credit scoring (which requires large homogeneous samples), whereas loans to businesses require more costly individual analysis; not surprisingly, loans to individuals have been securitized in far greater volumes than have loans to businesses. Also, the business loans that have been securitized tend to be high-grade credits that have low default risk even in recessions. Of course, my model is not the only explanation for the growth of securitization, which has undoubtedly been influenced by reduced information costs for *investors* and by bank regulatory capital requirements that unfairly penalize some classes of loans.

Failure to diversify and underinvestment in monitoring: Continental Illinois. Proposition 2.2 suggests that an undiversified bank does not monitor its loans when two conditions are met: first, monitoring does not pay in good sector states, so that $(1-q_G)L$ is less than the cost of monitoring c; second, risk-shifting gains are high, so that $r(M,B) < 1-[p/(1-p)][(1-q_G)L-c]$, which is more likely as p increases. Thus, my model predicts that monitoring is most problematic for undiversified institutions whose loans are believed to be quite safe in good times (q_G high) and for which bad times are believed to be remote (p high). Continental Illinois may be a case in point.

As noted in the introduction, Continental Illinois is often viewed as an example of how lack of

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diversified banks faced dangerous shocks from multiple sectors.

[23] The bank typically holds an equity claim (the so-called "residual") on the SPV and may inject some actual equity capital to reduce debtholders' risk of losses.

diversification leads to excessive exposure; however, on closer examination, the problem seems to have been poor monitoring as much as exposure to sectoral shocks. As shown by Herring (199?), a fifth of Continental's loans were concentrated in the energy sector, which certainly hurt when oil prices plummeted in the early 1980s. Nevertheless, it was the billion dollars of energy loans purchased from Penn Square Bank that produced the largest losses: roughly 50% during 1982-1984, as opposed to 6% for the other energy loans during the same period. As is well-known, these loans were overseen by an officer later found to be taking large subsidized personal loans from Penn Square. More generally, the Office of the Comptroller of the Currency found evidence of lax credit standards in Continental's commercial loan operation over a period of several years. In the late 1970s and early 1980s, Continental's loan growth rate was significantly higher and its capital/assets ratio significantly lower than that of the average money center bank; both would suggest a process of risk-shifting that was as much due to poor credit controls as to loan concentration per se.[24]

Continental's lax standards were undoubtedly fueled by the belief (widespread in the late 1970s) that energy prices were extremely likely to stay high, making default remote; in terms of the model, p was high. Furthermore, as long as energy prices stayed high, energy-producing firms were thought to have little risk; $1-q_G$ was low. These are precisely the circumstances in which my model predicts that monitoring incentives are most harmed by lack of diversification.

Specialization and improved performance. My model suggests that specialization can result in superior performance when underinvestment in monitoring is not a problem – i.e., when $(1-q_G)L$ exceeds c – and when lack of experience in a sector results in significantly worse performance (γ is low). Recent experiences in credit card lending illustrate this situation.

For credit cards, the screening interpretation of the model is most relevant, since recoveries on defaulting accounts are problematic at best; indeed, the industry focuses largely on computerized scoring models, as already noted, so that c is relatively low. Even in good times, credit card defaults are significantly higher than those on other consumer loans; in terms of the model, $1-q_G$ is relatively high for credit card loans. Thus, for skilled institutions, underinvestment need not be a problem.

In the 1990s, increased competition for credit card accounts led to a number of changes. Consumers became more sophisticated in "card-hopping" to take advantage of ever-more prevalent "teaser" rates (introductory low-rate offers good for a limited time), annual fees were much reduced, and more customers were already heavily-indebted, increasing both the chance and magnitude of potential defaults. Thus, average rates and fees decreased, decreasing lending returns, and the penalty for not using sophisticated, rapidly-updated scoring models increased. In terms of the model, r(U,B) and r(M,B) fell, as did γ. The model predicts

[24] Indeed, despite its rapid loan growth and low capital levels, Continental maintained investor confidence until 1982 because investors believed that the bank's specialization in energy made it better at picking out good energy loans from bad – a confidence that was admittedly misplaced. See Herring (199_).

that these changes should favor specialized institutions, whereas diversified institutions relying on "standard" scoring models should be more likely to suffer from poor performance and reduced monitoring incentives.

This is precisely what happened in the mid 1990s. After a rapid increase in lending volumes, defaults rose rapidly in 1996-1997. Nevertheless, the institutions that were hit hardest tended to be the ones for which credit cards had been a profitable sideline. By contrast, despite having grown more rapidly than the industry average, the specialized credit card issuers First USA, CapitalOne, and MBNA continued to have above-average credit performance due to superior credit scoring techniques (Hansell, 1997a,b).[25] Similarly, Citicorp, the largest issuer, also had above-average credit-card loan performance in 1996-1997, in marked contrast with its experience in the early 1990s when it followed a more-diversified strategy (see below).

