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Tying in Universal Banks

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Abstract. This paper examines the tying of lending to investment banking business by universal banks. Tying may alleviate credit rationing by assuring the lender of an adequate share of the social surplus that its lending generates; however, tying raises the profitability of loans to troubled entrepreneurs, softening entrepreneurial budget constraints and reducing effort levels. When investment banking is uncompetitive, the former effect dominates, and there is too little tying; when investment banking is competitive, there is too much tying. We relate our results to the authority structure of the universal bank, which we argue is the appropriate focus for regulation.

JEL Classification: G20, G21, G34

1. Introduction

The last decade has seen a rapid increase in the importance of universal banks, which combine the lending and payment services of commercial banks with a range of other services. In the USA, this is partly a response to the 1999 passage of the Gramm–Leach–Bliley Act, which dismantled legal barriers to commercial bank participation in security market business. But when the Act was passed, the same trend had been evident in Europe for at least a decade.[1]

Universal banking has generated some controversy. While there is little academic evidence in support of the concerns expressed in the 1930s that commercial banks underwrite low-quality securities issued by their borrowers,[2] modern commentators have identified other problems. In particular, an active policy debate in the USA concerns the phenomenon of "tying": that is, of selling one product

[1] This trend is documented by Lown *et al.* (2000) and the ECB (2004).

[2] For a discussion of the Pecora committee's 1932 conclusions on the operations of commercial bank security affiliates, see Morrison and Wilhelm (2007, pp. 196–215). There is very little evidence to support the notion that 1920s universal banks ripped off their customers by bringing poor quality securities to market. Indeed, as Kroszner and Rajan (1994) note, rational investors should anticipate this type of security issue, so that it could not succeed. Kroszner and Rajan (1994), Ang and Richardson (1994), and Puri (1994, 1996) present evidence that supports this hypothesis. Kanatas and Qi (1998) present a model in which universal banks determine their size by trading this price impact off against the potential for scope efficiencies.

conditional upon the sale of another product.[3] In 2002, US congressman John Dingell wrote an open letter to Alan Greenspan, then chairman of the Federal Reserve system, suggesting that financial institutions were using loans as "loss leaders" to attract more profitable investment banking business. Cross-selling of this type is illegal in the USA[4]; Congressman Dingell suggests that it may also undermine the safety and soundness of the banking system. More recently, the US Financial Accounting Standards Board has advanced proposals intended to identify cases where universal banks use their market power as lenders to secure investment banking business. These rules would require lenders explicitly to state whether the transaction price of a loan differs from its fair market value.[5]

We analyze the incidence and the desirability of tying as a function of the competitiveness of the commercial and investment banking markets, and we show that tying strategy and organizational form are closely related. Our two main results are as follows. First, we find that the socially optimal tying strategy is nonmonotonic in the surplus generated by investment banking: tying is socially desirable for low and high levels of surplus, and it is suboptimal for intermediate surplus levels. Second, we demonstrate that the appropriate policy response to tying depends upon the competitiveness of the investment banking industry. When investment banking is relatively uncompetitive, banks are insufficiently willing from a social point of view to tie; for higher levels of competition, this conclusion can be reversed.

In our formal analysis, we consider an entrepreneur with an existing bank relationship who requires an additional loan to remain in business. Considered on a stand alone basis, the bank would prefer not to make the loan, even though it would maximize social surplus. However, by tying the loan to future investment banking business, the bank can generate sufficient surplus to render lending profitable. The reason for this is that, on average, entrepreneurs that survive generate a social surplus from activities that rely more upon investment banking services than upon commercial banks. Some of that surplus is therefore captured by their investment banks, rather than by their commercial banks. Tying enables the universal bank to capture this surplus through its investment banking division and therefore induces the *ex post* socially optimal continuation decision. However, from

[3] This definition appears in Tirole's (2005) survey of tying. Tying is closely related to bundling, which is the practice of selling two products together. In the case that we analyze, the tied product (investment banking) is valueless without the tying product (commercial lending). Tirole argues that the distinction between tying and bundling is inconsequential in this case. We refer to "tying" throughout this paper since this term has been employed in recent policy discussions and also in regulations: for example, see 68 Fed. Reg. 52024 (August 29 2003).

[4] Under Sections 23A and 23B of the Federal Reserve Act, national banks may not charge below market rates on credit or other products to benefit affiliates. In fact, the Office of the Comptroller of the Currency (2003) finds no evidence that banks have contravened the law.

[5] See "US banks face fresh scrutiny on lending," Helen Thomas, *Financial Times*, March 20 2011.

the *ex ante* perspective, tying may be undesirable: because the entrepreneur anticipates that continuation finance will be available, his incentive to exert effort is attenuated. We show that, for certain parameter values, the expected cost of reduced effort is so great as to outweigh the expected benefit derived from tying.

In short, tying generates a classic soft budget constraint problem. The soft budget constraint literature evolved to understand the challenges that State ownership of industry poses in centrally planned economies (for surveys, see Kornai, Maskin, and Roland, 2003; Maskin, 1999). In the existing literature, soft budget constraints arise because financiers are large and liquid and so provide continuation finance whenever it is *ex post* desirable (e.g., Dewatripont and Maskin, 1995) or because a paternalistic government shares the costs of refinancing (e.g., Berglof and Roland, 1995). In contrast, our paper shows that soft budget constraints can be rooted in horizontal product market expansion. This source of softness has not previously been examined in the universal banking literature. Hence, we argue that soft budget constraints may also be pervasive in economies with developed financial markets.

The inability of diversified financiers credibly to commit not to refinance unsuccessful entrepreneurs appears to derive from a wider noncontractibility problem in tying. For example, despite a blanket legal prohibition on tying in the USA,[6] anecdotal evidence indicates that tying remains pervasive in the USA. The Association for Financial Professionals (2004, p. 2) states that "Financial professionals continue to report that commercial banks frequently make access to credit contingent upon the purchase of other financial services, despite assertions by regulatory bodies to the contrary." According to the Association, most of the claims of illegal tying relate to the tying of traditional banking products to products like underwriting services.[7]

Notwithstanding this evidence, prosecutions under tying legislation are extremely uncommon. The United States General Accounting Office (2003), or GAO, discusses this point in a report to Congressman Dingell. The GAO states that there is little documentary evidence that banks pressurize their customers to buy investment banking services because credit negotiations are conducted orally. Moreover, borrowers are uncertain about the formal law, and they fear that their access to credit may be impaired if they file formal complaints with banking regulators.

[6] Section 106 of the Bank Holding Company Act Amendments of 1970 prohibits banks from requiring the purchase of an additional product as a condition of sale for the purchase of a desired product, although the prohibition is not absolute: the law does not prevent banks from considering the aggregate profitability of their customer relationships when making pricing decisions, and it permits banks to tie credit to traditional banking services such as cash management.

[7] The Association states (p. 7) that "51% of large companies had credit denied or terms changed after they did not award bond underwriting business." See also "Banking's not-so-secret-weapon," Julie Creswell, *Fortune*, October 14 2002.

The difficulty of proving tying in court renders direct legislation on tying ineffective, and it also prevents banks from making a contractual up-front commitment not to tie. However, banks are able to commit to an authority structure that assigns lending decisions to specific agents so as to affect tying incentives in predictable ways. In devolved authority structures, lending decisions are made by commercial bankers who fail to internalize any benefits that might accrue from cross-selling investment banking services and hence will never tie loans. In centralized authority structures, lending decisions are made by a headquarters that accounts for the combined value of lending and investment banking deals and hence elects to tie the two whenever it is profitable to do so. Hence, choosing a devolved or a centralized authority structure is tantamount to committing to run a non-tying or a tying bank, respectively.[8] We therefore relate organizational form, tying, and the soft budget constraint problem in universal banks.

In line with the concerns expressed by policy makers and the press,[9] our model predicts that universal banks with centralized authority structures will advance unprofitable loans to unsuccessful entrepreneurs in order to transact investment banking business with them. This is in line with the empirical findings of Drucker and Puri (2005), who demonstrate that universal banks charge lower spreads on loans that are combined with underwriting services. Our model shows that these banks are more profitable than they would be with devolved authority structures, so it is unclear that tying has a negative marginal impact upon financial stability. In any case, our model indicates that a legal argument about "market rates" for credit should allow for differences in organizational form: interest rates may be lower in universal banks with centralized authority structures because this is the most effective way to incentivize their entrepreneurs, not because low interest rates are used as "loss leaders" to attract fee-based business.

We relate the welfare effects of universal bank tying to the competitiveness of the banking market. First, we assume that the bank can monopolize the entrepreneur in the commercial and investment banking markets.[10] We demonstrate that, relative to the social optimum, bankers in this case are biased against tying. Our analysis therefore indicates that there is too little tying when the investment banking sector is not competitive.

Second, we assume that, while the bank can monopolize the entrepreneur in the loan market, it faces competition in the investment banking market, so that entrepreneurs who are free to shop around can buy investment banking services at the cheapest price. This increases the effort level of entrepreneurs with non-tying banks

[8] Our emphasis upon organizational form as a means of overcoming soft budget constraint problems is reminiscent of the work of Qian and Roland (1998), in which they argue that devolving fiscal authority from central to local governments can help to overcome soft budget constraints in government.

[9] See, for example, "Thanks a Bundle," *The Economist*, August 24 2002.

[10] For example, Sapienza (2002) and Calomiris and Pornrojnangkool (2005) demonstrate that bank mergers can result in monopolistic lending; Petersen and Rajan (1995) and Degryse and Ongena (2005) find that banks can derive a competitive advantage from proximity to their borrowers.

and so results in a higher effort level. This causes the private value of the non-tying bank to increase. On the other hand, we show that tying banks are able to use their loan market monopoly to reverse the effects of competition in the investment banking market. As a result, because they are able to induce the effort level that they would have selected absent competition in the investment banking market, the private value of tying banks is unaffected by this competition.

Hence, we show that the private value of a tying bank is unaffected by competition in the investment banking market, while that of a non-tying bank increases. Nevertheless, we show that the social value of non-tying banks increases faster still. It follow that for high levels of competition, bankers are excessively willing to tie lending and investment banking.

