Does Competition Kill Relationships?
Inside Investment Banking[*]

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Abstract

An influential literature has emerged around the premise that there exists an uneasy tension between (1) bank-firm relationships that promote incentives for firm–specific investments by banks, and (2) competition between banks that can destroy such incentives. This paper studies the industrial organization of the investment banking market in order to shed light on how this tension may be resolved. This market is ideally suited to study this question because there is a vast literature establishing the fact that it is characterized by both relationships and competition.

The model studies the impact on relationships of four different faces of competition: non-exclusive relationships between banks and firms, competition from arm's-length banks, non-price competition, and endogenous entry. The key premise of the model is that relationships involve sunk and non-verifiable costs. The first set of implications provide "possibility" results, which show how relationships are sustainable in the face of each of the four types of competition. Further, banks are shown to establish relationships without either local or aggregate monopoly power. A second set of results yields predictions on several characteristics of the observed market structure. Vertical segmentation, invariance of market concentration to market size in the relationship segment, and a competitive fringe that coexists with a stable oligopoly in equilibrium, characterize market structure. The model is applied to study the effects of global competition, and to provide a logic for antitrust analysis.

Key words: investment banking, loose linkage, relationships, nonverifiability, sunk costs.
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1. Introduction

Banking is characterized by the existence of long-standing relationships between banks and their customers (e.g., Diamond 1991, Berglöf and von Thadden 1994, Petersen and Rajan 1995, and Boot 2000). A key insight of previous studies is that banks need some market power to sustain such long-term relationships. However, the trend in these markets is towards increased competition and openness. Some observers would also claim that in practise these markets are already characterized by some degree of competition. The central question is then, can relationships survive more competition? And, what exactly is the effect of competition on relationships?

Boot and Thakor (2000) have recently looked at this question head-on. They study competition from two sources—interbank competition and competition from the capital market—and their effect on relationships between commercial banks and firms. In their model, relationships differentiate banks from one another. In addition, investments in relationships face competition from arm's length lending that is done by banks or via the capital market. This setting yields the somewhat surprising result that competition need not destroy relationships. The reason is that with competition, rents from (differentiated) relationships fall less than rents from using an arm's-length technology which does not distinguish banks from one another. Thus, the *relative* attractiveness of investments in relationships increases with competition.

This paper tries to answer the same set of questions with a different approach. Boot and Thakor examine a model where relationships and competition interact, which can then be used to study the impact of *imminent* competition (as in commercial banking). Instead, this study primarily seeks to understand the effect of *existing* competition on the industrial organization of the investment banking market. This industry is ideally suited to study the tension between relationships and competition because there is a vast literature establishing the fact that, for many decades, it has been characterized by both relationships and competition.[1] The characteristics of this market therefore serve as the basis of the modeling approach here. The model itself embodies two key differences from Boot and Thakor. Specifically, banks cannot directly charge firms for the sunk relationship costs that they incur, and relationships do not per se differentiate banks. Consequently, both the benefits from market power and the source of rents are endogenous to the model.

Competition in investment banking occurs along four key dimensions. First, the market structure is characterized by the existence of a large number of banks (more than 1,100 in the United States). Second, each firm is also involved with many different banks which offer similar

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[1]Long-term relationships between investment banks and corporations have always been important in the U.S. investment banking market, and the sunk costs incurred by investment banks in establishing and maintaining each relationship are large. See Eccles and Crane (1988), Nanda and Warther (1998) and Wilhelm and Downing (2001) for descriptions of relationships between investment banks and firms, and trends in the strength of these relationships.

services, so there is no exclusive dealing. Third, regulation does not "contaminate" the observed market structure. Rather, there is free entry and exit. Fourth, there is evidence that there is fierce nonprice competition. Examples include the expenditures on sales effort by banks to generate demand for their advisory services. In this paper, we study how relationships are affected by competition on each of these four dimensions.

Relationships between investment banks and firms are characterized by a key empirical regularity. Each investment bank incurs relationship costs, but does not directly charge for these relationships nor receives (or demands) any contractual assurance that it will be selected by the firm on its deals. Instead, an investment bank collects fees only when it does a deal.[2] Eccles and Crane (1988) call this the "loose linkage" between relationship costs and deal revenues. Neither loose linkage, nor the previously cited fact that a large corporation typically maintains relationships with several banks, are characteristics peculiar to investment banks.[3] Together, however, these facts immediately raise the question of how investment banks can be assured that the prices charged ex-post will cover the ex-ante cost of relationships. In other words, how can relationships survive in the face of such competition among relationship banks?

To examine this problem, we study a model which incorporates the features of relationships and competition just described. Specifically, investment banks sell services, which we call "deals", to firms. A firm is characterized by its deal volume, v. Banks can employ one of two technologies to "do deals": an arms-length technology and a relationship technology, so that banks that maintain relationships compete with other banks that do not. The cost of implementing a volume v of deals using the arms-length technology is βv (i.e., this cost increases with deal volume). By contrast, doing deals with a relationship technology requires an upfront sunk cost R, but the marginal cost is 0. Thus, relationships involve higher sunk costs but lower variable costs. This difference between the technologies stems from the well established fact that information gathered when establishing a relationship can be reused. The second feature of relationships is that they are observable but non-verifiable, so that banks cannot directly charge for the sunk costs of relationships that they bear. Instead, they can only charge fees when they do a deal. This assumption captures the "loose linkage" feature described above. Last, each firm establishes multiple ($k \geq 1$) relationships, banks may exert sales effort to win deals from a firm, and entry and exit is endogenous.

The first set of results concerns competition between relationship banks (i.e., those that use the relationship technology) and fringe banks (those that use the arm's length technology). Does competition from fringe banks erode the incentives to establish relationships? The key result is that

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[2] By "deal" we mean, for example, a security flotation, a merger or an acquisition.

[3] Several studies document similar features of relationships in other banking markets. Although the term "loose linkage" is specific to investment banking, the problem of firms switching banks without paying all the costs incurred by the bank is a general one; see Petersen and Rajan (1995). Nonexclusive relationships in commercial banking markets are reported by Detriagache et al. (2000) and by Ongena and Smith (2001).

the scale economies intrinsic to relationships provide relationship banks with a cost advantage for serving firms with a high enough volume of deals. This makes relationships an *efficient* technology for providing services to any firm with volume v such that $v \geq \frac{kR}{\beta}$ (recall that k relationships are established by the firm, so that the total cost of establishing k relationships is kR). Ex-post competition for these firms from fringe banks will not threaten relationships because they cannot: any fee that makes profits for a fringe bank also makes ex-post profits for a relationship bank. Non-verifiability has an additional implication. Since relationship banks charge lower fees, it follows that any firm, regardless of v, would prefer to do its deals with them. However (because relationships are non-verifiable) relationship banks would make losses for any firm such that $\beta v < kR$. Thus, all firms want relationships, whereas banks do not. This implies that some firms must be rationed out by relationship banks.

The second set of results characterizes competition among relationship banks. To establish relationships, banks requires rents which come from soft price competition. Soft price competition is modeled here via an implicit contract between relationship banks not to compete, which appears to be the norm in the investment banking market.[4] But the key point is that soft price competition is *all* that is needed for relationships. The reason is that because prices, entry and exit are endogenous, competition from other sources can be overcome by adjustments in these margins. Thus, banks can compete in many ways without destroying relationships. To see this, consider, for example, the effect of non-exclusive dealing or more intense non-price competition. The higher profits necessary to recoup the higher costs of relationships in these cases will come from higher prices or exit.

It is worth pointing out that even though an implicit contract between relationship banks is the source of rents in the model, such a contract is robust to entry. The reason is that the implicit contract serves an efficiency role here rather than a purely collusive one.[5] Excess entry would make the implicit contract unenforceable.

Third, imperfect competition in the banking market can be traced to the non-verifiability of relationships. If that were not the case, then banks could charge directly for relationships, and the relationship segment could be perfectly competitive.[6] Indeed, there would be no tension between relationships and competition despite scale economies from relationships. The reason is that information reusability generates scale economies only at the level of each bank-firm relationship, i.e.,

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[4] See Chen and Ritter (2000) and Matthews (1994).

[5] The study of self-enforcing norms in the relationship segment is methodologically related to Dutta and Madhavan (1997) who study implicit collusion in broker-dealer markets. The collusive equilibrium in that model rationalizes a striking series of practises which have been empirically documented. Unlike that model, the implicit contract here is not a purely facilitating device, but supports rents that are necessary for a relationship segment to exist. Consequently, a self-enforcing norm is sustainable in equilibrium even with free entry.