Diversification into new areas and poor performance: Citicorp and the S&L industry. As mentioned in the introduction, during the 1980s and early 1990s, many well-known institutions diversified into new areas with disastrous results. Citicorp is a prime example. During the 1980s, it viewed its diversification as a strategic asset, arguing that this should greatly substitute for equity capital, yet the result of its rapid expansion was severe losses not only in its LDC loans but also in its U.S. commercial and residential real estate loans, credit card loans, and loans for "highly leveraged transactions" (leveraged buyouts). Subsequent accounts suggest that both lack of internal controls and lack of understanding of new market conditions go a long way toward explaining these losses. By late 1990, the situation was quite severe, but Citicorp survived, no doubt in part because of the government safety net already mentioned.

Once the U.S. recession of the early 1990s ended, Citicorp refocused its efforts on a few key areas: credit cards, loans to high net worth individuals, and loans to multinational corporations. Indeed, its skills in credit cards led to below average losses in 1996, when most U.S. issuers were experiencing high losses. In addition, by emphasizing credit card loans to high net worth individuals in emerging economies and exploiting superior credit scoring skills and systems technology, Citicorp was able to overcome the usual problems caused by entering new markets in the face of established lenders; few domestic banks could match Citicorp's expertise in evaluating and servicing large numbers of credit card customers. One could even argue that the emerging economies were a more favorable environment for Citicorp's credit card loans than the U.S., where it faced relatively stiff competition.[26]

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[25] The only "monoline" (specialized) credit-card issuer that experienced difficulty was Advanta, the smallest of the group, whose chargeoffs peaked at an annualized rate of 6.6% of receivables in the first quarter of 1997. Business press articles suggest that Advanta had suffered from outdated credit scoring models that did not capture increased "winner's curse" problems in the credit card market caused by increased competition. See Advanta's Annual Reports for 1994-1996, Advanta's Quarterly Releases for 1996 and 1997, and Hansell (1995, 1997a).

[26] See "Low-Doc Loans Low in Popularity" (United States Banker, January 1991), Hansell (1994), and Citicorp's Annual Reports, 1989-1996.

The S&L crisis of the 1980s provides another example of the risks of diversifying into new areas. As is well-known, the S&Ls' low net worth positions led them to take advantage of Federal deposit insurance by engaging in risky lending. Their risky loans were in large part a diversification from their traditional base of home mortgage loans into loans backed by commercial real estate – an area in which they lacked expertise (see Brewer and Mondschean, 1992). Indeed, the S&Ls' newfound ability to make such loans was made possible by a Congress anxious to let them diversify the credit and interest rate risks they faced from their traditional mortgage lending; however, any reduction in risk from the move into a somewhat different sector was more than offset by poor monitoring.

8. Policy Implications and Conclusions

Do my results suggest a role for regulators? Even if banks maximize shareholder value, which in turn incorporates expected benefits from monitoring and expected costs of bank failure, bank incentives to monitor and to diversify are affected by competitive conditions, which regulators can influence. Also, social costs of bank failure may be higher than those borne by investors alone, and social costs of bank capital are likely to be less than the private cost to bank shareholders (see Gorton and Winton, 1998), so in a richer model even value-maximizing banks may not choose socially optimal outcomes. Finally, bank managers may prefer diversification for its own sake as a form of empire-building.

Given these potential imperfections, my paper suggests that regulators must be careful in endorsing diversification across multiple sectors or regions as a goal for banks and related intermediaries. Although such diversification may reduce the odds of bank failure and improve bank performance by enhancing monitoring incentives, these beneficial effects of diversification are most likely for loans with moderate downside risk: when loans have limited downside, diversification adds little; if loans have high downside, diversification may actually increase the odds of bank failure. Furthermore, if diversification involves expansion into sectors where the bank is lacking in expertise, then the relatively worse performance the bank faces in these new sectors can increase its overall chance of failure and weaken monitoring incentives throughout the institution; again, this is most likely when loans in the bank's home sector have either low or high downside. Finally, while increased competition among banks can make diversification more attractive, it can also have the opposite effect.

In terms of capital regulation, although diversified banks may often need less capital than specialized banks, a general increase in the downside risk of loans can result in more diversified banks actually needing additional capital more than do less diversified banks. Similarly, a bank that diversifies into new areas may need more capital than a bank that focuses on sectors in which it already has significant credit expertise.

Finally, a more general point of this paper is that for institutions that act as delegated monitors of borrowers, credit risk is fundamentally endogenous; it is greatly affected by the bank's expertise and investment in loan screening and monitoring. This suggests that quantitative models such as CreditMetrics or CreditRisk$^+$ that take credit risk as exogenous should be used with caution: regulators must bear in mind that a bank's internal monitoring and evaluation systems are at least as important as these measures of portfolio risk. Also, although much of the literature on bank risk-shifting as a response to governmental safety nets assumes that this behavior takes the form of lack of diversification across sectors, this too may be somewhat misleading. Diversification is relatively easy to observe, while monitoring ability and effort are not. Thus, risk-shifting through underinvestment in monitoring may be the greater problem for regulators, and this can occur either through lack of diversification or through diversification into new sectors.