Our analysis is distinct from prior work on tying and bundling. Broadly speaking, the prior literature examines two reasons for bundling and tying. First, bundling and tying may enhance efficiency, for example, by lowering costs, raising quality, avoiding double marginalization, and facilitating price discrimination (e.g., Stigler, 1968; Schmalense, 1982; Salinger, 1995; McAfee, McMillan, and Whinston, 1989). Second, tying and bundling could have a strategic motive, for example, because they deter entry, enable the tying firm to gain competitive advantage, or mitigate competition (e.g., Whinston, 1990; Nalebuff, 2004). Our approach to tying differs from this literature in two respects: first, we show how the choice of organizational form can be used to commit to a tying strategy, and, second, we relate the principal's tying decision to the moral hazard principal–agent problem between the bank and its borrower.

Our analysis of decision-making authority within universal banks extends a growing literature on organizational form of financial institutions. This literature is largely concerned with a trade-off, identified by Fama and Jensen (1983), between the ability of bankers to transmit soft information through management hierarchies on the one hand and, on the other hand, the positive implications for bank governance of the separation of loan origination from loan approval decisions. Evidence of hierarchical decision-making procedures in commercial banks is presented by Liberti (2003) and Eggenberger (2006); Berger and Udell (2002) and Stein (2002) argue that such hierarchies undermine information transmission within banks, and Berger *et al.* (2005) and Liberti and Mian (2009) provide evidence in support of this hypothesis. Our focus upon the commitment effect of a particular organizational form provides fresh insights into the organizational form of banks, but it is distinct from this literature.

Our work also extends a growing literature on financial conglomeration and the efficiency implications of universal banking. Much of this literature is concerned with the systemic implications of universal banking. Allen and Jagtiani (2000) and Mälkönen (2004) use portfolio simulations to argue that universal banks may generate diversification benefits that increase their ability to withstand an economic shock. On the other hand, Boot and Schmeits (2000) argue that diversification

may reduce the accuracy of price signals and so weaken market discipline. A number of authors assert that universal banking may undermine financial stability by extending the deposit insurance safety net. For example, Boyd, Chang, and Smith (1998) argue that banks are more likely to take advantage of the safety net when they have equity stakes in their borrowers; Freixas, Lóránth, and Morrison (2007) argue that capital regulations for universal banks should be designed in light of the likelihood of this type of regulatory arbitrage. In practice, Benston (1994), White (1986), and Cornett, Ors, and Tehranian (2002) find no evidence that scope expansion reduces bank stability.

Two other theoretical papers examine the incentive implications of combining lending and investment banking business. Kanatas and Qi (2003) argue that when universal banks anticipate that they will garner lending businesses from firms whose security placements are unsuccessful, they will be less inclined to work hard to ensure that the underwriting is a success. Laux and Walz (2008) argue that this effect can be reversed when the underwriter has already lent to the issuing firm since a failed underwriting will have an adverse effect upon the value of the outstanding loan. Our paper differs from these contributions along several dimensions. We are concerned with the entrepreneur's incentives prior to any investment banking deals rather than with the incentives of the investment bank; we examine the relationship between bank authority structures and tying; and we incorporate a discussion of the impact of investment banking market competition upon our results.

Canals (1997, pp. 291–295) discusses the organizational design of universal banks. He argues (pp. 290–291) that differing organizational designs across universal banks reflect "the degree of autonomy given to the business units and the role of the group's corporate management": these are the factors that differentiate universal banks with devolved and centralized authority structures in our model. Indeed, Canals distinguishes between the divisional model, which is similar to the centralized authority structure in our work, and the confederated model, which corresponds to our devolved authority structure.[11] Similarly, Vander Vennet (2002) identifies several organizational approaches to the combination of traditional and nontraditional banking activities, distinguishing between combining them in-house, via a department of the bank, combining via a separately capitalized subsidiary of the bank, and doing so via a separately capitalized subsidiary of a bank holding company.

The remainder of the paper is laid out as follows. We present our basic model in Section 2. The solution is presented for a variety of assumptions about levels of bank competition in Section 3. Section 4 discusses the empirical implications of our

[11] Canals gives examples of each universal bank model: for example, the divisional model is practiced by Banco Central Hispano, and the confederated model is exemplified by Banc One.

work. Section 5 discusses the robustness of our results, and Section 6 concludes. The proofs appear in the Appendix.

2. Model

2.1 TECHNOLOGIES

The action in our model unfolds over three dates, $t = 0, 1, 2$. There is a unit mass of risk-neutral entrepreneurs, each of whom is endowed with a project that requires a Time 0 investment of I_1. After investment occurs, each entrepreneur selects an effort level $e \in [0, 1]$ at a personal cost $\Psi(e) = \alpha\frac{e^2}{2}$, where $\alpha > 0$; at Time 1, each project succeeds with probability e and is unsuccessful with probability $1 - e$. At Time 1, successful projects yield a verifiable return of $\Pi_1 > I_1$ and unsuccessful projects return 0. Unsuccessful projects can be continued or liquidated. Continuation requires a further capital injection of I_2 and yields a guaranteed verifiable return of Π_2 at Time 2; liquidated projects yield no Time 2 returns, and entrepreneurs experience a nonpecuniary cost of $b > 0$ if their projects are liquidated.

Assumption 1. *Lenders experience a pecuniary cost*

$$L \equiv I_2 - \Pi_2 > 0$$

from continuing an unsuccessful project. Nevertheless, the Time 1 cost to the lender of continuing an unsuccessful project is less than the nonpecuniary cost that the entrepreneur experiences upon project liquidation:

$$b > L. \tag{1}$$

We assume that entrepreneurs have no cash at Time 0, so that they require outside financing. Outside finance in our model is provided by a bank, which invests on behalf of risk-neutral shareholders. The bank makes Time 0 investments and also makes Time 1 continuation decisions for unsuccessful entrepreneurs. When a bank provides continuation finance to an unsuccessful entrepreneur, we will say that it *rescues* the entrepreneur.

Every bank in our model is a *universal bank*. This means that it is able to sell investment banking services to entrepreneurs that survive past Time 1. Throughout the paper, we refer to the part of the bank that extends loans as the *commercial banking division* and to the other part the *investment banking division*.

An entrepreneur that survives past Time 1, whether because it is successful or because it is rescued, performs activities that require investment banking expertise rather than commercial banking knowledge. The activities that are supported by

investment banking expertise include advisory work, capital market financing, and capital structure work.

The enterpreneur's investment banking business generates a surplus S.[12] Whether the entrepreneur or its bank captures the surplus S depends upon the competitive environment and, as we show in Section 3, upon the authority structure of its bank. Our assumption that the expected surplus derived from investment banking business is the same for entrepreneurs that are successful in the first period as for those that are unsuccessful makes our results simpler to derive and to present. However, it is not essential to our quantitative results, and in Section 5.1, we analyze an extension in which the surplus is higher for successful than for unsuccessful entrepreneurs.

2.2 FIRST-BEST OUTCOME

We define welfare to be the sum of the expected surplus that accrues to all the agents in the economy. Consider the benchmark case in which entrepreneurial effort and the Time 1 continuation decision are selected to maximize welfare. In this case, Assumption 1 implies that all unsuccessful projects will be continued.[13] With these decisions, the social surplus derived from entrepreneurial effort e is given by Equation (2):

$$W(e) \equiv e(\Pi_1 + S) + (1-e)(S-L) - I_1 - \psi(e). \tag{2}$$

It follows immediately that the first-best effort level is given by Equation (3):

$$e^{\mathrm{FB}} = \frac{\Pi_1 + L}{\alpha}. \tag{3}$$

Assumption 2. *The first-best effort level is strictly between 0 and 1:*

$$\alpha > \Pi_1 + L. \tag{4}$$

As illustrated in Figure 1, e^{FB} is monotonically increasing in pecuniary cost L of continuation and in the benefit Π_1 derived from Time 1 success and is decreasing in the effort cost parameter α.

[12] It is not necessary for our results that every entrepreneur generate a profit from investment banking business: merely that the unconditional expected return from selling these services is positive.

[13] In fact, because continuation may generate investment banking surplus, a weaker assumption than Assumption 1 would be sufficient to guarantee the social optimality of Time 1 continuation. See Section 5.2 for a more detailed discussion of this point.

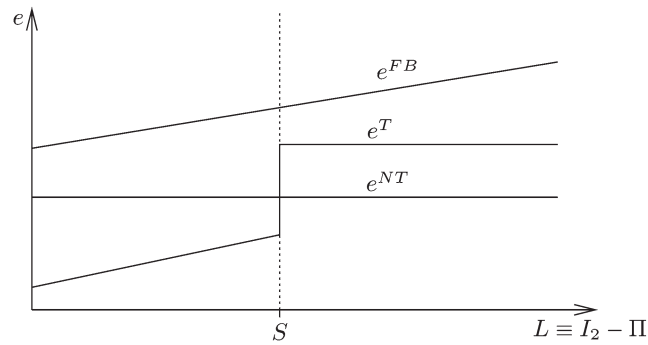

Figure 1. Equilibrium effort levels. The first-best effort level e^{FB} and the equilibrium levels e^{NT} and e^{T} that obtain, respectively, in non-tying and tying banks are plotted as functions of the cost L of rescuing an unsuccessful entrepreneur.

2.3 CONTRACTUAL LIMITATIONS

We now introduce three restrictions on the contracting environment that guarantee that the first best will not be achieved.

First, we assume that there is moral hazard between the entrepreneur and the bank.

Assumption 3. *The entrepreneur's effort is private nonverifiable information and, hence, cannot be the subject of a contract.*

Second, although the returns Π_1 and Π_2 on the entrepreneur's project are verifiable, we assume that the surplus created by investment banking activity is not verifiable.

Assumption 4. *The return generated by the entrepreneur's projects is verifiable, but the surplus S generated by investment banking business is not verifiable.*

Third, we allow for tying.

Assumption 5. *It is possible to tie commercial bank loans to investment banking services, and it is impossible to prove in a court that this type of tying has occurred.*

Because it is based upon oral and tacit agreements, tying is very hard to prove directly.[14] One consequence of our tying assumption is that universal banks cannot make a contractual commitment at Time 0 not to tie Time 1 lending to investment banking business.

[14] The mechanics of tacit tying agreements are outside the scope of a finite horizon model such as ours.