[6] For example, Detragiache et al. (2000) study a model where a firm optimally chooses the number of relationships. Relationship costs are not sunk but fixed, and the bank can charge directly for relationship costs. For that reason, price competition does not undermine relationships there.

at the "local" level. On the other hand, aggregate relationship costs increase (linearly) with the number of relationships that the intermediary establishes.

Several results on the aggregate structure of the banking market follow from other characteristics of the relationship technology. First, recall that large firms are served by relationship banks whereas small firms are rationed by these banks and instead served by arm's length banks. This implies that the market is "vertically segmented", and the banks that serve the two segments do not compete with each other. Moreover, the size distribution of firms (as measured by their deal volume v) determines the size of the relationship segment. This separation is similar to the common distinction between "bulge bracket" banks, which serve predominantly large corporations, and the rest, which serve smaller firms. Second, the implicit contract constrains relationship banks to have similar market shares. This prediction is consistent with the observed market share data, which has also led some commentators to describe the industry as an aggregate oligopoly comprised of a few large bulge bracket banks. Third, increases in the size of the market (for example, the volume of deals done by firms) changes neither vertical segmentation nor concentration in the relationship segment of the market.[7] Like the first two results on market structure, this result has empirical content as well. Since the 1950s market size in underwriting and M&A activity has increased almost twenty fold in real terms, whereas standard indices of market concentration have not changed over this period.

The comparative static exercises in sections 4 and 5 distinguish changes in the number of banks from a change in the intensity of competition. This points to a more general issue, namely that there are many forms of competition and they do not all affect relationships in the same way. This distinction follows Sutton (1991) and, more recently, Bliss and Di Tella (1997), who note that in models with endogenous entry the number of economic actors is an uninformative measure of "competition." The result on market segmentation provides an additional reason for caution when assessing how concentrated or competitive the investment banking industry is. Specifically, market segmentation implies that looking at the industry as a single market will inflate simple measures of competition (e.g., the inverse of a Herfindahl index). Section 5 discusses this and other policy implications.

Petersen and Rajan (1995) were the first to point out that market power is necessary to maintain relationships.[8] That conclusion still holds here. However, a key result of the model presented here is that neither local monopoly power nor aggregate monopoly is necessary to establish relationships. The reason that aggregate market power is not necessary is that relationships involve local scale economies, not aggregate ones. The reason that local monopoly power is not necessary is that endogenous entry and exit together with soft price competition can undo the deleterious

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[7]Section 5 contrasts the logic behind this result with that in Sutton (1991).

[8]See also Mayer (1988) and Hellwig (1991) for conceptual tratments of this issue

effect of multiple relationships. This "possibility" result contrasts with previous studies which have generally posited the need for either exclusive relationships (see, for example, the discussion in Hellwig 1991) or aggregate market power (following Petersen and Rajan 1995).

There is a large theoretical literature that explores the benefits and costs of relationships.[9] For example, Berglöf and von Thadden (1994), Boot and Thakor (1994), Chemmanour and Fulghieri (1994), Diamond (1991), Rajan (1992) and von Thadden (1995) all model the benefits of long-term bilateral relationships. Several papers in the literature have also studied the cost of exclusive relationships that come from the exploitation of market power when banks can hold up firms (e.g., Greenbaum et al. 1989, Rajan 1992, Sharpe 1990 and von Thadden 1998). Our result that local monopoly power is not necessary to establish relationships suggests that the ability to switch banks without destroying relationships may be a countervailing factor to such costs of holdup.

This paper is also related to Anand and Galetovic (2000), which studied how price norms affect the structure of the relationship segment of the market. That model ignores both competition *within* the relationship segment—through non-exclusive relationships or non-price competition— and competition *between* the relationship and arms-length segments. Consequently, their model does not address the tension between relationships and competition, which is the focus here.[10]

As mentioned above, Boot and Thakor (2000) is the closest study to this one. Like them, we study how banks that make relationships are affected by competition from banks that do not ("arm's-length banks"), and endogenize market structure. There are several differences, however. First, in Boot and Thakor banks are willing to make the sunk relationship-specific investment (called "sector specialization") because it leads to ex post differentiation between banks. In contrast, the model presented here does not assume that relationships induce differentiation per se. Consequently, multiple relationships can destroy relationship rents. This modeling approach is primarily justified by the characteristics of investment banking. Many empirical studies (e.g., Hayes et al. 1983) show that even though investment banks compete in different strategic groups, there are several banks within each group, and there is virtually no differentiation among them; and that firms establish relationships with several banks, the cost of switching between them is low, and information can be easily obtained by rivals.[11] Second, because there is no product differentiation in the model presented here, the source of rents to relationship banks is different from Boot and Thakor . This has different implications for the effect of multiple relationships and non-price competition, the

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[9]For surveys of this literature see Berger (1999), Boot (2000) and Ongena and Smith (2000).

[10]Notice, however, that the result here on market segmentation implies that the results obtained there concerning the structure of the relationship segment of the market continue to hold in this more general and realistic setting with multiple relationships and competition by fringe banks.

[11]Notice that local market power may be a sensible assumption in commercial banking. As Boot and Thakor point out (p.683), local market power of commercial banks stems from the illiquidity of each loan due to its information sensitivity. See also James (1987), Kang et al. (2000), Lummer and McConnell (1989), and Shockley and Thakor (1997).

structure of the market, and the size of equilibrium rents.[12] Third, unlike Boot and Thakor, sunk relationship costs are non-verifiable, and variable costs of relationships are lower than an arm's length deal. The results on market segmentation and comparative equilibria results that emerge as a consequence of these two features also differentiate the two models. Notice that both these distinguishing features of relationships from arm's-length technologies stem from characteristics that are intrinsic to relationships.[13]

Last, this paper is related to studies about investment incentives, incomplete contracting and the hold-up problem (see Hart 1995). The insight from these studies is that hold up problems ex-post can be moderated by the appropriate allocation of decision rights over the assets ex-ante. Examples include the allocation of ownership rights (that grant residual decision rights over the use of the asset) as in Grossman-Hart-Moore[14], or the allocation of explicit contractual rights such as an exclusivity right (that grant one party the right to effectively block the use of the asset in a transaction with a third party) as in Segal and Whinston (2000). Unlike this literature, rights over the use of the asset that is created by the investment cannot be allocated in the model that we study. The reason is that the asset—the bank-firm relationship—is itself intangible and thus noncontractible. Like this literature, however, investments in relationships will occur only if ex post price competition is softened. Thus, endogenous market structure and implicit contracts substitute here for ownership claims or exclusivity rights granted via explicit contract.

The rest of the paper is organized as follows. Section 2 documents the importance of relationships in investment banking, and uses this to motivate the formal description of the model. Section 3 describes how the tension between relationships and competition is solved, and presents the results of the model. There, the comparative static effects of lower switching costs, multiple relationships, and nonprice competition are also studied. Section 4 applies the model to examine the consequences of global competition and discusses some antitrust implications. Section 5 concludes with lessons for other banking markets.

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[12] Making the extreme assumption that relationship banks offer homogeneous services and compete Bertrand tilts the problem away from a solution, and therefore generates a broader set of conditions under which competition does not destroy relationships.

[13] Yafeh and Yosha (2000) have also recently studied how competition from arm's length loans affect relationship lending. Their focus, however, is not on the canonical intertemporal problem caused by sunk relationship investments, but on intratemporal competition between the arm's-length and relationship segments and the strategic use of relationships as an entry-deterrence device.

[14] See Grossman and Hart (1986) and Hart and Moore (1990).