Looking to the future, this paper suggests two avenues for further research. The first is empirical work on the impact of diversification and specialization on loan return distributions. Thus far, such work has either focused on the performance of big banks versus small banks (e.g., Boyd and Graham, 1991, Boyd and Runkle, 1993, Akhavein et al., 1996), used the bank-specific component of stock returns as an indicator of risk (e.g., Demsetz and Strahan, 1998),or examined the performance of randomly selected portfolios of actual loans (e.g., Carey, 1998). As more data on actual institutions' loans by sector becomes available, studies that focus on how mean loan returns and tail probabilities relate to actual diversification/specialization choices should be possible. The second is theoretical modeling of the impact of agency problems within a lending institution on tradeoffs between diversification and specialization. For some initial work along these lines, see Cerasi and Daltung (1996) and Boot and Schmeits (1998).

Appendix A. Proofs of Results in Text

Proof of Lemma 2.1. (i) This follows from the definition of marginal probabilities for a given sector's state.

(ii) Normalizing each sector i's return to $z_i = 0$ in state B and 1 in state G doesn't alter correlation. The mean and variance of z_i are p and p(1-p), while the covariance between sectors is $E[z_1 z_2] - E[z_1]E[z_2] = \varphi_{GG} - p^2$; the formula for correlation follows easily.

(iii) If p is constant, increased sector correlation implies φ_{GG} increases. From (i) and p constant, this implies that φ_{BG} decreases; since $1-p$ is also constant, this in turn implies that φ_{BB} increases). Q.E.D.

Proof of Proposition 2.2. (i) $(1-q_G)L > c$ implies r(M,G) > r(U,G) and r(M,B) > r(U,B), so for any debt face value D, $\pi(1,M,\cdot,D) > \pi(1,U,\cdot,D)$, and monitoring ($\sigma(1) = M$) is the only equilibrium choice. Equilibrium debt face values and associated failure probabilities follow from investors' breakeven constraint.

(ii) If r(M,B) < 1, the bank always fails in the bad state; since r(M,G) < r(U,G), the bank won't monitor. If r(M,B) $\geq$ 1, $\pi(1,M,\cdot,1) \geq \pi(1,U,\cdot,1)$guarantees D = 1 is consistent with equilibrium monitoring. This is equivalent to $\bar{q}R+(1-\bar{q})L-c-1 \geq p(q_G R-1)$; using the definition of $\bar{q}$ and rearranging yields the conditions in the text. (This is the weakest such condition, since D $\geq$ 1.) Q.E.D.

Proof of Proposition 3.1. That the bank will always monitor follows the same proof as Proposition 2.2(i).

(i) Under the convention that investors pick the lowest debt face value that is consistent with equilibrium monitoring, this result is obvious.

(ii) Since r(M,B) < 1, Proposition 2.2(i) implies $D^s = D^M$; also, the diversified bank must fail when both sectors are in bad states (state BB). A is the breakeven face value of debt that investors demand if the bank only defaults in state BB; ½[r(M,B)+r(M,G)]is the bank's loan portfolio return in states BG and GB. If this return weakly exceeds A, then $D^d = A$ is consistent with equilibrium and the bank fails in state BB only. Since A equals D^M with p replaced by $1-\varphi_{BB} \geq p$, and D^M is decreasing in p, $D^d < D^s$. Diversification does not affect monitoring and reduces failure probability, so it increases the bank's expected profits.

(iii) Since ½[r(M,B)+r(M,G)] < A, a diversified bank must fail in states BG and GB as well as BB, so its probability of failure is at least $1-\varphi_{GG} = 1-p+\varphi_{BG}$.. (Investors will demand an even higher debt face value, of course.) By contrast, a specialized bank fails with probability $1-p$. Since diversification does not affect monitoring and increases failure probability, the bank prefers not to diversify. Q.E.D.

Proof of Corollary 3.2. (i) Starting from moderate downside, changes that make high downside more likely are those that make ½[r(M,B)+r(M,G)] < A more likely. Multiplying through by $1-\varphi_{BB}$ and rearranging, this is equivalent to

$$\tfrac{1}{2}(1-\varphi_{BB})r(M,G) \quad \tfrac{1}{2}(1 \quad \varphi_{BB})r(M,B) \ < \ 1 \quad \varphi_{BB}\cdot b\,. \qquad \textbf{(A.1)}$$

The effect of increases in r(M,s) on (A.1) is obvious, proving (a). Also, $\frac{1}{2}(1-\varphi_{BB}) < p$ and $\frac{1}{2}(1+\varphi_{BB}) > 1-p$, so the LHS of this expression puts more weight on r(M,B) and less on r(M,G) than the bank's mean sector return; if r(M,G) increases and r(M,B) decreases without changing mean return, the LHS decreases and the RHS is unchanged. The described changes in q_G and q_B have this effect, proving (b). Returning to ½[r(M,B)+r(M,G)] < A, the LHS is independent of correlation and b, while A is increasing in correlation (A increases in φ_{BB}, and φ_{BB} increases in correlation by Lemma 2.1) and in b; this proves (c) and (d). Finally, an increase in correlation makes φ_{BB} bigger, so $(1-p)-\varphi_{BB}$ decreases.