The bank and the entrepreneur are therefore able to write state-contingent contracts over the verifiable returns that the entrepreneur's projects yield. The Time 0 contract (R_1, R_2) stipulates the payments R_1 and R_2 that the bank receives at Times 1 and 2 from successful and rescued unsuccessful projects, respectively. As a consequence of Assumption 4, neither the bank nor the entrepreneur is able to commit *ex ante* to a scheme to share investment banking surplus, based for example, upon the success or failure of the entrepreneur's project.

We also restrict attention to renegotiation-proof contracts. In other words, we require the bank and the entrepreneur to write contracts that they will not find it mutually advantageous to alter at Time 1. Without this restriction, it would be possible for banks to commit up-front to a closure policy and so to avoid the soft budget constraint problem that drives our results.

2.4 AUTHORITY STRUCTURES

Although it is impossible for universal banks to contract directly over continuation finance and tying in our model, we assume that they are able to commit at Time 0 to an authority structure that allocates Time 1 lending powers. Specifically, we examine two organizational forms, involving *devolved* and *centralized* authority structures.[15]

In a universal bank with a centralized authority structure, lending and investment banking decisions are consolidated centrally, so that loss-making loans are extended whenever doing so generates profitable investment banking business. We therefore refer to universal banks with a centralized authority structure as *tying* banks.

In a universal bank with a devolved authority structure, lending decisions are made at the divisional level. In this case, the profit that the commercial banking division derives from lending to an unsuccessful entrepreneur is insufficient to induce it to lend.

Assumption 4, that the surplus generated by investment banking business is nonverifiable, precludes *ex post* bargaining over this surplus between the commercial and investment banking divisions of a universal bank with a devolved authority structure. If such bargaining were possible, then it is clear from the Coase theorem that refinancing would always occur when $S \geq L$ and hence that the surplus would always be realized. In this case, the entrepreneur would always face a soft budget constraint, independently of the authority structure of the bank.

Even with Assumption 4, one might argue that an appropriately designed compensation structure from the headquarters could create tying incentives in any universal bank. We assume that such a contract would be ineffective (it would be sufficient to assume that such contracts were verifiable and, hence, that the

[15] Other, hybrid, authority structures are possible. We demonstrate in an earlier version of this paper that they are weakly dominated by either devolved or centralized authority structures: the proof is available upon request.

headquarters could commit not to write them). But, even without this assumption, our analysis could be used to compare integrated universal banks, which always tie, with stand-alone commercial banks.

In the following section, we examine the bank's choice of authority structure under a variety of assumptions about the competitiveness of the commercial and investment banking markets, and we analyze the welfare consequences of these choices.

3. Model Solution

Real outcomes in our model depend upon the level of competition in the commercial and investment banking markets. We therefore begin our analysis by analyzing the base case where the universal bank can monopolize its customers in the commercial and investment banking markets. We then relax our assumption that the investment banking market is uncompetitive, and, finally, we examine the effects of competition in the commercial banking market. It transpires that competition is important for outcomes in non-tying banks and hence for profitability and welfare comparisons between bank authority structures, but that it does not affect the behavior of tying banks.

The model as we present it applies to a single marketplace containing a unit mass of entrepreneurs, all of whom have the same S and L parameters. In other words, we think of S and L as mainly reflecting overall market conditions rather than as reflecting properties of the entrepreneur. Nevertheless, our analysis generates insights into the alternative case where S and L are entrepreneurial properties. In this case, universal banks would *ex ante* face a choice between market sectors, each of which was characterized by different S and L parameters. Banks would select a sector and choose the optimal authority structure for that sector using the analysis that we present below. In such a model, organizational form would be hard to change. Hence, the analysis below would apply on a case-by-case basis to each sector, and all the banks in a sector would compete at Time 0 to attract commercial banking clients. A complete model of entry would significantly complicate our analysis. Nevertheless, it is clear that, in such a model, entry into segments would occur in such a way as to ensure that moving between sectors was never profitable: profits in each sector would therefore be approximately equal.

3.1 MONOPOLY BANKS

In this section, we consider the case where the bank is a monopolist in the markets for loans and for investment banking services. We consider in turn the non-tying and the tying banks of Section 2.4. We first derive optimal bank contracts for different authority structures (Section 3.1.a). We then determine the banker's choice of authority structures (Section 3.1.b). Finally, we discuss the welfare implications of our analysis (Section 3.1.c).

3.1.a. Optimal bank contracts

We first analyze the optimal lending contract for a non-tying bank. Since it never rescues an unsuccessful entrepreneur, its lending contract comprises only a Time 1 repayment R_1. Lemma 1 summarizes the resultant equilibrium.

Lemma 1. *A non-tying bank never rescues a failed entrepreneur, and it sets* $R_1 = R_1^{\mathrm{NT}} \equiv \frac{1}{2}(b + \Pi_1)$*, which induces entrepreneurial effort* $e^{\mathrm{NT}} \equiv \frac{1}{2\alpha}(\Pi_1 + b)$*. The total expected combined profit of the universal bank's commercial and investment banking divisions is then* $V^{\mathrm{NT}} \equiv \frac{(\Pi_1+b)^2}{4\alpha} - I_1 + \frac{S}{2\alpha}(\Pi_1 + b)$.

e^{NT} and e^{FB} differ for three reasons. First, entrepreneurs pay an interest rate when they borrow from a non-tying bank and therefore fail to internalize the full benefits of success. Second, whereas entrepreneurs experience the full cost L of continuation in the first-best case, this cost is not incurred, and hence is not internalized, in a non-tying bank. These effects both serve to decrease the entrepreneur's effort relative to the first best. A third, countervailing, effect arises because the non-tying bank, which ignores the costs to the entrepreneur of project liquidation, does not rescue unsuccessful projects. Hence, unsuccessful entrepreneurs experience a cost b when they borrow from a non-tying bank, which does not arise in the first best; this effect serves to increase their effort incentives.

We now consider tying banks. Unlike a non-tying bank, a tying bank may elect to rescue unsuccessful projects at Time 1 because it internalizes the expected profits that its investment banking division will make from rescued entrepreneurs. If rescue occurs, the bank extracts all the surplus from continuation finance and hence sets $R_2 = \Pi_2$. Expressions for the equilibrium interest rate R_1^{T}, entrepreneurial effort e^{T}, and bank profit V^{T} appear in Lemma 2.

Lemma 2. *A tying bank rescues unsuccessful entrepreneurs at Time 1 precisely when* $L \leq S$*. It sets* $R_2 = \Pi_2$ *and sets* R_1 *equal to the following value:*

$$R_1^{\mathrm{T}} \equiv \begin{cases} R_{1,\mathrm{SBC}}^{\mathrm{T}} \equiv \frac{1}{2}(\Pi_1 - L), & \text{if } L \leq S, \\ R_{1,\mathrm{HBC}}^{\mathrm{T}} \equiv \frac{1}{2}(\Pi_1 + b - S), & \text{if } L > S. \end{cases} \tag{5}$$

This induces entrepreneurial effort

$$e^{\mathrm{T}} \equiv \begin{cases} e_{\mathrm{SBC}}^{\mathrm{T}} \equiv \frac{1}{2\alpha}(\Pi_1 + L), & \text{if } L \leq S, \\ e_{\mathrm{HBC}}^{\mathrm{T}} \equiv \frac{1}{2\alpha}(\Pi_1 + b + S), & \text{if } L > S. \end{cases} \tag{6}$$

and expected bank profit

$$V^{\mathrm{T}} \equiv \begin{cases} V^{\mathrm{T}}_{\mathrm{SBC}} \equiv \frac{(\Pi_1 + L)^2}{4a} + S - I_1 - L, & \text{if } L \leq S, \\ V^{\mathrm{T}}_{\mathrm{HBC}} \equiv \frac{(b + S + \Pi_1)^2}{4\alpha} - I_1, & \text{if } L > S. \end{cases} \tag{7}$$

The discontinuity in the equilibrium R_1 and e values is a consequence of the change in the tying bank's rescue policy for failed entrepreneurs that occurs at $L = S$. For $L > S$, entrepreneurs face a hard budget constraint, which serves as a counter to the deleterious impact of higher interest rates upon entrepreneurial effort. As a result, tying banks charge higher interest rates and achieve higher levels of entrepreneurial effort when a hard budget constraint applies ($L < S$) than when a soft budget constraint applies ($L < S$).

Assumption 6 ensures that the agency problem between the entrepreneur and the bank is large enough to cause a problem.

Assumption 6. *Effort is always lower than the first best:*

$$2L + \Pi_1 - S > b. \tag{8}$$

Figure 1 plots e^{T}, e^{NT}, and the first-best effort level e^{FB} as a function of the cost L of rescuing an unsuccessful entrepreneur. The first-best effort level is increasing in L because all unsuccessful entrepreneurs are rescued in the first-best world. Assumption 6 guarantees that the first-best effort level is never attained with any feasible bank authority structure. Because non-tying banks never rescue an unsuccessful entrepreneur, e^{NT} is L-invariant. Finally, the effort level e^{T} generated by tying banks is increasing in L in the parameter region $L \leq S$ where they rescue unsuccessful entrepreneurs; for higher L, tying banks liquidate unsuccessful entrepreneurs, and so e^{T} is L-invariant.

The intuitive explanation for e^{T} crossing e^{NT} from below at $L = S$ is as follows. First, when $L \geq S$, tying and non-tying banks both liquidate failed entrepreneurs, but non-tying banks fail to account for the consequential loss of investment banking revenue. Consequently, the marginal cost for non-tying banks of a higher interest rate is lower than it is for tying banks; as a result, they charge a higher interest rate and achieve a lower effort level. In contrast, for $L < S$, tying banks rescue failed entrepreneurs; this reduces entrepreneurial effort incentives relative to the non-tying case, where they are not rescued after failure.

3.1.b. Choice of authority structure

Proposition 1 shows how the universal bank resolves its Time 0 choice between a devolved authority structure that rules out tying and a centralized structure that renders it inevitable.

Proposition 1. *At Time 0, the bank's optimal authority structure is nonmonotonic in the investment banking surplus S. Tying is optimal for* $S \leq L$ *and for* $S > \max(S_{\mathrm{NT,T}}(L), L)$*, where* $S_{\mathrm{NT,T}}(L)$ *is an increasing function of L; non-tying is optimal for* $L < S \leq S_{\mathrm{NT,T}}(L)$.