2. The model

2.1. Relationships in investment banking

Studies in financial intermediation often sharply distinguish between bank- and market-based financial systems. On the one hand, in bank-based systems intermediaries establish long-term relationships with firms and keep loans on their balance sheets. On the other hand, in market-based systems firms sell their securities 'directly' to investors[15] who form portfolios to diversify risks. While this distinction is useful to think about striking cross country differences among financial systems (see, for example, Allen and Gale [1995 and 2000]), it obscures that in developed security markets firms sell their securities through investment banks with whom they establish long-term relationships. Crane and Eccles (1993, p. 136) note that "access and information exchange are the key elements in the definition of relationships" between investment banks and client firms. Consequently, suppliers with relationships often have "preferred vendor status" because without such information they would, for example, be "making virtually random blue-book pitches with little chance of hitting the target."[16] In other words, the key role of investment bank-firm relationships is to provide banks with access to firm-specific information that can be used to structure deals or price securities. In a recent survey, Boot (2000, p.7) points out that even the task of underwriting public issues involves absorbing credit and placement risk which may be "facilitated by the proprietary information and multiple interactions that are the hallmark of relationship banking." And, Wilhelm and Downing (2001) note that while changes in information technology might commoditize those investment banking services that have to do mostly with the storage and dissemination of information to investors, the information needed for corporate advisory services still rests largely on bank-firm relationships.

Relationships are well-documented for the US. market, the paradigmatic market-based system.[17] Until about 25 years ago, the rule in the industry was that a corporation would establish long-term relationships with only one investment bank. While relationships have varied in strength over time, they still remain important today.[18] In a recent Institutional Investor survey of 1,600 chief financial officers of firms made in August 2001, 44% of those who prefer "specialized institutions" for their different needs, and 64% of those who prefer one-stop banks, stated that their primary reason for choosing a bank was "prior relationships" with it. Moreover, even though it is access to firm-specific information, rather than share of the firm's transaction volume, that defines

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[15] In 'direct' markets firms are supposed to meet face to face with investors.

[16] Se Crane and Eccles (1993, pp.131-136).

[17] See Wihelm and Downing (2001) for an overview.

[18] See Nanda and Warther (1998) for an analysis of the trends in the strength of underwriting relationships. Crane and Eccles (1993, p.132) note that relationships were even more important in the early 1990s than they were in the previous decade.

a bank-firm relationship, evidence on firms' choices of investment banks points indirectly to the strength of relationships as well. For example, Baker (1990) examined ties between investment banks and corporations with market value of more than $50 million between 1981 and 1985. He reports that the 1,091 corporations that made two or more deals during this period used three lead banks on average (these firms made eight deals on average). All but nine granted more than 50% of their business to their top three banks and, on average, 59% of the business was allocated to the top bank. Similarly, Eccles and Crane (1988, ch.4) report that among the 500 most active corporations in the market between 1984 and 1986, 55.6% used predominantly one bank to float their securities, and the rest maintained relationships with only a few banks. They did not find any corporation selecting underwriters on a deal-by-deal basis. James (1992) finds that in the first common stock security offering after an initial public offering (IPO), 72% of firms choose the same lead bank as before; for debt offerings, 65% of issuers do not switch banks. And, Krigman et al. (2001) show that 69% of firms that made an IPO between 1993 and 1995 and a secondary equity offering within three years of the IPO, chose the same lead underwriter in both transactions.

It has been argued that relationships may subject the firm to a hold up from the intermediary with whom it has a relationship. As we will see now, however, the opposite seems to be more relevant in the case of investment banks: firms may find it too easy to switch investment banks once they have established the relationship.[19]

2.2. The technology of relationships

Empirical work has documented three important characteristics of relationships in investment banking: relationships require sunk set up costs at the level of each firm, they involve "loose linkage," and information gathered through relationships is not proprietary. We discuss and motivate each in turn.

Firm-bank relationships are long-term and there is evidence that investment banks have to incur sunk costs to set them up and acquire information. For example, James (1992) presents evidence suggesting that the information gathered by an investment bank for one deal can be reused in future deals.[20] Moreover, a significant fraction of this sunk cost is incurred by the investment bank. This occurs because most of the exchange of information takes place through direct interaction with the bank's staff person (often referred to as a "relationship manager").

Second, firms and investment banks interact constantly in the course of a relationship, but the bank is paid only when a deal is made. Eccles and Crane (1988) call this the 'loose linkage' between

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[19]Ongena and Smith (2001) study the duration of firm-bank relationships in Norway and find that firms are more likely to leave a given bank as the relationship matures, thus suggesting that firms do not get locked into relationships in commercial banking either.

[20]On information reusability in banking see also Chan et al. (1986)

costs and fees. As Crane and Eccles (1993, p. 142) describe "[...] the strategy of investment banks [is] to incur substantial costs in delivering value—in the form of advice, special studies, and market information—as a way of creating obligations that are hopefully converted into transaction fees in the future."[21] Loose linkage implies that investment banks recover sunk relationship costs only if selected to do a deal. Further, Eccles and Crane (1988, pp. 39-40) point out that one reason for loose linkage is that it is difficult for business firms to evaluate the quality of the advice provided, unless deals are done. In other words, loose linkage is not merely an industry practise that can be changed, but is a technological feature of relationships. Following this discussion, we assume that relationships are non-verifiable in what follows. That is, banks cannot receive contractual assurances that they will be paid for the costs of relationships.

Third, investment banks often find it difficult to establish property rights over the information gathered in a long-term relationship. In other words, information is "non-excludable".[22] This is so for three reasons. First, as said, most of the exchange of information takes place through direct interaction between the firm and the investment bank's staff person. This relationship-specific knowledge often walks with employees when they are hired away.[23] As an example, Deutsche Bank built a global investment bank in a year (Deutsche Morgan Grenfell) by hiring away staff en masse from other major banks. The second reason is that ideas and products can be copied. Tufano (1989) notes that most product innovations by banks involve large sunk costs but are copied by rivals within a day of introduction.[24] And, Eccles and Crane (1988, p. 90) note that banks often fear that firms will take their ideas to be implemented by rival banks for less money. Last, as is the case in commercial banking, most firms have more than one relationship.[25]

2.3. Model description

There are three types of agents: a continuum of firms of measure f that want to do deals; m identical and risk-neutral investment banks that can establish relationships and implement deals (henceforth these are called 'relationship banks'); and an arbitrary number of investment banks

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[21]Indeed, because banks "are willing to incur current costs in the hope of getting future fees, [t]his gives the customer an opportunity to receive services that he or she may never have to pay for" (Crane and Eccles, 1993, p. 143). The extreme case of loose linkage is the "analysis" function of investment banks, where banks earn most of their commisions from investors who trade the firm's security.

[22]A good or service is excludable if the owner can prevent others from using it at a very low cost.

[23]See Anand and Galetovic (2000).

[24]Tufano (1989) estimates the costs of designing a security, including product development, marketing and legal expenses to be between $0.5 million and $5 million. These products cannot be patented and all details become publicly available once the offering is filed with the SEC. For a model of product innovation in investment banking with weak property rights, see Bhattacharya and Nanda (2000) and Persons and Warther (1997).

[25]See Eccles and Crane (1988). Moreover, in their survey on relationships in commercial banking Ongena and Smith (2000) conclude that multiple relationships are a common feature of nearly all countries for which evidence has been collected.

that can implement deals but cannot establish relationships, which we call 'fringe banks'.

Each firm is described by the deal size s and number of deals d that it does in a given period, with $v \equiv s \cdot d$ denoting its total dollar volume of deals in any period. Volume v is uniformly distributed in the interval $[0, \overline{v}]$, with density function $g(v) = \frac{1}{\overline{v}}$ and corresponding cdf $G(v) = \int_0^v \frac{1}{\overline{v}} \mathrm{d}u = \frac{v}{\overline{v}}$. Thus $f \cdot \frac{v}{\overline{v}}$ is the measure of firms whose deal volume during the period is at most v.

Deals can be implemented using two distinct technologies. The first is a relationship technology that is used only by relationship banks.[26] To use this technology to establish a relationship with a given firm a bank must incur a sunk cost R, which is independent of s and d. Once R is incurred, however, the bank can do any number of deals with the same firm at no additional cost. Hence, there are scale economies at the level of each relationship (or *local* level). Since relationships are non-verifiable, fees to banks cannot be contingent on them establishing a relationship, but banks can only get paid when deals are done. Firms that do deals with banks that use this technology establish $k > 1$ relationships; hence, relationships are not exclusive. Following Eccles and Crane (1988) we call this the firm's group of "k core banks". For simplicity, k is assumed to be exogenous and the same for all firms.[27] Note that we assume away any differentiation among core relationship banks—any of the k banks is as good as any other to do the deals of the firm.