(ii) This follows directly from the effects of these changes on the condition r(M,B) < 1. Q.E.D.

Proof of Proposition 4.1. The proof that the bank always monitors loans in either sector follows the same lines as the proof that the bank always monitors in Proposition 2.2(i).

(i) If $\frac{1}{2}[r(M,B)+r(N,B)] \geq 1$, a diversified bank never fails; in this case, its expected profit is $\bar{q}R+\frac{1}{2}(1-\bar{q})(1+\gamma)L-c-1 < \bar{q}R+(1-\bar{q})L-c-1$, which is the expected profit of a specialized bank. If $\frac{1}{2}[r(M,B)+r(N,B)] < 1$, the diversified bank's profit is even lower due to expected failure costs.

(ii) If both home and new sector loans have moderate downside, a specialized bank fails when the home sector is in its bad state (probability $1-p$) while a diversified bank only fails in state BB (probability φ_{BB}). A specialized bank's expected profits are $\bar{q}R+(1-\bar{q})L-c-[1+(1-p)b]$, while a diversified bank's are $\bar{q}R+\frac{1}{2}(1-\bar{q})(1+\gamma)L-c-[1+\varphi_{BB}\cdot b]$. Recalling that $\varphi_{BB}+\varphi_{BG} = 1-p$, thisleads to the condition in the text.

(iii) If new sector loans have high downside, a diversified bank fails in states BB and GB. Thus, its expected financing cost is at least $1+(1-p)b$, which is the financing cost for a specialized bank; since it has lower expected loan returns, the diversified bank is less profitable. Q.E.D.

Proof of Proposition 5.1. To simplify notation, I will write $\pi(\frac{1}{2},\sigma_1,\sigma_2,D)$ as $\pi(\sigma_1,\sigma_2)$. If the bank is to monitor both sectors, two conditions are required: $\pi(M,M) \geq \pi(M,U)$ and $\pi(M,M) \geq \pi(U,U)$. Also, note that $\max\{\frac{1}{2}[r(\sigma_1,s_1)+r(\sigma_2,s_2)]-D, 0\} = \frac{1}{2}[r(\sigma_1,s_1)+r(\sigma_2,s_2)]-D + \max\{D-\frac{1}{2}[r(\sigma_1,s_1)+r(\sigma_2,s_2)], 0\}$, so expected bank profits equal expected loan returns less D plus any expected shortfalls on repaying D.

(i) If $r(M,B) \geq 1$, then if the bank is expected to monitor, $D(1) = 1$ and the bank does not fail, so $\pi(M,M) = \bar{q}R+(1-\bar{q})L-c-1$. We know that $r(U,B) < 1 \leq r(M,B) < r(M,G) < r(U,G)$, so the bank never defaults when both sectors are in good states, and $\frac{1}{2}[r(M,B)+r(U,G)] > 1$. Thus

$$\pi(U,U) = \bar{q}R - 1 + \varphi_{BB}[1-r(U,B)] + 2\varphi_{BG}\cdot\max\{1-\tfrac{1}{2}[r(U,B)+r(U,G)], 0\}, \quad \text{and}$$

$$\pi(M,U) = \bar{q}R + \tfrac{1}{2}[(1-\bar{q})L-c] - 1 + \varphi_{BB}\cdot\max\{1-\tfrac{1}{2}[r(U,B)+r(M,B)], 0\} + \varphi_{BG}\cdot\max\{1-\tfrac{1}{2}[r(U,B)+r(M,G)], 0\}. \qquad \textbf{(A.2)}$$

$\pi(M,M) \geq \pi(U,U)$ iff $(1-\bar{q})L-c \geq \varphi_{BB}[1-r(U,B)] + 2\varphi_{BG}\cdot\max\{1-\frac{1}{2}[r(U,B)+r(U,G)], 0\}$; since $\varphi_{BB}+\varphi_{BG} = 1-p$, the RHS $= (1-p)\cdot[1-r(U,B)] - \varphi_{BG}\cdot\min\{1-r(U,B), r(U,G)-1\}$. $\pi(M,M) \geq \pi(M,U)$ is equivalent to $(1-\bar{q})L-c \geq (1-p)[1-r(U,B)] - \varphi_{BB}\cdot\min\{r(M,B)-1, 1-r(U,B)\} - \varphi_{BG}\cdot\min\{r(M,G)-1, 1-r(U,B)\}$. In both cases, the RHS equals $(1-p)\cdot[1-q_BR]$ less a nonnegative term that increases with φ_{BG}, and φ_{BG} is decreasing in sector correlation. The other results in (i) follow from Proposition 2.2(ii).