Figure 2 illustrates the locus of $S_{\mathrm{NT,T}}(L)$ for feasible L-values. To understand why the tying strategy is nonmonotonic in L, note that for a given liquidation policy, non-tying banks generate less shareholder surplus than tying banks. This is because only tying banks internalize the effects of their lending policy upon the second-period income that they derive from investment banking divisions. Hence, tying structures always dominate non-tying structures when $L > S$ because both types of bank implement the same closure policy in this parameter region. For $L \leq S$, tying banks always rescue failed entrepreneurs; a non-tying bank will therefore dominate precisely when the positive effect that a hard budget constraint has upon entrepreneurial effort incentives outweighs the corresponding loss of investment banking revenue that tying banks derive from rescued entrepreneurs. This is the case when S is not too great.

3.1.c. Welfare

Recall from Section 2.2 that welfare is defined to be the sum of the expected surplus that accrues to all the agents in the economy. Proposition 2 details the socially optimal policy and compares it to the bank's privately optimal choice of organizational form.

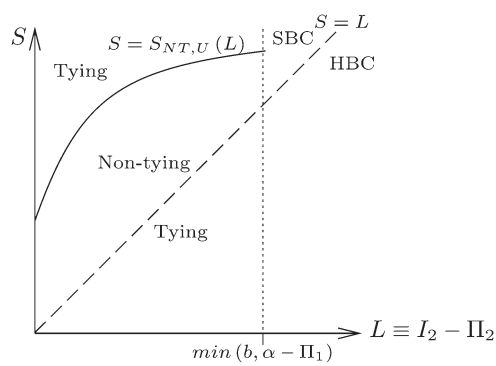

Figure 2. Privately optimal authority structures. When $L > S$, the entrepreneur faces a hard budget constraint irrespective of the strategy adopted by his universal bank, and the bank operates as a tying bank. When $L \leq S$, the entrepreneur faces a soft budget constraint. When the surplus it could make from rescuing unsuccessful entrepreneurs and selling them investment banking services is not too high, the bank will elect to operate as a non-tying bank.

Proposition 2. *At Time 0, the socially optimal bank structure is nonmonotonic in the investment banking surplus S. Tying is socially optimal for* $S \leq L$ *and for* $S > \max(\Sigma_{\mathrm{NT,T}}(L), L)$*, where* $\Sigma_{\mathrm{NT,T}}(L)$ *is an increasing function of L with* $\Sigma_{\mathrm{NT,T}}(L) < S_{\mathrm{NT,T}}(L)$*; non-tying is socially optimal for* $L < S \leq \Sigma_{\mathrm{NT,T}}(L)$.

Proposition 2 is illustrated in Figure 3. The social indifference curve $\Sigma_{\mathrm{NT,T}}(L)$ between non-tying and tying banks is indicated on the figure as a bold line. Note that $\Sigma_{\mathrm{NT,T}}(L)$ lies below the corresponding private indifference curve $S_{\mathrm{NT,T}}(L)$. In the region between the social and private indifference curves, the banker opts not to run a tying bank, although it would be socially better to do so; outside this region, the banker's private choice of authority structure coincides with the social optimum.

From a social point of view, the bank is insufficiently willing to tie commercial and investment banking when $L \leq S$, and the entrepreneur faces a soft budget constraint. On the one hand, when it ties, the bank undervalues entrepreneurial effort (its marginal benefit to the tying bank is $\Pi_1 - R_1$, while it is $\Pi_1 - R_1 + b$ when the bank does not tie); on the other hand, entrepreneurial effort is cheaper to incentivize when the bank does not tie than when it does. This is because entrepreneurial incentives are provided through the threat of liquidation when banks do not tie, and the associated cost b is not internalized by the banker. The second effect outweighs the first, and the banker has a bias against tying.

Proposition 2 is striking because it appears to run against the thrust of recent policy discussions on tying. Most policy makers assume that tying is damaging. Assuming that universal banks can monopolize their customers in the commercial

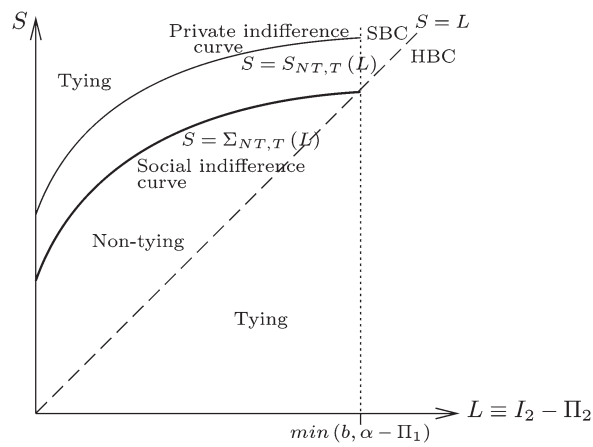

Figure 3. Socially and privately optimal authority structures. The social surplus derived from non-tying and tying banks when $L \leq S$ is identical along the bold dividing line that separates them; the private surplus derived by the bank is identical along the non-bold lines. Hence, bankers are socially insufficiently willing to run tying banks.

and investment banking markets generates the surprising conclusion that, from a social perspective, tying levels will be insufficient. Regulations designed to prevent tying may actually reduce welfare.

3.2 INVESTMENT BANKING COMPETITION

So far, we have assumed that universal banks can monopolize their investment banking customers. We now relax this assumption: in practice, universal banks face competition in a number of businesses that are characterized by lower information and switching costs than lending (DeYoung and Roland, 2001). Hence, in this section, we assume that an imperfectly competitive market exists for investment banking services. By Assumption 4, the investment banking surplus cannot form the basis of a long-term Time 0 contract. It follows that banks are unable to write Time 0 financing contracts that insulate them from the effects of Time 1 competition in the investment banking market. Since, by Assumption 4, the investment banking surplus is not verifiable, it is impossible to contract at Time 0 over the allocation of this surplus between the entrepreneur and the universal bank. Hence, the Time 1 distribution of the surplus depends upon competition levels in the Time 1 market for investment banking services. We discuss the cases of entrepreneurial success and failure separately.

We continue to assume in this section that banks are monopoly lenders at Times 0 and 1. Once again, Assumption 4 guarantees that non-tying banks liquidate unsuccessful entrepreneurs at Time 1.

A successful entrepreneur is free to buy investment banking services from any market participant and hence can shop around for the best deal. We assume that because it competes for business, the entrepreneur's bank extracts a surplus $S(N) \leq S$ from the investment banking business that it transacts with the entrepreneur, where $N \geq 0$ is an index of market competition and $S(.)$ is a continuous differentiable function with $S(1) = S$, $S'(N) < 0$, and $\lim_{N \to \infty} S(N) = 0$. The remainder $S - S(N)$ of the surplus accrues to the entrepreneur.

Unsuccessful entrepreneurs rely upon their bank for continuation finance and cannot buy investment banking services without it. This monopoly power in lending allows the bank to extract all the future returns from an unsuccessful entrepreneur, including those from investment banking products. In the language of the foreclosure literature (Rey and Tirole, 2007), the bank controls an "essential facility": in this case, the supply of continuation finance. As the entrepreneur cannot remain in business without an additional loan, the bank can extend its monopoly power in lending and, hence, eliminate potential competition from its rivals in the investment banking market.

Proposition 3 discusses the effect that investment banking competition has upon observed contracts.

Proposition 3. *Competition in the investment banking has the following effect upon equilibrium outcomes:*

1. Entrepreneurial effort and the interest rate in non-tying banks increase relative to the monopolistic case by $\frac{1}{2\gamma}(S - S(N))$ *and* $\frac{1}{2}(S - S(N))$*, respectively. The social surplus and the profitability of non-tying banks are increasing in the level N of competition in the investment banking market;*
2. The interest rate charged by tying banks increases by $S - S(N)$*. The entrepreneurial effort, the profitability, and the social surplus generated by tying banks is unaffected by the level of competition in the investment banking market.*

To understand Part 1 of the proposition, note that higher levels of competition in the investment banking market increase the proportion of the surplus S that accrues to the entrepreneur and so heighten his incentives to exert effort. As a result, there is less need for the bank to set low interest rates to induce entrepreneurial effort. The net effect with heightened investment banking competition in non-tying banks is therefore higher entrepreneurial effort, higher interest rates, increased bank profitability, and increased social surplus.

Part 2 of Proposition 3 indicates that tying banks are insulated from the effects of competition. This observation has the following simple intuitive explanation. Given his demand for the Time 0 loan and for Time 1 investment banking services, the entrepreneur selects an effort level contingent upon the sum of the interest rate R_1 and the part of the investment banking surplus that he pays to the bank and not upon their individual values. Hence, because it is a monopolist in the loan market, the bank can always compensate for a lower share of the investment banking surplus by raising the interest rate R_1. The bank is therefore able to induce the effort level that it would have selected absent competition and to generate the same profit.

In contrast to tying banks, heightened competition in the investment banking market raises the profitability of non-tying banks. This result is perhaps rather surprising. It arises because, in the second-best world that we model, banks are unable to contract *ex ante* upon the division of S and, hence, they cannot use it to incentivize entrepreneurial effort. Heightened levels of competition moves non-tying banks closer to the optimal incentive contract by allowing their entrepreneurs to capture a fraction of S. Competition therefore has a similar effect for non-tying banks as a device that commits them *ex ante* to giving entrepreneurs performance-related pay. This device is unavailable for tying banks because they will always reverse its effects by altering their lending rate, R_1.

Proposition 3 shows that competition in the investment banking market increases the interest rate charged in both tying and non-tying banks. The increase in a tying bank is twice as big as the increase in a non-tying bank. Indeed, for a sufficiently competitive investment banking market, a tying bank may even charge a higher

interest rate than a non-tying bank. This observation casts doubt upon the suggestion of the United States General Accounting Office (2003) that lower interest rates may be evidence of illegal tying.

We now turn to the welfare effects of investment banking competition. We start by identifying the effect that competition has upon the bank's choice of authority structure.

Lemma 3. *Heightened investment banking competition expands the set of parameters for which non-tying banks are selected.*

This result is a straightforward consequence of the observation in Proposition 3 that increasing investment bank competition raises the profitability of non-tying banks, without affecting the profitability of tying banks.