Deals can also be implemented with a linear, "arm's-length" technology which enables any bank, relationship or fringe, to implement a deal without having a relationship. Thus, arms-length deals provide a natural source of competition that can potentially undermine relationships. Banks incur no sunk cost when using this technology, but an arms-length transaction imposes a transaction cost on firms. The magnitude of the transaction cost depends on whether the firm has a group of k core banks, and the type of bank it transacts with. Specifically:

- When the firm has a group of k core banks, then implementing a deal with a non-core relationship bank imposes a transaction cost αv, with $\alpha \in [0, \frac{R}{\overline{v}})$ (that is, α is "small"; this is nonexcludability). On the other hand, a deal implemented by a fringe bank imposes a transaction cost βv, with $\alpha < \beta < 1$.

- When the firm does not have any core banks, then implementing the deal with any bank imposes a transaction cost βv on the firm.

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[26]There is no loss of generality in excluding fringe banks from relationships. All the results we report hold in a model where all banks are endowed with the relationship technology and m (the number of banks that establish relationships) is endogenous and determined in equilibrium.

[27]We make this assumption because we are interested in studying whether multiple relationships affect their viability, not in explaining why firms establish multiple relationships. Detragiache et al (2000) study a model where a firm optimally chooses the number of relationships with commercial banks. Unlike our model, relationship costs are not sunk but fixed, and the bank recovers all relationship costs regardless of the amount it lends. For that reason, price competition does not undermine relationships.

Doing a deal with a non-core bank thus imposes an additional transaction cost on the firm. One reason is that when doing a deal these banks do not have all the information and knowledge which is gathered in a relationship that may be useful in designing the right deal structure and are thus more likely to make a mistake (see Eccles and Crane [1988] for an elaborate account). The cost of mistakes (e.g. mispricing) should be roughly proportional to the size of the deal and larger in the case of fringe banks. A more fundamental reason for the lower variable cost of doing deals with a relationship bank stems from information reusability in relationships. Notice that this assumption implies that a relationship technology is an *efficient* technology to do deals for firms with large enough deal volume. It would be hard to justify the contrary: if arm's length technologies were always more efficient, then relationships would not be observed.

Contrary to relationships, the arm's length relationship exhibits no economies of scale at the firm level (larger deals are more costly) and, more important, no loose linkage. Because of this, there is no loss of generality in assuming that banks incur no cost when using the arm's length technology, since competition would ensure that firms pay any cost incurred by banks in equilibrium.

It is also assumed that each time a relationship or a fringe banks i does a deal (but only then), it charges a fee that is a proportion $\lambda^i \in [0, 1)$ of the dollar value of the deal. Hence, total fees charged by bank i to a firm that generates volume v are $\lambda^i v$. For simplicity, each bank is assumed to charge the same proportional fee to all its clients, regardless of v.[28] Below we extend the analysis to consider non-linear fee schedules and show that this does not change our conclusions.

3. Relationships versus competition

3.1. The well-known tension

To begin, consider a one-period game where each firm establishes a relationship with k investment banks. After investment banks incur the sunk relationship cost R, they compete Bertrand and offer a fee which is a fraction λ of the dollar value of the deal. Then the firm chooses an investment bank, deals are implemented and fees paid.

It is straightforward to characterize the equilibrium of this game.[29] Non-exclusive relationships imply that *any* relationship bank that is a member of the firm's core group can do the deal at zero cost after the relationship cost R has been sunk. Hence, in a one period game every bank finds it profitable to undercut, and Bertrand competition drives the equilibrium fee to zero. Even if relationships were exclusive ($k = 1$), competition from non-core banks would drive fees to α,

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[28] In practice, there is evidence that smaller deals tend to pay higher fees as a proportion of deal size (see Ritter [1987] and Lee et al. [1996]).
[29] The formal proof is in Appendix A.

which is not enough to recover R because $\alpha < \frac{R}{v}$ (this is nonexcludability). Loose linkage, in turn, implies that investment banks cannot charge for establishing relationships. Anticipating all this, no investment bank will establish a relationship in the first place in a one period game.

In this setting, relationships can emerge only if competition is imperfect. This is the well-known tension between relationships and competition. In what follows we characterize this imperfectly competitive equilibrium market structure when banks that establish relationships face competition from other such banks, as well as from fringe banks.

3.2. Three key conditions

This section describes three conditions that must hold in an equilibrium with relationships. Assume that a symmetric equilibrium with relationships exists where all relationship banks charge fee λ^c (where the superscript 'c' stands for 'core bank').[30]

Competition by fringe banks The first condition says that the fee charged by a relationship bank cannot exceed β, that is

$$\lambda^c \leq \beta. \tag{3.1}$$

Since the arm's length technology exhibits constant returns to scale, and all transactions costs are borne by firms, competition ensures that the fee charged by fringe banks, call it λ^f, will equal zero in equilibrium. But a firm characterized by volume v which does its deals with a fringe bank would incur a transaction cost βv, from which condition (3.1) follows. (Notice that even if banks incurred the transaction cost βv, firms would be charged this full cost in equilibrium, hence the assumption on whether banks or firms bear the arms-length cost is not central.)

Relationships and deal volume The second condition says that banks will not establish relationships with firms that generate low volumes of deals. To see this note that since each firm's core group contains k relationship banks, each bank in that group wins a given deal with probability $\frac{1}{k}$. Therefore, banks will establish relationships only with those firms with volume v such that

$$\frac{1}{k}\lambda^c v - R \geq 0, \tag{3.2}$$

from which a lower bound $\underline{v} = \frac{kR}{\lambda^c}$ follows. Sunk set up costs introduce scale economies at the level of each deal. Since these set up costs are incurred by relationship banks that cannot charge for them directly, banks will choose not to establish relationships with firms that generate a low volume of deals. Note that since $\lambda^c \leq \beta$ (from 3.1), it follows that $\underline{v} \geq v_\beta \equiv \frac{kR}{\beta}$.

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[30]Strategy combinations that ensure this is an equilibrium are derived in Appendix B. In section 3.5 it is shown that results do not change if banks charge nonlinear fees.

Conditions (3.1) and (3.2) are depicted in figure 1, which plots deal volume on the horizontal axis and the total cost of doing a deal of a given volume on the vertical axis. Given λ^c, firms whose total deal volume does not exceed $\underline{v} \geq v_\beta$ are rationed out by relationship banks.

For future reference it is useful to note that the measure of firms establishing relationships equals $f \cdot \left(\frac{\overline{v} - \underline{v}}{\overline{v}} \right) \equiv f^r$; the total volume of deals intermediated by relationship banks is $f \cdot \int_{\underline{v}}^{\overline{v}} \frac{v}{\overline{v}} dv = f \cdot \left(\frac{\overline{v}^2 - \underline{v}^2}{2\overline{v}} \right) = f^r \cdot \left(\frac{\underline{v} + \overline{v}}{2} \right)$; and the average size of a deal done by relationship banks is $V = \frac{\underline{v} + \overline{v}}{2}$.

Relationships and imperfect competition   The third condition describes the source of rents for relationship banks. Among the mechanisms that can restrain price competition are regulations, frictions like informational monopolies, contracts, and self-enforcing norms.[31]   Neither of the first three seem very relevant in restraining price competition in the investment banking market. On the other hand, as mentioned earlier, many accounts of the industry suggest that price competition is restrained by informal unwritten rules. For example, in a colorful recent account of investment banking, Rolfe and Troob (2000, p.103), note that spreads have stayed high

> " [...] because there has always been an unspoken agreement among the bankers that when it comes to underwritings they won't compete on price. The spreads are sacrosanct. He who cuts spreads will himself become an outcast [...]. The community of investment banks has always been small enough so that if one bank were to break ranks on the pricing issue, the others would quickly join forces and squash the offender [...]. Every banker knows that the pricing issue is a slippery slope best avoided because once the price cutting begins, there's no telling where it will end."

Specifically, relationships can be sustained when the long-run profits that each relationship bank expects to make from continuing with an implicit contract not to undercut are greater than the short-run profits that can be made from undercutting. To obtain the precise condition, assume that banks are infinitely lived with discount factor $\delta \in \left(\frac{k-1}{k}, 1 \right)$. They play the one-period game an infinite number of times. For simplicity, assume that each generation of firms lives only one period.