(ii) In this case, regardless of its monitoring choices, the bank always fails in state BB. If the bank is expected to monitor both sectors, its rate D^d equals A (Proposition 3.1(ii)), so regardless of its actual monitoring choice, it won't fail in state GG ($r(U,G) > r(M,G) > A$). If it does in fact monitor both sectors, it won't fail in state BG or GB; if it only monitors Sector 1, it won't fail in state BG; other states are ambiguous. Let $X = p[(1-q_G)L-c]+\varphi_{BG}[(1-q_B)L-c]$. A little algebra shows that

$$\pi(M,M) - \pi(U,U) = X - 2\varphi_{BG}\cdot\max\{A-\tfrac{1}{2}[r(U,B)+r(U,G)],0\} \leq X, \quad \text{and}$$

$$\pi(M,M) - \pi(M,U) = \tfrac{1}{2}X - \varphi_{BG}\cdot\max\{A-\tfrac{1}{2}[r(U,B)+r(M,G)],0\} \leq \tfrac{1}{2}X. \qquad \textbf{(A.3)}$$

Since $r(M,G) < r(U,G)$, it is immediate that $\pi(M,M) \geq \pi(M,U)$ implies $\pi(M,M) \geq \pi(U,U)$. It follows that a diversified bank monitors both sectors if and only if $X \geq 2\varphi_{BG}\cdot\max\{A-\frac{1}{2}[r(U,B)+r(M,G)], 0\}$.

When the condition holds, the bank prefers to diversify because a diversified bank will monitor and only default in BB (probability $1-\varphi_{BB}$), where a specialized bank would not monitor and would fail with probability $1-p > 1-\varphi_{BB}$.

To see that the condition is less likely to hold as correlation increases, note that higher correlation means lower φ_{BG} and higher φ_{BB}. Since X is increasing in φ_{BG}, this gives the desired result when the RHS of the condition is zero. If $A > \frac{1}{2}[r(U,B)+r(M,G)]$, moderate downside risk means $A \le \frac{1}{2}[r(M,B)+r(M,G)]$, so $A-\frac{1}{2}[r(U,B)+r(M,G)] \le \frac{1}{2}[r(M,B)-r(M,G)] = \frac{1}{2}[(1-q_B)L-c]$; also, A is increasing in φ_{BB}. It follows that $X-2\varphi_{BG}\cdot\{A-\frac{1}{2}[r(U,B)+r(M,G)]\}$ is increasing in φ_{BG} and decreasing in φ_{BB}, so the desired result follows.

Finally, if $X < 0$, the condition clearly fails and the bank won't monitor all loans. Since $\hat{p}[(1-q_G)L-c]+(1-\hat{p})[(1-q_B)L-c] = 0$, $X < 0$ iff $p/(p+\varphi_{BG}) > \hat{p}$.

(iii) I have already shown that the conditions in (i) and (ii) are necessary for the bank to monitor all loans. Next, I claim that, when M,U is the dominant strategy, the bank fails in states BB and GB but not states BG or GG (loan return in GB is $\frac{1}{2}[r(M,G)+r(U,B)] < \frac{1}{2}[r(M,B)+r(U,G)]$ = loan return in BG).

Suppose $r(M,B) \ge 1$. If the bank never fails with strategy M,U, $\pi(M,U)-\pi(M,M) = -\frac{1}{2}[(1-\bar{q})L-c] < 0$, so M,U is dominated by M,M. If the bank fails only in state BB under strategy M,U, then let $D' > 1$ be the debt face value consistent with this strategy. $\pi(M,U) > \pi(M,M)$ iff $\frac{1}{2}[(1-\bar{q})L-c] < \varphi_{BB}\cdot\{D'-\frac{1}{2}[r(U,B)+r(M,B)]\} - \varphi_{BB}\cdot\max\{D'-r(M,B), 0\}$, while $\pi(M,U) \ge \pi(U,U)$ iff $\frac{1}{2}[(1-\bar{q})L-c] \ge \varphi_{BB}[D'-r(U,B)] - \varphi_{BB}\cdot\{D'-\frac{1}{2}[r(U,B)+r(M,B)]\}$. Combining the two conditions yields a contradiction.

If $r(M,B) < 1$ and $\frac{1}{2}[r(M,B)+r(M,G)] \ge A$, then the bank always fails in state BB regardless of its monitoring choice. If under strategy M,U the bank fails only in state BB, then $\pi(M,U)-\pi(M,M) = -\frac{1}{2}X$, while $\pi(M,U)-\pi(U,U) = \frac{1}{2}X$; thus, either M,M weakly dominates M,U, or U,U strictly dominates, yielding a contradiction. (Note that since $r(U,G)+r(U,B) > r(M,G)+r(U,B)$, the bank fails only in state BB even if it doesn't monitor any loans.)