Recall from Proposition 2 that, in the absence of competition, universal banks are socially excessively biased against tying commercial and investment banking business. The welfare implications of increasing the competition parameter N follow from two observations. First, heightened competition serves to increase effort in non-tying banks, which renders them more socially desirable and so diminishes the non-tying bias. Second, by Lemma 3, increased competition in the investment banking market expands the parameter set for which non-tying banks are selected: this effect increases the non-tying bias.

Which of the two welfare effects identified in the preceding paragraph dominates depends upon the specification of $S(N)$: even monotonicity of the welfare effect of heightened investment banking competition is not guaranteed. However, we are able to draw some general conclusions about the effect upon welfare in the limiting case where there is perfect competition in the investment banking market.

Proposition 4. *There exist feasible parameterizations for which, with a sufficiently high level of competition in the investment banking market, tying banks are privately preferred to non-tying banks, while non-tying banks are preferred from a social perspective.*

The proof of Proposition 4 identifies two types of parameterizations for which, from a social point of view, there is excessive tying. The first type has low b, so that the social damage caused by liquidating unsuccessful projects is not too great; in the second type, α is high, which makes it costly to generate high enough entrepreneurial effort levels, so that the effort effect identified above is particularly important.

Proposition 4 shows that, with an appropriate parameterization, introducing investment bank competition can reverse the private bias against tying identified in Proposition 2. On the one hand, non-tying banks induce higher effort levels with investment banking competition and, hence, become relatively more attractive from both a social and a private point-of-view. On the other hand, tying banks

are able to extract a greater share of the *ex post* continuation surplus; this effect is socially neutral because it relates to the distribution of surplus, but it is privately advantageous for the tying bank. Hence, the marginal gain from switching from a tying to a non-tying structure is greater from a social than a private perspective. For high levels of competition, this yields Proposition 4.

3.3 COMMERCIAL BANKING COMPETITION

So far, we have ignored the existence of competition in the commercial banking market. This assumption is reasonable for many of the relationships between banks and entrepreneurs.[16] However, there may be some, imperfect, competition to lend, particularly at Time 0, when all lenders face the same informational barriers to lending. In this section, we examine the consequences of such competition.

Intuitively, Time 0 and Time 1 competition to lend occur in different markets. Time 0 competition is competition to form a relationship with a new entrepreneur, after which the initial lender acquires information assets that give it an advantage in Time 1 competition (e.g., see Bhattacharya and Nanda, 2000; Kanatas and Qi, 1998, 2003). The time 0 lender's informational advantage is augmented if the seniority of initial claims deters new lenders.[17] In contrast, one can think of Time 1 competition as arising in a market where Time 0 entrepreneurs could be of high or low quality, so that banks face Time 0 adverse selection. In this situation, geographically local banks may have a Time 0 informational advantage over more distant competitors; this advantage dissipates as entrepreneurial businesses mature, so that at Time 1 bank competition is more intensive: see Jappelli and Pagano (1993) for a model along these lines.

First, we examine the situation where there is Time 1 competition to lend. Since it is only worth lending to unsuccessful entrepreneurs if the loan can be tied to investment banking business, the effect of Time 1 competition will be to supply tied lending and investment banking. Provided the investment banking business is sufficiently profitable, unsuccessful entrepreneurs will always be able to attract continuation finance, and hence, they face a soft budget constraint. As non-tying no longer hardens the entrepreneur's budget constraint, it will never be selected. Hence, all banks will adopt centralized authority structures and will tie investment and commercial banking.

The welfare effects of Time 1 bank competition are ambiguous. With Time 1 competition, all banks tie: Proposition 2 indicates that this is not the optimal policy.

[16] See Footnote 10 for supporting references.

[17] While super-priority of new finance can occur in bankruptcy, as in Chapter 11 of the US bankruptcy code, numerous studies find that banks rarely forgive debt to firms in financial distress (see Asquith, Gertner, and Scharfstein, 1994; Franks and Sussman, 2005); in line with these observations, Gertner and Scharfstein (1991) show that as a result of debt overhang problems, new financing for distressed firms is likely to come from existing senior lenders.

On the other hand, Proposition 2 states that without such competition there is too little tying from a social perspective. Whether or not the excessive tying induced by Time 1 competition welfare-dominates the lack of tying that arises without competition depends on the model parameters.

Now suppose that there is Time 0 competition to lend. In this case, banks will choose between tying and non-tying so as to generate the highest possible *ex ante* expected surplus, and they will compete this surplus away. Hence, the Time 1 tying decision will be unaffected by Time 0 competition. However, because Time 0 competition results in lower interest rates, it generates higher entrepreneurial effort and, hence, in higher welfare.

Proposition 5 summarizes our discussion.

Proposition 5.

1. Time 0 competition in the lending market does not affect the equilibrium choice between running a tying bank and a non-tying bank. It increases the surplus that accrues to entrepreneurs and raises welfare;
2. When there is Time 1 competition in the lending market, all banks are tying banks. Entrepreneurial effort levels are reduced. The welfare effect is ambiguous.

Proposition 5 indicates that the welfare effects of competition depends upon the stage in the entrepreneur's business life cycle at which the competition occurs. While competition to lend to new businesses is welfare enhancing, competition to lend to mature businesses need not be.

4. Empirical Implications

In this section, we discuss the empirical predictions that follow from our model and, where applicable, we relate them to the existing literature.

We assume in this paper that it is not possible to prove in court that an investment bank has tied lending to investment banking business; this assumption reflects the difficulties that supervisors have experienced in identifying and prosecuting cases of illegal tying. Similarly, it is hard for the econometrician to identify unambiguously whether or not tying has occurred, and hence, we cannot present empirical hypotheses based upon tying strategies.

In our model, banks select an authority structure in order to commit to a tying strategy. This is necessary because at Time 1, banks will always elect to tie if it is possible. Hence, devolved authority structures can be effective only if they make Time 1 tying infeasible, either by ensuring that a bank's headquarters is unable to identify or to interfere with lending decisions or by rendering cooperation between the commercial and investment banking divisions of the bank impossible. These

features have to be hardwired into the design of the bank. As a result, we contend that it is possible to categorize authority structures empirically.

It follows from the previous paragraph that devolved authority, which prevents tying, is characterized in practice by subsidiary structures. Subsidiary businesses are separately capitalized and managed and hence have a great deal of autonomy. At the same time, the commitment not to coordinate the activities of the commercial and investment bank subsidiaries can be reinforced by ensuring that they have separate reporting systems. A centralized authority structure requires consistent reporting systems across divisions and a coordinating central headquarters. Such coordination is easier when the universal bank operates as a single, multidivisional firm in which the commercial and investment banking businesses are divisions that report directly to the headquarters.

The relationship between organizational form, authority structure, and tying is important from a policy perspective. We return to this point in Section 6.

4.1 ACCESS TO FUNDS

In our model, tying increases willingness to lend because it increases the size of the lender's investment banking market. Hence, we obtain the following.

Hypothesis 1. *Centralized authority structures in universal banks increase corporate access to funds.*

As far as we are aware, Hypothesis 1 has not been directly tested. However, some existing works are consistent with the hypothesis. First, Petersen and Rajan (1994) find in a study of small business lending that firms face less stringent financial constraints when they buy more than one product from a bank. Second, Ramirez (1995) presents evidence that J. P. Morgan's banking customers at the turn of the twentieth century enjoyed a lower cash flow sensitivity of investment than their peers. The lower sensitivity suggests, in line with our work, that unsuccessful entrepreneurs were more likely to receive fresh financing because J. P. Morgan anticipated benefits from cross-selling. However, Fohlin (1998) is unable to find evidence that a relationship with one of Germany's nine universal "great banks" had a similar effect for nineteenth century German corporations.[18]

[18] This literature is related to Gerschenkron's (1962) classic study of economic development, in which he argues that universal banks allow the expert human capital of the banker to be most effectively brought to bear upon the organization of large-scale industry. Similarly, Gorton and Schmid (2000) argue that concentrating voting rights in universal banks improved firm performance in Germany between 1975 and 1985.

4.2 LOAN MARGINS AND PROFITABILITY

When $L \leq S$, universal banks with centralized authority structures cannot use the threat of liquidation to motivate entrepreneurs. When investment banking competition is low, they therefore incentivize entrepreneurs by charging lower interest rates than banks with a devolved authority structure (see Lemmas 1 and 2). This yields Hypotheses 2.

Hypothesis 2. *Universal banks with centralized authority structures charge lower interest margins than banks with devolved authority structures for low levels of investment banking competition.*

While we believe that it is possible to distinguish different universal bank authority structures, it is easier to distinguish between universal banks and stand-alone commercial banks. While we do not discuss stand-alone commercial banks in our model, it is clear that they make lending decision without reference to any possible benefit that could accrue from related investment banking business. Hence, their lending decisions will mirror those of a commercial banking division in a universal bank with a devolved authority structure. This argument yields the following hypothesis.

Hypothesis 3. *After controlling for variations in L, average interest margins across all universal investment banks are lower than in stand-alone commercial banks for low levels of investment banking competition.*

Recent work by Lepetit *et al.* (2008) confirms Hypothesis 3 in the European context. Lepetit *et al.* examine the effect of expansion into fee-based business upon 602 European banks between 1996 and 2002. They find that an increased income share from commissions and fees is associated with lower margins and loan spreads. Using US data, Drucker and Puri (2005) present evidence from deals in which underwriters lend to firms and simultaneously underwrite their seasoned equity offerings. In this case, consistent with Hypothesis 3, they find that loan spreads are lower than those for matched nonconcurrent loans.

Our model yields another prediction, which is closely related to the above point. We identify two factors that affect the profitability of the lending business within universal banks that tie lending and investment banking. First, tying banks charge lower interest rates than other banks. Second, tying universal banks provide continuation finance at a loss to entrepreneurs in order to profit from investment banking business. While both of these effects reflect rational decisions that increase the aggregate profitability of universal banks, both serve to reduce the profitability of the lending business. Hence, we have the following hypotheses.