Each period relationship banks compare the long run gains from the implicit contract against the one-time gains of undercutting to significantly increase their market share. We start by computing the value of the implicit contract. Bank i will compete for deals with $k-1$ other banks in each core group of which i is a member. Thus bank i will make deals of value $\frac{V}{k}$ on average. Each firm will pay $\frac{\lambda^c V}{k}$ in fees on average and total costs will be R per firm, regardless of the number of deals done. Hence, profits per firm are $\frac{\lambda^c V}{k} - R$ on average. If bank i has relationships with

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[31] See Aoki and Dinc (1997).

a fraction η_i of all f^r firms that establish relationships (with $\eta_i \in [0,1]$ and $\sum_{j=1}^{m} \eta_j = k$),[32] its long-run profits from period $t+1$ on are

$$\frac{\delta}{1-\delta} f^r \eta_i \left(\frac{\lambda^c V}{k} - R \right).$$

The short-run gains from undercutting are obtained as follows. By setting λ_i^c slightly below λ^c, bank i can get an additional $\lambda^c V - \frac{\lambda^c V}{k} = \left(1 - \frac{1}{k} \right) \lambda^c V$ on average from firms with whom it has a relationship. Moreover, by setting λ_i^{nc} slightly below $\lambda^c - \alpha$, bank i can win deals from the remaining $(1 - \eta_i) f^r$ firms with whom it does not have a relationship, thus obtaining slightly less than $(\lambda^c - \alpha) V$ per firm. Assuming for simplicity and without loss of generality that undercutting destroys the implicit contract forever (i.e. after one bank undercuts they never cooperate again),[33] it yields a one-time gain a shade below

$$f^r \left[\eta_i \left(1 - \frac{1}{k} \right) \lambda^c + (1 - \eta_i)(\lambda^c - \alpha) \right] V.$$

Therefore, the implicit contract condition reads:

$$\frac{\delta}{1-\delta} f^r \eta_i \left(\frac{\lambda^c V}{k} - R \right) \geq f^r \left[\eta_i \left(1 - \frac{1}{k} \right) \lambda^c + (1 - \eta_i)(\lambda^c - \alpha) \right] V. \tag{3.3}$$

For future reference it is useful to note that when all banks establish relationships with the same number of firms, $\eta_i = \frac{k}{m}$. Then, condition (3.3) can be rewritten as

$$\frac{\delta}{1-\delta} \frac{f^r}{m} k \left(\frac{\lambda^c V}{k} - R \right) \geq \frac{f^r}{m} \left[(m-1)\lambda^c - (m-k)\alpha \right] V. \tag{3.4}$$

Notice that the implicit contract condition (3.3) is necessary for the existence of a market with relationships, unlike in standard oligopoly markets where it is merely a facilitating device. In other words, the implicit contract serves an efficiency role here, like in Anand and Galetovic (2000).

The three conditions can now be used to analyze how the relationship–competition tension is resolved in the investment banking market.

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[32]Note that η_i is not a market share. Bank i may have a relationship with all firms and yet not be a monopoly, since each firm has relationships with k banks. There is a direct relation between η_i and i's market share, however. If on average banks get a fraction $\frac{1}{k}$ of deals made by firms with whom they have a relationship, bank i will make a fraction $\mu_i \equiv \frac{\eta_i}{k}$ of all deals, with $\sum_{j=1}^{m} \mu_j = 1$. Thus, μ_i is bank's i market share.

[33]There is no loss of generality because this is the strongest feasible punishment (see Anand and Galetovic, 2000). Hence, from the resulting implicit contract condition a lower bound on concentration and fees obtains.

3.3. Competition among relationship banks

The implicit contract conditions (3.3) and (3.4) impose several restrictions on competition and market structure. The first result indicates that the relationship segment is an oligopoly:

Proposition 3.1. *Relationships will be established only if there are few relationship banks with similar market shares.*

Proof. Fix the equilibrium number of banks, m. Then:

$$\underline{\eta} \leq \eta_i \leq k - (m-1)\underline{\eta}, \tag{3.5}$$

where

$$\underline{\eta} = \frac{(\lambda^c - \alpha)V}{(\lambda^c - \alpha)V + \frac{\delta}{1-\delta}\left(\frac{\lambda^c V}{k} - R\right) - \left(1 - \frac{1}{k}\right)\lambda^c V} < 1.$$

Since $\mu_i \equiv \frac{\eta_i}{k}$, condition (3.5) also imposes a lower and upper bound on market shares:

$$\underline{\mu} \leq \mu_i \leq 1 - (m-1)\underline{\mu}.$$

It is straightforward to see that the upper bound on μ_i must be less than 1.

At the same time, the lower bound on the market share of any given bank implies that the maximum number of banks, $\overline{m}$, that is consistent with relationships is given by $\frac{1}{\underline{\mu}} = \frac{k}{\underline{\eta}}$. Thus, in equilibrium relationship banks must be "few". ∎

Proposition 3.1 implies that relationship banks must have a similar number of relationships. On the one hand, if one becomes too small and establishes relationships with few firms, then cheating becomes profitable. On the other hand, if one relationship bank becomes too large, then there will be too few relationships left for the other relationship banks, which would like to deviate from the implicit contract. Notice that the lower bound on market shares also imposes an *upper* bound on the number of relationship banks, thus a lower bound on concentration. Figure 2 plots $\mathcal{L}$, the set of pairs of λ^c and m such that condition (3.4) holds. It is seen that the upper bound $\overline{m}$ is increasing with the equilibrium fee λ^c.

The implicit contract conditions (3.3) and (3.4) have a second key implication:

Result 3.2 (Equilibrium rents). *Relationship banks make profits in equilibrium, even with free entry.*

The reason for this result, quite simply, is that because relationship banks can always make positive profits by cheating, rents are needed to make the implicit contract incentive compatible.

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But despite rents, the implicit contract is robust to entry. Why? Should entry go beyond the lower bound on concentration and too many relationship banks enter, then the implicit contract is no longer self-enforcing.

Note that incumbents' rents and an upper bound on m may resemble entry deterrence.. In fact, as shown by Yafeh and Yosha (2000), banks may want to invest in relationships to deter entry. Nevertheless, here the upper bound on m and rents serve an efficiency role—to make the implicit contract self enforcing.

Conditions (3.3) and (3.4) generalize the results of Anand and Galetovic (2000). While the logic here is the same as when free-riding on a single relationship is prevented—to achieve both requires soft price competition— there are two important differences. First, as shown in the next subsection, the implicit contract is self-enforcing despite of the presence of a competitive fringe. Second, the model here shows that relationships can survive even if they are not exclusive. Thus we have the following result:

Result 3.3 (Multiple relationships). *Multiple relationships can exist in equilibrium even if relationship banks are not local monopolies.*

Result 3.3 highlights that restrains on *price* competition are needed to sustain relationships. As we will see, however, other forms of competition need not necessarily be restrained as long as they do not erode the incentives to maintain the implicit contract.

3.4. Competition from fringe banks

As seen, rents made by relationship banks in equilibrium do not attract entry. But can relationships survive competition by fringe banks? This section and the next show why it follows from the two characteristics of relationships—specifically, nonverifiability and information reusability—that fringe banks do not effectively compete with relationship banks.

The argument proceeds in two parts. The first part of the argument says that low-volume firms are rationed out of relationships by relationship banks. That is, these firms would like to establish a relationship but relationship banks will not do so with them. To see this, note that condition (3.1) implies that the maximum that can be charged by relationship or arm's length banks for doing a firm's deals is βv. Since each firm establishes k relationships, relationship banks will not establish a relationship with a firm whose volume is less than $v_\beta \equiv \frac{kR}{\beta}$, because in that case $\frac{\beta v}{k} < R$. But, on the other hand, since $\lambda^c \leq \beta$, these *firms* would like to establish a relationship. It follows that low-volume firms must be rationed out from relationships by banks.

The second part of the argument says that for high-volume firms, relationship banks are not threatened by competition from arms-length banks. This is because of scale economies inherent in the relationship technology. Since $\beta v > kR$ for sufficiently large volumes ($v > v_\beta$), it follows that

relationship banks will have a cost advantage which grows with volume; this is seen clearly in figure 1. Thus, arm's-length banks cannot compete for the business of large-volume firms because they are inherently more costly (and they must be, otherwise there would be no value to relationships).