If the bank fails in all states but GG, it is easy to show that $\pi(U,U) > \pi(M,U)$. This proves the claim.

Thus, if M,U dominates, a diversified bank fails with probability $\varphi_{BB}+\varphi_{BG} = 1-p$. A specialized bank has the same failure probability; since a diversified bank monitors *some* loans while a specialized bank does not, the bank prefers to diversify.

The debt face value D' equals $A^* \equiv p^{-1}\{1+(1-p)b-\frac{1}{2}\varphi_{BB}[r(M,B)+r(U,B)]-\frac{1}{2}\varphi_{BG}[r(M,G)+r(U,B)]\} > A$. To get the condition ruling out *any* monitoring, note that $\frac{1}{2}[r(M,B)+r(U,G)] \ge A^*$, and so

$$\pi(M,U) - \pi(U,U) = \tfrac{1}{2}X - 2\varphi_{BG}\cdot\max\{A^*-\tfrac{1}{2}[r(U,B)+r(U,G)],0\} + \varphi_{BG}\cdot\{A^*-\tfrac{1}{2}[r(M,G)+r(U,B)]\}. \quad \textbf{(A.4)}$$

The last two terms on the RHS equal $\varphi_{BG}\cdot\min\{\frac{1}{2}[r(U,B)+r(U,G)]-A^*, 0\} + \frac{1}{2}\varphi_{BG}\cdot[r(U,G)-r(M,G)]$, which is less than $\frac{1}{2}\varphi_{BG}\cdot[r(U,G)-r(M,G)] = -\frac{1}{2}\varphi_{BG}[(1-q_G)L-c]$. Thus, $\pi(M,U) < \pi(U,U)$ if $X - \varphi_{BG}[(1-q_G)L-c] = \varphi_{GG}[(1-q_G)L-c]+\varphi_{BG}[(1-q_B)L-c] \equiv Y < 0$. $Y < 0$ is equivalent to $\varphi_{GG}/(\varphi_{GG}+\varphi_{BG}) = \varphi_{GG}/p > \hat{p}$. Also, since $p/(p+\varphi_{BG}) = (\varphi_{GG}+\varphi_{BG})/(p+\varphi_{BG}) > \varphi_{GG}/p$, $\varphi_{GG}/p > \hat{p}$ implies $p/(p+\varphi_{BG}) > \hat{p}$; thus by (ii), $\pi(M,M) < \pi(U,U)$ when $Y < 0$. Finally, an increase in correlation increases φ_{GG} but leaves p and $\hat{p}$ unchanged.

(iv) If it monitors both sectors, the bank fails in all states but GG. The same is true if it does not monitor any loans: $\frac{1}{2}[r(U,G)+r(U,B)] = \frac{1}{2}[r(M,G)+r(M,B)] - \frac{1}{2}(1-q_G+1-q_B)L-c < \frac{1}{2}[r(M,G)+r(M,B)]$, since $q_G < q_B$ and $p \ge \frac{1}{2}$ imply $\frac{1}{2}(1-q_G+1-q_B) \ge 1-\bar{q}$, and $(1-\bar{q})L-c > 0$. Thus, $\pi(M,M)-\pi(U,U) = \varphi_{GG}[(1-q_G)L-c] < 0$. If the bank monitors only Sector 1, it fails in states BB and GB; however, for M,U to be chosen, the argument from (iii) above shows that the bank must survive in state BG, so $\frac{1}{2}[r(M,B)+r(U,G)] \ge A^*$, where A^* is defined in (iii). Rearranging yields

$$\frac{p+\varphi_{BB}}{2}r(M,B) + \frac{\varphi_{BG}}{2}r(M,G) + \frac{p}{2}r(U,G) + \frac{1-p}{2}r(U,B) \ge 1+(1-p)b. \quad \textbf{(A.5)}$$

Since ½[r(M,B)+r(M,G)] < A, (A.1) holds. Subtracting (A.1) from (A.5) yields $-[(1-\bar{q})L-c] > \varphi_{BG}\cdot b \geq 0$, which is a contradiction. Thus M,U cannot be an equilibrium choice, and the bank won't monitor any loans.

Since a diversified bank won't monitor and will fail with probability $1-\varphi_{BG}$, it is better off specializing, where it won't monitor and will only fail with probability. Q.E.D.

Proof of Proposition 5.2. (i) By Proposition 2.2(ii), a specialized bank monitors and never fails. Since at best a diversified bank monitors all loans and does not fail, specializing is better, as per Proposition 4.1(i).

(ii) Here, a specialized bank won't monitor, so its expected loan returns are $\bar{q}R$ and its expected financing costs are $1+(1-p)b$. If M,N is a diversified bank's choice, then it never fails, its expected loan returns are $\bar{q}R+½(1-\bar{q})(1+\gamma)L-c$, and its financing costs are 1, so diversification will be preferred.