Hypothesis 4. *Lending businesses are less profitable in universal banks with centralized authority structures than in those with devolved authority structures.*

Hypothesis 5. *The average profitability of lending businesses across all universal banks is lower than in stand-alone commercial banks.*

Recent work that examines the relationship between total bank profitability and organizational form is cited in Section 1. However, we are unaware of a direct test of Hypotheses 4 and 5, although Edwards and Fischer (1994) argue that German universal banks appear to make lower quality loans than do specialized banks; Vander Vennet (2002) finds that specialized banks are more efficient in traditional intermediation activities, while conglomerates outperform when nontraditional activities are included.

Finally, our analysis indicates that, when $L < S$, entrepreneurial effort is lower in tying banks than in non-tying banks. Lower entrepreneurial effort translates in our model to greater credit risk, which generates the following hypotheses.

Hypothesis 6. *Universal banks with centralized authority structures have riskier credit portfolios than those with devolved authority structures.*

Hypothesis 7. *The average riskiness of loan portfolios in universal banks is higher than in stand-alone commercial banks.*

Consistent with Hypothesis 7, DeYoung and Roland (2001) find a positive relationship between aggregate earnings volatility and fee-related business in US consolidated bank holding company data that predates the Gramm–Leach–Bliley Act; Barth, Caprio, and Levine (2004) find in a study of bank regulation in 107 countries that diversification into nonlending activities does not translate into higher quality loans. However, Hypotheses 6 and 7 have not been directly tested.

Finally, Proposition 3 demonstrates that the interest rate that universal banks charge is increasing in the competitiveness of the investment banking market. This is because heightened competition increases the income that accrues to a successful entrepreneur, which offsets the deleterious effect upon entrepreneurial effort of higher loan rates. This gives us the following hypothesis.

Hypothesis 8. *The interest rate that universal banks charge for loans is increasing in the competitiveness of the investment banking market.*

We are unaware of any test of Hypothesis 8.

4.3 COMPETITION AND AUTHORITY STRUCTURES

In our model, authority structures are an optimal response to competition levels in the banking industry. Lemma 3 shows that because heightened competition in the

investment banking business reduces the on-going value of a banking relationship, it reduces the attractiveness of tying. Hence, we have the following hypothesis.

Hypothesis 9. *Heightened levels of competition in the investment banking business should reduce incidence of centralized authority structures in universal banks.*

5. Robustness

This section examines the robustness of our results to two extensions to our base model. First, we demonstrate that our results are qualitatively unchanged when we allow the investment banking surplus generated by successful and unsuccessful entrepreneurs to differ. Second, we show that our results are robust to a relaxation of Assumption 1.

5.1 VARYING INVESTMENT BANKING SURPLUS

In our base model, the investment banking surplus is the same for all entrepreneurs, irrespective of whether they succeed or fail. This allows us to make our central point in a simple setting. However, it is reasonable to assume that entrepreneurs that are successful in the first period generate a higher investment banking surplus than those that fail in the first period. Hence, we examine in this section an extension of our base model, in which the surplus derived from investment banking business is S when transacted with an unsuccessful entrepreneur and is $S + \delta$ when transacted with a successful entrepreneur. We focus our discussion below on changes to our results in the extended model.

Lemma 4 identifies changes to the contracts that tying and non-tying banks write as a result of this extension.

Lemma 4. *Suppose that successful entrepreneurs generates investment banking surplus $S + \delta$ and that unsuccessful entrepreneurs generate surplus S. Then:*

1. The loan contract offered by a non-tying bank is precisely as detailed in Lemma 1; this generates the same entrepreneurial effort as in Lemma 1 and expected combined profit for the universal bank's commercial and investment banking divisions of $\frac{(\Pi_1+b)^2}{4\alpha} - I_1 + \frac{(S+\delta)}{2\alpha}(\Pi_1 + b)$;

2. The interest rate charged by a tying bank is precisely $\frac{\delta}{2}$ below the rate stated in Lemma 2; the corresponding entrepreneurial effort is $\frac{\delta}{2\alpha}$ higher than in Lemma 2, and the value of the tying bank is obtained by replacing Π_1 by $\Pi_1 + \delta$ in Equation (7).

The intuition for this result is straightforward. Non-tying banks do not account for the investment banking surplus when they make lending decisions, so the extension does not affect their interest rate choice. However, because the success

surplus increases by δ, the value of non-tying banks increases. This effect also applies to tying banks but is augmented by an additional incentive effect: because tying banks internalize the relatively lower investment banking profits from failed entrepreneurs, they lower R_1; this induces a higher effort level e and, hence, raises the probability of success.

Lemma 5 examines the social and private trade-off between tying and non-tying banks. It shows that the results of Propositions 1 and 2 are robust to the introduction of a positive difference δ between the investment banking surplus generated by successful and unsuccessful entrepreneurs. In particular, the bank's excessive bias against tying becomes more severe as δ increases.

Lemma 5. *Suppose that successful entrepreneurs generates investment banking surplus $S + \delta$ and that unsuccessful entrepreneurs generate surplus S. Then:*

1. The Time 0 optimal authority structure for the bank is given by Proposition 1, with the indifference curve $S_{\mathrm{NT,T}}(L)$ replaced by the curve $S^{\delta}_{\mathrm{NT,T}}(L)$. $S^{\delta}_{\mathrm{NT,T}}(L)$ is an increasing function of L, and $S^{\delta}_{\mathrm{NT,T}}(L) > S_{\mathrm{NT,T}}(L)$ precisely when $\delta < (b - L)$;

2. The Time 0 socially optimal authority structure for the bank is given by Proposition 2, with the indifference curve $\Sigma_{\mathrm{NT,T}}(L)$ replaced by the curve $\Sigma^{\delta}_{\mathrm{NT,T}}(L)$. $\Sigma^{\delta}_{\mathrm{NT,T}}(L)$ is an increasing function of L, and $\Sigma^{\delta}_{\mathrm{NT,T}}(L) > \Sigma_{\mathrm{NT,T}}(L)$ precisely when $\delta < \frac{1}{3}(4b - 2\Pi_1 - 6L)$.

3. The difference $S^{\delta}_{\mathrm{NT,T}}(L) - \Sigma^{\delta}_{\mathrm{NT,T}}(L)$, and, hence, the excessive bias against tying, is an increasing function of δ.

The intuition for Parts 1 and 2 of Lemma 5 is similar. The two results examine the impact upon a bank that is indifferent from a private and a social welfare perspective, respectively, of an increase of δ in the investment banking surplus generated by a successful entrepreneur. Increasing δ raises the value of success and, hence, of entrepreneurial effort. This mitigates in favor of the non-tying bank structure because the hard budget constraint that it imposes upon entrepreneurs generates higher effort. However, when δ is very high, tying banks also place a high value on entrepreneurial success and, hence, upon effort. As a result, for high δ the increase in entrepreneurial effort that derives from a hard budget constraint may not be high enough to justify the attendant costs (i.e., the lost revenue from investment banking). Hence, a bank that is on the (private or social) indifference curve between tying and non-tying banks when $\delta = 0$ will shift toward non-tying banks when δ is small and positive and will favor the tying bank for high δ. This corresponds to an upward shift in the difference curve for low δ and a downward shift for high δ, as in the proposition.

Part 3 of the Proposition follows because the social indifference curve, which incorporates the entrepreneur's cost of closure, shifts down faster in response to

increases in δ than the private indifference curve, which ignores externalities imposed upon the entrepreneur.

5.2 $b < L$

Assumption 1 states that the private entrepreneurial cost b of liquidation exceeds the pecuniary cost L to the bank of continuation. Because continuation allows for the creation of investment banking surplus, this assumption is stronger than we need for continuation to be socially optimal. In particular, when $S + b > L$, continuation of failed projects is optimal from the social perspective even if $b < L$. In this section, we consider the effect of relaxing Assumption 1 upon our results.

First, consider the case where $b < L$, but $b + S > L$, so that continuation remains socially optimal. In this case, because $S > L$, the tying bank imposes a soft budget constraint upon the entrepreneur. The cost L to a tying bank of entrepreneurial failure exceeds the cost b to the entrepreneur in a non-tying bank. Hence, the tying bank values entrepreneurial effort more than the entrepreneur does in a non-tying bank. As a result, the tying bank induces a higher entrepreneurial effort than the non-tying bank. Tying banks are therefore socially preferred to non-tying banks for all parameter values. Hence, as in Section 3.1.3, banks are insufficiently willing from a social point of view to tie.

Now consider the case where $b + S < L$. In this case, continuation is never socially optimal, and, hence, will never happen in tying banks. Hence, because tying banks with a hard budget constraint induce higher effort than non-tying banks, tying banks are socially preferred for every L. Once again, banks are insufficiently willing to tie from a social perspective.

6. Conclusion

This paper examines the incentives that universal banks have to tie lending to investment banking business. Policy makers are critical of tying, which is seen as anticompetitive. However, bank competitiveness is influenced by several factors, only one of which is tying. An analysis of the welfare effects of tying should therefore acknowledge the combined effects of these other factors. We show that the desirability of anti-tying legislation depends upon the level of competitiveness of the investment banking market in the absence of tying.

The policy trade-off that we study is the following. When the entrepreneur extracts some of the surplus that he generates after receiving a loan, the income that can be pledged to the lender is reduced, and tying may be the only way that the lender can assure itself of an adequate return on capital. Hence, tying can

alleviate credit rationing and so raise welfare. On the other hand, when a bank is able to tie it may be unable to commit to withdraw funding from an unsuccessful entrepreneur. Hence, tying may reduce welfare by softening the entrepreneur's budget constraint and reducing his equilibrium effort level.

The relative sizes of these effects depend upon the competitiveness of the investment banking market. When the market is highly competitive, the profitability of investment banking business is increased by tying it to commercial lending. As a result, investment banking is more profitable when transacted with weak entrepreneurs, who need loans and hence can be tied. This diminishes the damage that low entrepreneurial effort does to the lender and so increases its incentive to perform socially suboptimal tying. However, when the investment banking market is uncompetitive, this effect does not obtain, and banks are relatively less inclined to tie lending and investment banking business. In fact, we demonstrate that in this case, there is too little tying from a social perspective.

Although tying is illegal in several countries, including the USA, it is hard to prove in court that it has occurred. The United States General Accounting Office (2003) argues that low-priced credit may be evidence of illegal tying, but in our analysis, the reverse may be the case when the investment banking market is competitive. The problems faced by bank supervisors are also faced by the econometrician, who finds it equally hard to incorporate tying directly into statistical tests. Our approach to this problem is to concentrate upon the effect that universal bank structure has upon tying incentives: institutional structure is observable and hence can serve as the basis for policy decisions.