In conclusion, low-volume firms would like to be served by relationship banks, but will be rejected by them. On the other hand, the relevant banking market for high-volume firms is the relationship segment. The cost advantage of relationship banks in serving these firms is large enough that fringe banks are not meaningful competitors, despite the fact that relationship banks make rents. This yields a central result on why relationships are sheltered from competition from arms-length banks:

Result 3.4 (Vertical segmentation). *There are two different markets: fringe banks serve low-volume firms and a few large relationship banks serve large-volume firms. Fringe banks do not compete with relationship banks, which make rents in equilibrium.*

Result 3.4 contrasts with Boot and Thakor (2000). In the model they study, banks face competition from arm's length loans made through the capital market. They find that more intense competition from arm's length lenders (similar to a lower β here) reduces relationship lending by commercial banks at the margin. Why? The reason is that although relationship lending adds value, this increment in value is smaller, the higher is the (intrinsic) quality of the firm. When the cost of arm's length lending falls, firms at the margin switch from bank to capital market lending.

Nevertheless, while in their model firms differ in quality, the size of each loan is the same for all. By contrast, the model studied here allows for firm heterogeneity in deal volume. Therefore, relative to arm's length lending, relationship lending (which uses a high sunk–low marginal cost technology) is more advantageous the larger the volume of deals. This difference protects relationship lending from arm's length competition at the margin.

3.5. Robustness

It is instructive to consider precisely which features of the model drive the preceding results. To begin, nothing hinges on the assumption that fringe banks cannot establish relationships. If all banks were endowed with both technologies, the decision on whether to establish a relationship with a given firm would still depend only on its deal volume, and the number of relationship banks in equilibrium would still be limited by condition (3.4).

The result that competition from arm's-length banks does not affect relationships follows only from the fact that relationships involve sunk costs and are non-verifiable. To see why, note that if relationship banks could directly charge a firm for establishing a relationship—that is, relationship costs were verifiable and the loose linkage assumption would no longer hold—then a relationship would be priced at R and the relationship segment could exhibit perfect competition. In that case,

a firm with volume v would establish a relationship only if $kR \leq \beta v$, and a firm with $v = v_\beta$ would be indifferent between either type of bank, not rationed by relationship banks. The following result summarizes this point:

Result 3.5 (Relationships and perfect competition). *If relationships were verifiable and investment banks could charge directly for them, then relationships can be sustained in a perfectly competitive market.*

Result 3.5 implies that local increasing returns is *not* what drives imperfect competition. Rather, soft price competition is necessitated by the inability to charge directly for relationships. Here, this is a consequence of nonverifiable relationships. In a related literature on commercial banking, the inability of banks to charge for relationship costs is that young firms do not generate surpluses that are big enough to pay for the costs of relationships, and it is difficult to share surpluses intertemporally (see Petersen and Rajan, 1995).

The assumption that relationship banks charge linear fees (i.e., that banks do not price discriminate, using volume discounts for example) is not essential to any result. First, rationing follows from non-verifiable relationships, because relationship banks cannot charge more than βv to any firm, regardless of how this sum is collected—whether through a linear fee, a two-part tariff or a more complex nonlinear schedule. Similarly, the result that high-volume firms are served only by relationship banks follows purely from the reusability of information in relationships, which, as seen earlier, implies $\beta v > kR$. Indeed, this condition allows, for example, not just a linear fee such that $\beta v \geq \lambda^c v \geq kR$, but nonlinear schedules as well, call them $\mathcal{F}(v)$, such that $\frac{\mathcal{F}(v)}{k} \geq R$. Again, market separation follows from non-verifiable relationships, a problem that cannot be solved by charging non-linear fees.

Of course, whether relationship banks charge linear or nonlinear fees may affect $\underline{v}$, the cutoff volume below which relationship banks ration firms. As seen, if a linear fee λ^c is charged, then $\underline{v} = \frac{kR}{\lambda^c}$. Thus, the exact value of $\underline{v}$ only affects the relative sizes of the relationship and arm's-length segments, not the result that banks in these segments effectively do not compete.

Second, condition (3.3) could be substituted by any fee schedule $\mathcal{F}(v)$, and then it would read

$$\frac{\delta}{1-\delta} f^r \eta_i \left(\mathrm{E}_{v \geq \underline{v}}[\mathcal{F}(v)] - R \right) \geq f^r \left[\eta_i \left(1 - \frac{1}{k} \right) \mathrm{E}_{v \geq \underline{v}}[\mathcal{F}(v)] + (1 - \eta_i) \mathrm{E}_{v \geq \underline{v}}[\mathcal{F}(v, \alpha)] \right],$$

where $\mathrm{E}_{v \geq \underline{v}}[\mathcal{F}(v)]$ is the expected fee income generated from a firm that established a relationship and $\mathrm{E}_{v \geq \underline{v}}[\mathcal{F}(v, \alpha)] \leq \mathrm{E}_{v \geq \underline{v}}[\mathcal{F}(v)]$ is the expected income generated from a firm that is poached after undercutting. In other words, rents sustain the implicit contract in equilibrium and these may, but need not, come from linear fees.

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Last, it has been shown that the implicit contract serves an efficiency role here. But because it softens price competition, one might argue that it can prevent the firm from switching for a better deal. Might market power thus created undo the benefits of relationships? A result by Segal and Whinston (2000) in a similar setting shows that it should not. Specifically, in a model where the amount of investment is a continuous variable, Segal and Whinston (2000) show that when relationship-specific investments are "external"—i.e., they affect the value of a buyer's trade with other sellers—a contract that grants exclusivity rights to the agent making the investment is welfare increasing. In other words, the improved incentive to invest outweighs the costs of market power. This result is relevant to the case here when $k = 1$ (exclusive relationships) since, like the model they study, investments made by banks in relationships with firms are "external".[34]

3.6. The intensity of competition and relationships

The analysis thus far has established the effect on relationships of three faces of competition: multiple relationships, entry, and banks that use a different production technology. This section examines the effect of increases in the intensity of competition on relationships. Two cases are considered: a fall in a firm's cost of switching from a core to a non-core bank, and an increase in the number of relationships by a firm. Both changes are often thought to weaken relationships. Here we show that they need not.

It has been shown that fringe and relationship banks serve different segments. Consequently, in analyzing the effect on relationships of changes in the relevant parameters, one can restrict attention to their effect on the equilibrium in the relationship market while ignoring fringe banks. The analysis below describes how the set $\mathcal{L}$ in figure 2—namely, the bounds of the set of points (λ, m) such that the implicit contract condition (3.4) holds—varies with exogenous parameters. That is, the derivatives examine the effect of parameter changes on the upper bound on m and the lower bound on λ^c. This "bounds" approach follows Sutton (1991).

Lower cost of switching from core to non-core banks   Since relationships are nonexcludable, the incentive to undercut exists not only for core banks, but also for non-core relationship banks. We now examine what happens to relationships when a firm's cost of switching to a non-core relationship bank (α) falls. In section 4.2 we discuss an empirical application of this exercise.

When α falls, the gains from undercutting increase because non-core banks need to discount their fees by a smaller amount to compete with core banks. Then, the implicit contract becomes less

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[34]Relationship investments are "external" in the Segal-Whinston terminology since nonexcludability implies that investments made by core banks increase the value of trade between the firm and a non-core relationship bank. Note also that local market power of banks is greatest in the case $k = 1$, so the costs of market power will be the largest in that case as well.

attractive unless fees increase. To confirm this intuition, totally differentiate (3.4) and rearrange to obtain:

$$\frac{\mathrm{d}\underline{\lambda}^c}{\mathrm{d}\alpha} = -\frac{(m-k)\alpha}{\left[\frac{\delta}{1-\delta} - (m-1)\right](1 - \varepsilon_{V,\lambda^c}) - \frac{\alpha}{\lambda^c}(m-k)\varepsilon_{V,\lambda^c}},$$

where $\varepsilon_{V,\lambda^c}$ is the elasticity of average volume to a change in the fee λ^c (see Appendix C for the details of the derivation). This derivative is negative as long as the no-undercutting locus CC derived from (3.3) is upward sloping. Hence, when α falls, locus CC shifts leftward (see Figure 3). Similarly,

$$\frac{\mathrm{d}\overline{m}}{\mathrm{d}\alpha} = \frac{\overline{m} - k}{\lambda^c - \alpha} > 0.$$

Result 3.6. *When switching costs from core to non-core banks fall, fees tend to be higher for a given number of banks m. Conversely, concentration increases for a given fee λ^c.*

Moreover, if α falls from α' to $\alpha'' < \alpha'$ then $\mathcal{L}(\alpha'') \subset \mathcal{L}(\alpha')$. Therefore, the implicit contract is harder to sustain when competition from non-core banks is more intense.