The necessary and sufficient conditions for M,N to be the monitoring choice are $\pi(M,N) \geq \pi(M,U)$ and $\pi(U,U)$. Both $\pi(M,U)$ and $\pi(U,U)$ are given by (A.2); similar manipulations as per the proof of Proposition 5.1(i) lead to $(1-\bar{q})\gamma L-c \geq (1-p)\cdot[1-r(U,B)]-h'$. (When $\pi(M,N) \geq \pi(M,U)$ is binding, $h' = h$ from Proposition 5.1(i); when $\pi(M,N) \geq \pi(U,U)$ is binding, $h' = h + ½(1-\bar{q})(1-\gamma)L$.) It is straightforward to show that the condition is more binding as correlation increases or effectiveness γ decreases.

(iii) By assumption, a specialized bank won't monitor, so it earns $\bar{q}R$ less $1+(1-p)b$. If a diversified bank chooses M,N when Sector 2 loans have moderate downside, it fails only in state BB, so its loan returns are as in (ii) and its financing costs are $1+\varphi_{BB}\cdot b$; thus, diversification is preferred.

The derivation of the necessary and sufficient condition for M,N to be chosen follows the same lines as that of the condition in Proposition 5.1(ii). The debt face value is A', and the bank fails only in BB; analogy to (A.3) shows that

$$\pi(M,N) - \pi(M,U) = ½X' - \varphi_{BG}\cdot\max\{A' - ½[r(U,B) + r(M,G)], 0\}, \qquad \textbf{(A.6)}$$

where $X' = p[(1-q_G)\gamma L-c]+\varphi_{BG}[(1-q_B)\gamma L-c]$. Simple rearrangement yields the condition in the text. $\pi(M,N) \geq \pi(U,U)$ can be rearranged to give a similar condition; using $½(1+\gamma) > \gamma$ and $r(U,G) > r(M,G)$, it is easy to show that this second condition is less binding than $\pi(M,N) \geq \pi(M,U)$. It is straightforward to show that $\pi(M,N) \geq \pi(M,U)$ becomes more binding as correlation increases or effectiveness γ decreases.

The sufficient condition for ruling out monitoring both sectors follows by noting that, when $p/(p+\varphi_{BG}) \geq \tilde{p}$, $½p[(1-q_G)\gamma L-c] + ½\varphi_{BG}[(1-q_B)\gamma L-c] \leq 0$.

(iv) Since (i) is violated, a specialized bank won't monitor and fails with probability $(1-p)$. Since (ii) and (iii) give the necessary conditions for a diversified bank to monitor both sectors, their violation (a) rules out strategy M,N, and a diversified bank chooses either M,U or U,U; (b) leads to the same result, since if the bank did choose M,N, it would fail in states BB and GB, in which case monitoring Sector 2 would be unattractive. From here on, the proof for mirrors that of Proposition 5.1(iii).

(v) The proof is identical to that of Proposition 5.1(iv). Q.E.D.

Appendix B. Alternative Equilibria

Proposition B.1. Alternative equilibria for specialized bank.
(i) If $(1-q_G)L \le c$, $\bar{q}R \ge 1 + (1-p)b$, and $r(M,B) \le D^U \equiv p^{-1}\{1-(1-p)\cdot[r(U,B)-b)]\}$, then there is an equilibrium in which the bank does not monitor ($\sigma(1) = U$), the face value of its debt D(1) is $D^U > D^M > 1$, and the bank fails with probability $1-p$. If any of these conditions are not met, there is no equilibrium in which the bank can raise funds and not monitor its loans. The no-monitoring equilibrium coexists with the monitoring equilibrium from Proposition 2.2(ii) if $(1-p)^2[1-q_BR+b] \ge -p^2[(1-q_G)L-c]$.
(ii) If $(1-q_G)L \le c$, $r(M,B) \le D^U$, and $\bar{q}R+(1-\bar{q})L-c-1 > p(q_GR-1)$, then there exists D^*, $1 < D^* < r(M,B)$, s.t. the bank is indifferent between monitoring and not monitoring if its debt face value is D^*. Defining β by

$$\beta = \frac{1-pD^*-(1-p)(q_BR-b)}{(1-p)(D^*-q_BR+b)},$$

then so long as β is between 0 and 1, there is an equilibrium in which the bank monitors with probability β and investors demand face value D^*. Whenever this equilibrium exists, there is also an equilibrium in which the bank monitors with certainty and the bank's debt face value is 1.