Specifically, we consider two authority structures for universal banks. With devolved authority, lending decisions are made by commercial bankers who fail to internalize the benefits that their decisions might confer upon the investment banking division: as a result, devolved banks do not tie lending to investment banking business. With centralized authority, lending decisions are made by a headquarters that accounts for their aggregate effect upon the profitability of all bank divisions: it follows that centralized universal banks tie commercial and investment banking whenever it is profitable to do so.

Legislators could prevent tying by requiring investment banks to devolve lending authority to their commercial banking divisions. The Glass–Steagall Act of 1933 went further, achieving the same goal by outlawing universal banking altogether. Although Glass–Steagall prevented tying by legislating over organizational form, it was cruder than the approach we suggest, which would also prevent tying while at the same time allowing the realization of efficiency gains from universal banking.

Notwithstanding these observations, our analysis indicates that it may not be desirable to prevent tying. As noted above, this is the case when the investment banking market is uncompetitive, so that, from a social perspective, bankers have insufficient incentives to tie commercial and investment banking. Tying becomes

more of a problem, and devolved authority structures become more socially desirable, as the investment banking sector becomes more competitive.

Appendix

Throughout this appendix, we adopt the notational convention that equilibrium values are denoted by superscripts, while functions are denoted with subscripts. Hence, for example, $V_{\text{com}}^{\text{NT}}$ is the equilibrium value of the commercial bank division of a non-tying bank in the proof of Lemma 1, and $V_{\text{com,NT}}(e, R_1)$ is the value of the same division for arbitrary effort e and interest rate R_1; V^{NT} refers to the equilibrium profit of the entire non-tying universal bank.

Proof of Lemma 1:

The interest rate R_1 in a non-tying bank is set by the commercial banking division, which fails to account for any profits generated by the investment banking division. With entrepreneurial effort e, an interest rate R_1 generates expected profit $V_{\text{com,NT}}(e, R_1) \equiv eR_1 - I_1$ for the commercial banking division, and an expected utility $U_{\text{NT}}(e, R) \equiv e(\Pi_1 - R_1) - (1-e)b - \Psi(\text{e})$ for the entrepreneur. $U_{\text{NT}}(e, R_1)$ is maximized when $e = e_{\text{NT}}(R_1) \equiv \frac{b+\Pi_1-R_1}{\alpha}$. Substituting this value into $V_{\text{com,NT}}(e, R_1)$ and maximizing with respect to R_1 give us $R_1 = R_1^{\text{NT}}$; substituting R_1^{NT} into $e_{\text{NT}}(R_1)$ yields e^{NT}. The equilibrium value $V_{\text{com}}^{\text{NT}}$ of the commercial banking division is equal to $V_{\text{com,NT}}(e^{\text{NT}}, R_1^{\text{NT}})$; the combined value V^{NT} of the commercial and investment banking divisions is equal to $V_{\text{com}}^{\text{NT}}$, plus the value $Se^{\text{NT}} = \frac{S}{2\alpha}(\Pi_1 + b)$ of the investment banking division.

Proof of Lemma 2:

Let x be the probability that the bank will rescue an unsuccessful entrepreneur at Time 1. Because the bank cannot commit at Time 0 to a rescue policy, rescues occur precisely when they are profitable at Time 1; it follows that $x = 1$ when $L \leq S$ and $x = 0$ when $L > S$. The interest rate R_1 in a tying bank is set to maximize the total profit generated by the universal bank (in contrast to the non-tying bank of Lemma 1, which set R_1 to maximize the value of the commercial banking division). The total profit generated by the tying bank is given by $V_{\text{T}}(e, R_1, x) \equiv e(R_1 + S) + (1-e)x(R_2 + S - I_2) - I_1$. For a given interest rate R_1, closure policy x, and effort level e, the entrepreneur's expected utility is given by $U_{\text{T}}(e, R_1, x) \equiv e(\Pi_1 - R_1) - (1-e)(1-x)b - \Psi(e)$.

$U_{\text{T}}(e, R_1, x)$ is maximized when $e = e_{\text{T}}(R_1, x) \equiv \frac{\Pi_1 - R_1 + (1-x)b}{\alpha}$. Substituting $e = e_{\text{T}}(R_1, x)$ into $V_{\text{T}}(e, R_1, x)$ and maximizing with respect to R_1 give us $R_1 = R_1^{\text{T}}$; setting $R_1 = R_1^{\text{T}}$ in $e_{\text{T}}(R_1, x)$ yields e^{T}. Finally, $V^{\text{T}} = V_{\text{T}}(e_{\text{T}}(R_1^{\text{T}}, x), R_1^{\text{T}}, x)$.

Proof of Proposition 1:

For $S \leq L$, both tying and non-tying banks implement the same closure policy. Since only tying banks internalize the effects of their lending policy upon second-period revenue, they dominate in this region. When $L \leq S$, the difference between the expected value of a non-tying and a tying bank is

$$\begin{aligned}\Phi(L) &\equiv e^{NT}\left(R_1^{NT}+S\right)-\left(e_{SBC}^{T}\left(R_{1,SBC}^{T}+S\right)+\left(1-e_{SBC}^{T}\right)(S-L)\right)\\ &=\underbrace{\left(e^{NT}-e_{SBC}^{T}\right)\left(S+R_1^{NT}\right)+\left(R_1^{NT}-R_{1,SBC}^{T}\right)e_{SBC}^{T}}_{\text{Benefit of commitment to liquidate}}-\underbrace{\left(1-e_{SBC}^{T}\right)(S-L)}_{\text{Cost of commitment to liquidate}}\end{aligned} \quad \text{(A1)}$$

The first two terms in Equation (9) represent the increased expected income that the non-tying bank achieves from a commitment to liquidate unsuccessful entrepreneurs; this derives from a higher equilibrium effort level and a higher equilibrium interest rate. The third term in the equation represents the foregone investment banking revenue from liquidated entrepreneurs. $\Phi(L)$ is positive precisely when $S \geq S_{\mathrm{NT,T}}(L) \equiv L - b - \frac{(L-b)^2-4b\alpha}{2(2\alpha-\Pi_1-b)}$. $S_{\mathrm{NT,T}}(L)$ has an inverted-U shape because, by Assumptions 2 and 6, $2\alpha - \Pi_1 - b > 0$.

$S_{\mathrm{NT,T}}(L)$ attains its maximum when $L = 2\alpha - \Pi_1$; since, by Assumption 2, $L < \alpha - \Pi_1$, it follows that $S_{\mathrm{NT,T}}(L)$ is increasing in L within the feasible parameter range.

Proof of Proposition 2:

The welfare generated when the entrepreneur exerts effort e and faces a hard budget constraint is given by Equation (10):

$$W_{\mathrm{HBC}}(e) \equiv -I_1 + e(\Pi_1 + S) - (1-e)b - \psi(e). \quad \text{(A.2)}$$

Note that because non-tying banks always impose hard budget constraints, the welfare that non-tying banks generate is given by $W^{\mathrm{NT}} = W_{\mathrm{HBC}}(e^{\mathrm{NT}})$.

When $L > S$, tying banks also impose a hard budget constraint and therefore generate welfare $W_{\mathrm{HBC}}^{\mathrm{T}} = W_{\mathrm{HBC}}(e_{\mathrm{HBC}}^{\mathrm{T}})$. Moreover, it is clear from Figure 1 that $e^{\mathrm{T}} > e^{\mathrm{NT}}$ when $L > S$, so that the banker selects the socially optimal authority structure in this case.

We now consider the case where $L \leq S$. For this parameterization, tying banks impose a soft budget constraint and hence generate the welfare $W_{\mathrm{SBC}}^{\mathrm{T}}$ given by Equation (A.3):

$$W_{\mathrm{SBC}}^{\mathrm{T}} \equiv -I_1 + S + e_{\mathrm{SBC}}^{\mathrm{T}}\Pi_1 - (1-e_{\mathrm{SBC}}^{\mathrm{T}})L - \psi(e_{\mathrm{SBC}}^{\mathrm{T}}). \quad \text{(A.3)}$$

The social surplus derived from tying and non-tying banks is the same when $W_{\mathrm{SBC}}^{\mathrm{T}} = W^{\mathrm{NT}}$; this is the case precisely when

$$S = \Sigma_{\mathrm{NT,T}}(L) \equiv \frac{(b-L)(3(b+L)-8\alpha+6\Pi_1)}{4(2\alpha-b-\Pi_1)};$$

for lower values of S, $W^{\mathrm{T}}_{\mathrm{SBC}} < W^{\mathrm{NT}}$, and for higher values of S, $W^{\mathrm{T}}_{\mathrm{SBC}} > W^{\mathrm{NT}}$. Finally,

$$S_{\mathrm{NT,T}}(L) - \Sigma_{\mathrm{NT,T}}(L) = \frac{8\alpha b-(b-L)(2\Pi_1+L+b)}{4(2\alpha-\Pi_1-b)}.$$

The denominator of this expression is positive by Assumptions 2 and 6. The numerator can be written as follows:

$$\begin{aligned} L(2\Pi_1+L+b)+b(8\alpha-2\Pi_1-L-b) &> L(2\Pi_1+L+b)+b(8\alpha-3\Pi_1-3L) \\ &> L(2\Pi_1+L+b)+5b(\Pi_1+L), \end{aligned}$$

where the first inequality follows from Assumption 6 and the second from Assumption 2. This expression is positive, as required.