Result (3.6) appears counterintuitive because lower switching costs for firms (or easier free-riding) are thought to decrease market power of banks. While true, that effect operates only at the local level. The reduced profit from each relationship is counteracted by exit of relationship banks, and therefore higher aggregate market shares for those that stay. In other words, increased competition for *deals* is offset by a decrease in competition for *relationships*.

Multiple relationships   For a variety of reasons, firms have tended over the last two decades to increase the number of investment banks with which they have relationships. Eccles and Crane (1988, ch. 4) term this a shift from a "dominant bank model" to a "core group model." Firms may increase the number of relationships because of "increased information flow and ideas from multiple relationships",[35] an increase in underwriting and corporate restructuring business that can be allocated amongst more banks, or a desire to increase competition among relationship banks. Some observers question whether relationships can survive this trend.

Do multiple relationships weaken the incentives to establish them? Assume that k increases, so that firms establish relationships with more banks. To study the equilibrium effects on fees, substitute $\underline{\lambda}^c$ into condition (3.4), let it hold as an identity, and totally differentiate with respect to $\underline{\lambda}^c$ and k (see Appendix C for the details of the derivation). Rearranging yields

$$\frac{\mathrm{d}\underline{\lambda}^c}{\mathrm{d}k} = \frac{[(m-1)]\lambda^c - (m-k)\alpha]\frac{\overline{v}}{2k} + \alpha V + \frac{\delta}{1-\delta}\lambda^c\frac{\overline{v}}{2k}}{\left\{\left[\frac{\delta}{1-\delta} - (m-1)\right](1 - \varepsilon_{V,\lambda}) + \frac{\alpha}{\lambda}(m-k)\varepsilon_{V,\lambda}\right\}V},$$

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[35]Eccles and Crane (1988, page 78)

where we used that $\frac{\partial V}{\partial k} = \frac{v}{2k}$. This derivative is positive as long as α is sufficiently small (again, see Appendix C), which implies:

Result 3.7. *For a given number of banks, m, fees tend to be higher when firms establish more relationships.*

Multiple relationships are often thought to toughen price competition. Result 3.7 runs counter to this intuition. While the analysis confirms that the effect of an increase in k is to reduce the probability of winning a deal, and therefore the net margin per firm to each bank, $\frac{\lambda^c V}{k} - R$, it shows that the gains of unilaterally undercutting also increase. Thus, given m, each bank wants to establish relationships only if fees increase.[36] Similarly,

$$\frac{\mathrm{d}\overline{m}}{\mathrm{d}k} = -\frac{[(m-1)\lambda^c - (m-k)]\frac{v}{2k} + \alpha V - \frac{\delta}{1-\delta}\left(\lambda^c \frac{v}{2k} - R\right)}{(\lambda^c - \alpha)V},$$

which is negative. An increase in k therefore reduces $\mathcal{L}$, the set of pairs (λ, m) that can be sustained in equilibrium. Multiple relationships reduce firm-specific rents to banks since revenues per firm fall while relationship costs do not. The increased profits from which to recoup relationship costs can then be created by increasing prices or inducing exit.

An increase in k will, for a given λ^c, not just affect the concentration of banks in the relationship segment of the market, but the size of the relationship segment itself. To see this, note that the lower bound $\underline{v}$ on firm volume, kR/λ^c, increases in k. This will both reduce the number of firms that establish relationships with banks, f^r, and the aggregate volume of deals intermediated by relationship banks, $f^r \cdot \frac{v+\overline{v}}{2}$. Thus, the effect of firms establishing more relationships is to increase concentration of relationship banks on the one hand, while increasing the size of the market served by the competitive fringe on the other.[37] This apparent increase in both competition and concentration might explain why the effects of such changes often appears puzzling to observers.

Intensity of competition and relationships Both results in this section stress that the effect of changes in market conditions cannot be analyzed simply at the local firm-bank level. Market equilibrium requires entry and exit by banks and should involve adjustments at the aggregate level in fees or market concentration to preserve the incentives to incur the sunk costs of relationships. This suggests a general result:

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[36]This result is consistent with the finding of Petersen and Rajan (1994) that small firms who borrow from more than one commercial bank pay higher interest rates on average.

[37]Boot and Thakor (2000) find a somewhat similar result in the context of commercial bank relationships. They argue that the effect of increased interbank competition on relationship lending by commercial banks includes both a negative *absolute* effect on volume of loans lent through relationships but a positive *relative* (substitution) effect on the capacity devoted by banks to relationship lending.

Result 3.8. *An increase in the intensity of competition need not destroy relationships as long as the implicit contract remains sustainable.*

Result 3.8 illustrates a general lesson. That is, the deleterious effects on relationships of changes in the intensity of one type of competition may be partially undone by changes of market structure and the intensity of other types of competition. Boot and Thakor (2000) obtain a result with a similar flavor. There, stronger competition from the capital market induces exit from commercial banking. This softens competition from other commercial banks and induces increased investments in relationship capital.

3.7. The role of nonprice competition

Investment banks compete in various nonprice dimensions. They incur sales expenditures, advertise, provide "free" advice on other financial and investment matters. Indeed, it is often claimed that banks price some services below their cost in order to get access to clients. One might ask how nonprice competition would alter the previous results. In particular, is it the case that nonprice competition dissipates the rents that banks get in equilibrium, thus undermining the incentive to establish relationships? This section extends the model to include nonprice competition among banks. A central result is that, somewhat surprisingly, banks still make excess profits. But, the increased "competition for deals" does restrain bank market power by imposing an *upper* bound on the fee λ^c that banks can charge in equilibrium.

To study nonprice competition, it is assumed that at the beginning of each period, each relationship bank spends a total amount $\mathcal{E}_i \equiv f^r E_i$ in sales expenditure (or, 'sales effort') to contact firms. Sales efforts result in contacts with firms according to the following assumptions:

Assumption 3.9. (i) *A relationship bank spends at least $\underline{\mathcal{E}} = f^r \underline{E}$ in sales expenditures to contact firms.*

(ii) *Firms contact relationship banks who have spent the k'th highest amounts in sales expenditures. If $y > 1$ banks spend the kth highest amount, then each bank contacts a firm with probability $\frac{1}{y}$.*

(iii) *If fewer than k banks spend $\underline{\mathcal{E}}$ or more, then firms contact no bank.*

It will be useful to number relationship banks according to their sales expenditures and adopt the following notational convention: $\mathcal{E}_1 \geq \mathcal{E}_2 \geq ... \geq \mathcal{E}_k \geq ... \geq \mathcal{E}_m$. That is, relationship bank 1 spends the (weakly) largest amount in sales expenditures. Note that according to this convention $\mathcal{E}_k$ is by definition the (possibly not unique) kth highest sales expenditure.

The thrust of assumption 3.9 is to make the marginal gains in relationships very sensitive to sales expenditures at the margin. As will be seen below, this assumption is not extreme. Specifically,

one consequence of nonprice competition is to yield an upper bound on λ^c. It turns out that any assumption that makes the marginal benefits to relationships less sensitive to sales effort at the margin yields an upper bound on λ^c that is smaller.

We now study a symmetric equilibrium where all relationship banks spend $\mathcal{E} \geq \underline{\mathcal{E}}$ (strategy combinations that support this equilibrium are rigorously constructed in Appendix D). Ceteris paribus, sales efforts reduce the profits from cooperating on prices by $\mathcal{E}$ every period. Hence, the long-run payoff from sticking to the implicit contract is $\frac{\delta}{1-\delta} f^r \left[\frac{k}{m} \left(\frac{\lambda^c V}{k} - R \right) - E \right]$ (recall that if all relationship banks spend the same amount in sales effort, they obtain the same number of relationships). On the other hand, at the time that a relationship bank decides to undercut, sales expenditures are sunk, just as relationship costs R are. Hence, the gains from undercutting are not affected by sales efforts, and the no-undercutting condition reads

$$\frac{\delta}{1-\delta} f^r \left[\frac{k}{m} \left(\frac{\lambda^c V}{k} - R \right) - E \right] \geq \frac{f^r}{m} \left[(m-1)\lambda^c - (m-k)\alpha \right] V. \tag{3.6}$$

This condition is very similar to (3.4) except for term E on the left-hand-side. Call $\mathcal{L}^E$ the set of points in the space (λ^c, m) such that condition 3.6 holds. Then $\frac{\partial \underline{\lambda^c}}{\partial E} > 0$ and $\frac{\partial \overline{m}}{\partial E} < 0$, so that $\mathcal{L}^E \subset \mathcal{L}$. Thus:

Proposition 3.10. *When nonprice competition by banks increases, fees tend to be higher for a given number of banks m. Conversely, the market tends to be more concentrated for a given λ^c.*

Proof. See Appendix E. ∎

The intuition behind Proposition 3.10 should be clear by now: sales efforts, and, more generally, *any* sunk expenditures, reduce the gains from the implicit contract but not those of cheating. Adhering to the price norm must then be made more attractive, which is achieved either by exit (and increased concentration) or higher fees. The invariance of the gains of cheating to sunk expenditures has another implication:

Result 3.11. *Relationship banks do not compete away rents with sales efforts.*

In many models ex-ante nonprice competition is a mechanism to dissipate ex-post rents. This does not occur here because the incentive to make relationship-investments relies on rents. Thus, sales efforts do not do away with soft price competition, which is the source of rents in this model.