Proof. (i) The definition of D^U follows from the investors' break-even constraint; feasibility then requires that $\bar{q}R \ge 1 + (1-p)b$; and Proposition 2.2(i) gives the first condition. If $r(M,B) > D^U$, then the bank strictly prefers monitoring even for $D = D^U$. For this equilibrium to coexist with the monitoring equilibrium of Proposition 2.2(ii), $D^U \ge r(M,B)$ and r(M,B) must meet the bound described in Proposition 2.2(ii). Substituting in for D^U and rearranging yields the condition given in the proposition.
(ii) If the first condition doesn't hold, the bank always monitors. D^* is defined by $\bar{q}R+(1-\bar{q})L-c-D^* = p(q_GR-D^*)$, which is between 1 and r(M,B) so long as the second and third conditions hold. When the bank monitors with probability β and does not monitor with probability $1-\beta$, the investors' breakeven constraint is $\beta D^* + (1-\beta)[pD^* + (1-p)(q_BR-b) = 1$, which gives rise to the expression for β; since investors break even and the bank is indifferent between monitoring and not monitoring, this is an equilibrium. On the other hand, if this equilibrium exists, then the bank strictly prefers to monitor when D = 1, and this satisfies all the conditions in Proposition 2.2(ii) for such an equilibrium to exist. Q.E.D.

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Fig. 1: **Diversification When Monitoring Incentives Are Stronger**

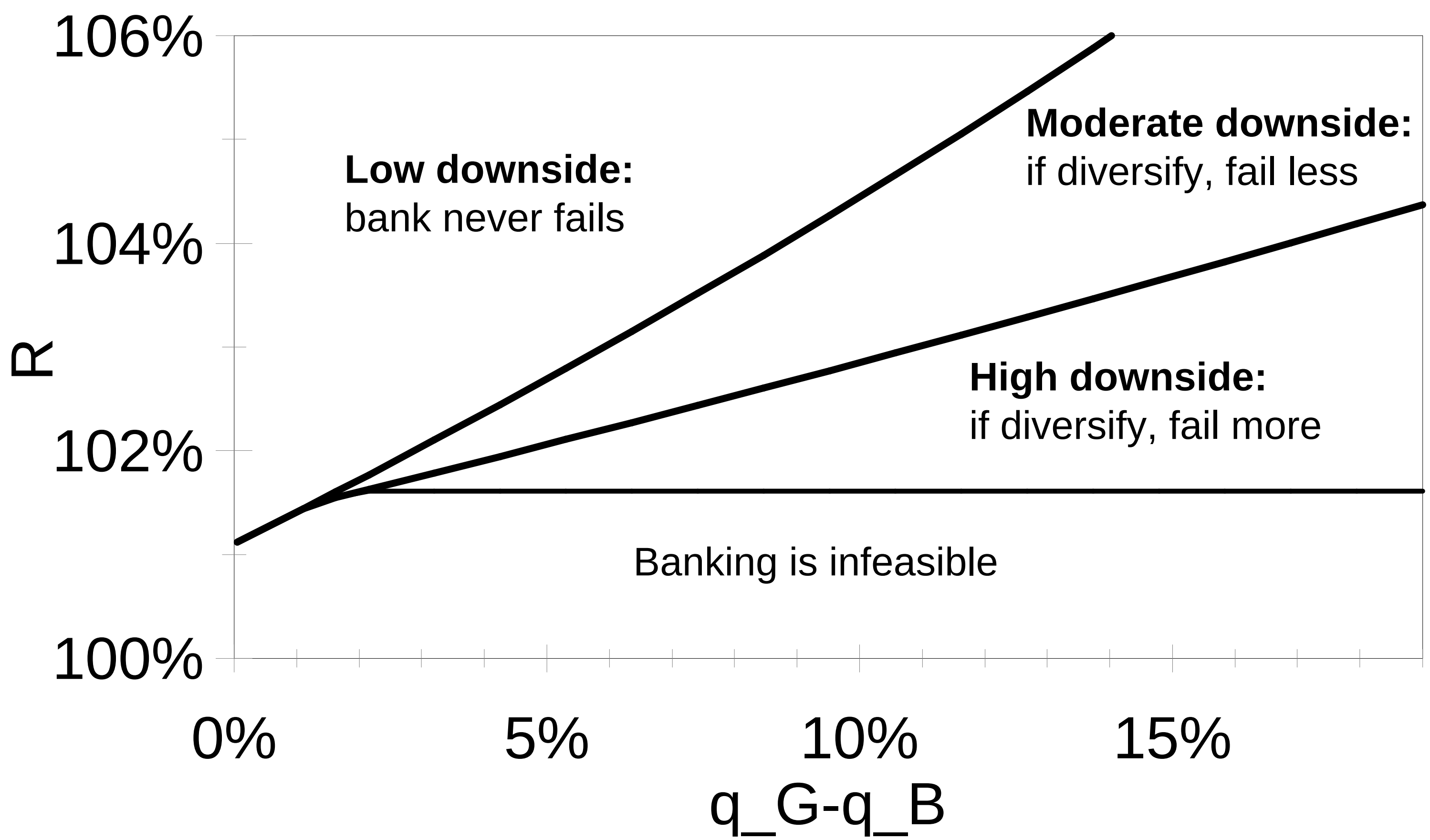

Fig. 2: **Diversification When Monitoring Incentives Are Weaker**