Proof of Proposition 3:

When there is competition in the investment banking market, the investment bank surplus earned is reduced from S to $S(N)$ and the entrepreneur's *ex post* utility is increased by $S - S(N)$ when he is able to transact investment banking business. However, only tying banks internalize these effects when they make lending decisions because non-tying banks select interest in order to maximize the value of the commercial banking division. The respective objective functions $\widehat{V}$ and $\widehat{U}$ for banks and entrepreneurs with competition in non-tying and tying banks are therefore as follows:

$$\begin{aligned} \widehat{V}_{\mathrm{com,NT}}(e,R_1) &\equiv eR_1 - I_1; \\ \widehat{U}_{\mathrm{NT}}(e,R_1) &\equiv e(\Pi_1 - R_1 + S - S(N)) - (1-e)b - \Psi(e); \\ \widehat{V}_{\mathrm{T}}(e,R_1,x) &\equiv e(R_1 + S(N)) + (1-e)x(R_2 + S - I_2) - I_1; \\ \widehat{U}_{\mathrm{T}}(e,R_1,x) &\equiv e(\Pi_1 - R_1 + S - S(N)) - (1-e)(1-x)b - \Psi(e). \end{aligned}$$

A standard maximization of the type performed in the proofs of Lemmas 1 and 2 then yields the following values for equilibrium effort levels and interest rates in non-tying banks:

$$\begin{aligned} \widehat{e}^{\mathrm{NT}} &= e^{\mathrm{NT}} + \tfrac{S-S(N)}{2\alpha}; \\ \widehat{R}_1^{\mathrm{NT}} &= R_1^{\mathrm{NT}} + \tfrac{S-S(N)}{2\alpha}. \end{aligned}$$

The profitability $\widehat{V}^{\mathrm{NT}}$ of non-tying universal banks with investment banking competition is given by Equation (A.4):

$$\begin{aligned}\widehat{V}^{\mathrm{NT}} &= \widehat{V}_{\mathrm{com,NT}}(\widehat{e}^{\mathrm{NT}}, \widehat{R}_1^{\mathrm{NT}}) + \widehat{e}^{\mathrm{NT}} S \\ &= \frac{(S - S(N) + \Pi_1 + b)(3(S - S(N)) + \Pi_1 + b)}{4\alpha} - I_1. \end{aligned} \tag{A.4}$$

The welfare generated by a non-tying bank with competition is obtained by substituting $e = \widehat{e}^{\mathrm{NT}}$ into Equation (10). After some simplification, we obtain

$$\widehat{W}^{\mathrm{NT}} = \frac{3(S + \Pi_1)^2 + 3b(2S + 2\Pi_1 + b) - S(N)(2(S + \Pi_1 + b) + S(N))}{8\alpha}.$$

Since $S(N)$ is decreasing in the level N of competition, it is immediate by inspection of the expressions for $\widehat{V}^{\mathrm{NT}}$ and $\widehat{W}^{\mathrm{NT}}$ that both are increasing in N. This concludes the proof of the first part of the proposition.

For the second part of the proposition, we again follow the proofs of Lemmas 1 and 2 to obtain

$$\begin{aligned}\widehat{e}^{\mathrm{T}} &= e^{\mathrm{T}}, \\ \widehat{R}_1^{\mathrm{T}} &= R_1^N + (S - S(N)).\end{aligned}$$

Substituting these values into the expressions for $\widehat{V}_{\mathrm{T}}(e, R_1, x)$ and $\widehat{U}_{\mathrm{T}}(e, R_1, x)$ in the cases where $x = 0$ and $x = 1$ gives us the equilibrium values $\widehat{V}^{\mathrm{T}}$ and $\widehat{U}^{\mathrm{T}}$, which are equal to the equilibrium values V^{T} and U^{T} that obtain in the absence of competition.

Proof of Proposition 4:

First, recall from Proposition 3 that, irrespective of the level N of competition in the investment banking market, the private value V^{T} of a tying bank is given by Equation (7) and that it generates an N-invariant social welfare $W^{\mathrm{T}}_{\mathrm{SBC}}$, given by Equation (A.3).

It is straightforward to show that the equilibrium effort level $\widehat{e}^{\mathrm{NT}}(N)$ and the interest rate $\widehat{R}_1^{\mathrm{NT}}$ for non-tying banks with a competition index N for the investment banking business are given by the following expressions:

$$\widehat{e}^{\mathrm{NT}} \equiv \frac{1}{2\alpha}(\Pi_1 + S - S(N) + b), \tag{A.5}$$

$$\widehat{R}_1^{\mathrm{NT}} \equiv \frac{1}{2}(\Pi_1 + S - S(N) + b). \tag{A.6}$$

Hence, the corresponding private value $\widehat{V}^{\mathrm{NT}}(N)$ generated by non-tying bank is as follows:

$$\begin{aligned}\widehat{V}^{\mathrm{NT}}(N) &\equiv \widehat{e}^{\mathrm{NT}}(\widehat{R}_1^{\mathrm{NT}} + S(N)) - I_1 \\ &= \tfrac{1}{4\alpha}((\Pi_1 + S + b)^2 - S(N)^2) - I_1.\end{aligned}$$

The social value $\widehat{W}^{\mathrm{NT}}(N)$ generated by the non-tying bank is as follows:

$$\widehat{W}^{\mathrm{NT}}(N) \equiv \widehat{e}^{\mathrm{NT}}(\Pi_1 + S) - (1 - \widehat{e}^{D})b - I_1.$$

Straightforward manipulations now give us

$$\begin{aligned} W_\Delta(S) &\equiv \lim_{N \to \infty} (W^{\mathrm{T}} - \widehat{W}^{\mathrm{NT}}(N)) \\ &= -\tfrac{(b-L+S)(3(b+L+S)-8\alpha+6\Pi_1)}{8\alpha} \end{aligned}$$

and

$$\begin{aligned} V_\Delta(S) &\equiv \lim_{N \to \infty} (V^{\mathrm{T}} - \widehat{V}^{\mathrm{NT}}(N)) \\ &= \tfrac{-(b+S)^2 + L(L-4\alpha) + 4S\alpha - 2(b-L+S)\Pi_1}{4\alpha}. \end{aligned}$$

Now observe that

$$\begin{aligned} W_\Delta(S') &= 0, \\ V_\Delta(S') &= \tfrac{1}{9}(8\alpha - 6(L + \Pi_1)) - b, \end{aligned}$$

where $S' = -b - L + \frac{8\alpha}{3} - 2\Pi_1$. By Assumption 2, $\alpha > \Pi_1 + L$. Hence, $V_\Delta(S') > 0$ whenever $\alpha > 9b/2$. Then for S marginally above S', $W_\Delta < 0$ and $V_\Delta > 0$, so that non-tying banks are socially preferred to tying banks, while private preferences run in the opposite direction.

Proof of Lemma 4:

Part 1: Since the non-tying bank does not internalize the profits generated by a successful entrepreneur, it makes precisely the same interest rate and closure decisions when $\delta > 0$ as it does when $\delta = 0$. Hence, the only effect that δ has upon the universal bank is via the effect that it has upon the post-success value $e(S + \delta)$ of the entrepreneur.

Part 2: The value of a tying bank with positive δ is $V_{\mathrm{T}}^{\delta}(e, R_1, x) \equiv e(R_1 + S + \delta) + (1 - e)x(R_2 + S - I_2) - I_1$; the entrepreneur's expected utility is given by the expression $U_{\mathrm{T}}(e, R_1, x)$ in the proof of Lemma 2. Following the proof of Lemma 2, with V_{T}^{δ} in place of V_{T} yields the required results.

Proof of Lemma 5:

Part 1: Replacing the value of universal banks with and without tying employed in the proof of Proposition 1 with the values presented in Lemma 4 and proceeding as in the proof of Proposition 1 give us a private indifference curve between tying and non-tying banks equal to $S^{\delta}_{\mathrm{NT,T}}(L) \equiv L - b - \frac{(L+\delta-b)^2 - 4b\alpha}{2(2\alpha - \Pi_1 - b)}$. $S^{\delta}_{\mathrm{NT,T}}(L) - S_{\mathrm{NT,T}}(L) = \frac{b-L-\delta}{2\alpha - \Pi_1 - L}$, which is positive precisely when $\delta < b - L$.

Part 2: Following the proof of Proposition 2, we have the following expressions for welfare when $\delta > 0$, analogous to $W^{\mathrm{T}}_{\mathrm{SBC}}$ and W^{NT}:

$$W^{\mathrm{T},\delta}_{\mathrm{SBC}} \equiv -I_1 + S + e^{\mathrm{T},\delta}_{\mathrm{SBC}}(\Pi_1 + \delta) - (1 - e^{\mathrm{T},\delta}_{\mathrm{SBC}})L - \psi(e^{\mathrm{T},\delta}_{\mathrm{SBC}}),$$
$$W^{\mathrm{NT},\delta} \equiv -I_1 + e^{\mathrm{NT},\delta}(\Pi_1 + S + \delta) - (1 - e^{\mathrm{NT},\delta})b - \psi(e^{\mathrm{NT},\delta}),$$

where the effort levels $e^{\mathrm{T},\delta}_{\mathrm{SBC}}$ and $e^{\mathrm{NT},\delta}$ correspond to the effort levels for tying banks with a soft budget constraint and for non-tying banks that are identified in Lemma 4. Proceeding as in the proof of Proposition 2, we substitute these effort levels and set $W^{\mathrm{T},\delta} = W^{\mathrm{NT},\delta}$; this yields the following social indifference curve between tying and non-tying banks:

$$S = \Sigma^{\delta}_{\mathrm{NT,T}}(L) \equiv \frac{(b - L)(3(b + L) - 8\alpha + 6\Pi_1) + 2\delta(2b - 3L - \Pi_1) - 3\delta^2}{4(2\alpha - b - \Pi_1)}.$$

Straightforward manipulation gives us the following:

$$\Sigma^{\delta}_{\mathrm{NT,T}}(L) - \Sigma_{\mathrm{NT,T}}(L) = \frac{\delta(4b - 2\Pi_1 - 6L - 3\delta)}{4(2\alpha - b - \Pi_1)},$$

from which the result follows.

Part 3: The difference between the private and the social indifference curves when $\delta > 0$ is as follows:

$$S^{\delta}_{\mathrm{NT,T}}(L) - \Sigma^{\delta}_{\mathrm{NT,T}}(L) = \frac{(L - b + \delta)(2\Pi_1 + L + \delta + b) + 8\alpha b}{4(2\alpha - \Pi_1 - b)}.$$

The derivative of this expression is

$$\frac{\mathrm{d}}{\mathrm{d}L}(S^{\delta}_{\mathrm{NT,T}}(L) - \Sigma^{\delta}_{\mathrm{NT,T}}(L)) = \frac{\Pi_1 + L + \delta}{2(2\alpha - \Pi_1 - b)} > 0,$$

as required.

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