Result 3.11 has another interesting implication on cross-subsidies among different lines of business for multiproduct banks. Suppose that one way to attract clients to do "high margin" deals is to sell them other commodity services at fees below cost. This cross subsidization should not dissipate rents in the high margin activities performed by the bank. If that were the case,

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then relationship banks would want to unilaterally deviate from price norms, thus undermining relationships.

There is one sense, however, in which nonprice competition restrains the market power of banks. As is shown now, nonprice competition imposes an upper bound on the fee that investment banks can charge in equilibrium. To see this, note that an additional way for a relationship bank (say, bank 1) to deviate from equilibrium is by escalating sales expenditures. In that case bank 1 establishes a relationship with every firm and increases the proportion of firms in its portfolio of relationships, η_1, from $\frac{k}{m}$ to 1. If this occurs, so that bank 1 establishes a relationship with every firm and $E_2 = E_m = E$, there are $k - 1$ relationships left for $m - 1$ banks for any given firm. η_i then falls from $\frac{k}{m}$ to $\frac{k-1}{m-1}$ for $i = 2, 3, ..., m$. Thus, if every bank sticks to $\lambda_i^c = \lambda^c$, and then every bank, including bank 1, pays $E_i = E$ from $t + 1$ on, then bank 1 makes a one-time gain of slightly less than

$$f^r \left[\left(\frac{\lambda^c V}{k} - R \right) - E_1 \right] - f^r \left[\frac{k}{m} \left(\frac{\lambda^c V}{k} - R \right) - E \right] \cong f^r \left(\frac{\lambda^c V}{k} - R \right) \left(1 - \frac{k}{m} \right)$$
$$\equiv f^r \left(\frac{\lambda^c V}{k} - R \right) \Delta \eta_1 > 0,$$

since relationship bank 1 sets E_1 a shade above E. But, of course, if this is so, then playing $E_1 = E$ forever cannot be the outcome of an equilibrium, since every bank would have an incentive to unilaterally increase sales efforts every period. It follows that relationship banks will not escalate sales expenditures only if that makes undercutting profitable. This is so if (given m) λ^c is such that the no-undercutting condition (3.4) does *not* hold. Since η_i (for $i = 2, 3, ..., m$) falls to $\frac{k-1}{m-1}$ when bank 1 escalates its sales efforts, continued cooperation is not profitable if λ^c is such that

$$\frac{\delta}{1 - \delta} f^r \left[\frac{k}{m} \left(\frac{\lambda^c V}{k} - R \right) - E \right] < \frac{f^r}{m} \left[(m - \rho)\lambda^c - (m - k\rho)\alpha \right] V, \tag{3.7}$$

with $\rho \equiv \frac{m}{k} \frac{k-1}{m-1}$.

Figure 4 plots the right and left hand sides of condition (3.7) as a function of λ^c. As can be seen (and some tedious algebra in Appendix D shows), condition (3.7) holds for $\lambda^c < \overline{\lambda}^c$, with $\overline{\lambda}^c$—derived straightforwardly from condition (3.7)—being equal to

$$\frac{\frac{\delta}{(1-\delta)} kR - (m - k\rho)\alpha V}{\left[\frac{\delta}{1-\delta} - (m - \rho) \right] V}.$$

It is straightforward to show that $\overline{\lambda}^c > \underline{\lambda}^c$ (see Appendix D). Thus:

Result 3.12. *Competition for establishing relationships sets an upper bound on fees charged by relationship banks.*

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The intuition behind Result 3.12 is as follows. When λ^c is too high, adhering to the implicit contract is very attractive and it is not profitable to undercut *even if* a unilateral deviation in bank's 1 sales efforts reduces everybody's else's market share. But this, of course, cannot occur in equilibrium because then every relationship bank would like to unilaterally increase sales effort. This determines the upper bound on λ^c. In other words, fees that are too high make it profitable to escalate sales efforts.

Note that the upper bound on λ^c would be *smaller* had a unilateral increase in sales effort yielded a smaller increase in the market share of bank 1. This follows because the gains from undercutting (the left hand side in condition (3.7) would then be correspondingly smaller. Therefore, there is no loss of generality in assuming that a marginal increase in sales effort will enable the escalating relationship bank to grab all relationships.

This role of nonprice competition in reducing rents is similar to that obtained in standard models, where ex-ante nonprice competition can eliminate ex-post rents. The difference is that here nonprice competition only restricts the size of such rents, and does not eliminate them. The reason, again, is that rents are necessary to support efficient relationship investments, a feature that is absent when rents are merely a consequence of market power.

4. Applications

4.1. Global competition and relationships

Our model studied competition *within* a particular investment banking market, and how this affects relationships. This section uses the model to explore the effect on relationships of an increase in competition *across* markets—for example, due to opening up of markets or increased global competition.

Deregulation has allowed many investment banks to set foot in foreign markets, both through acquisitions and foreign subsidiaries. Will global competition, as some observers predict, lead to a unified global investment banking market with only a few megabanks?[38] The model suggests that the answer is not straightforward.

Consider, first, changes in regulation that allow or make it easier for foreign banks to enter national markets. This is equivalent to an increase in the number of banks without a change in market size. Since "global" banks typically specialize in relationships, condition (3.4)—that specifies combinations of prices and market shares that will sustain relationships—applies. This condition implies that there is room for at most a few relationship banks in each relevant market. If entry by some foreign banks is successful, it necessarily implies that some domestic banks must

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[38]See, for example, *The Economist:* "The Doomed and the Dangerous (December 5, 1998), "Investment Banking Boutiques: Small Fried" (June 8, 1996); and "The Last of the Mohicans" (July 20, 1996).

exit; otherwise the incentives to maintain relationships cannot be preserved. Thus, when foreign banks enter an established market, one should expect changes in the identities of players, but not substantial consolidation.

A second set of regulatory changes affect firms rather than banks. One such change is to allow firms to list their securities in foreign markets. This enlarges the relevant investment banking market that serves large firms[39] from the national to the international level (e.g. one common European market, or Asian and Latin American firms floating their securities in New York).[40] For investment banks, this increases the size of the market. How should this affect banking concentration? Result 4.1 provides a guide.

Result 4.1. *Ceteris paribus, an increase in market size f will have no effect on concentration.*

Standard theory suggests that concentration should fall as market size increases because entry costs and scale economies become less important (see Mas Collel et al. [1995, ch. 12] for a rigorous proof of this assertion). However, condition (3.3) suggests a different story. Note that all terms in that equation are multiplied by f^r, the number of firms that establish relationships. When this number increases, i.e., as the size of the market increases, both the gains from abiding to price norms and from price undercutting increase in the same proportion. Any combination (λ^c, m) satisfying condition (3.3) in the smaller market will also satisfy it in the larger market. Hence, the result follows.

Data on concentration versus market size in investment banking appear to be consistent with Result 4.1. As can be seen from figures 5a and 5b, the volume of deals increased almost twenty times in real terms between 1950 and 1986, yet market structure and concentration has not fallen. Notice that this result is similar to that obtained in markets with endogenous aggregate sunk costs (Sutton, 1991). Here, however, the exogenous sunk cost R is incurred only at the local level. As a result, the aggregate technology exhibits constant returns to scale. Hence, sunk costs are naturally "escalated" when the size of the market and the number of firms increases.[41] It follows from this discussion that liberalization of listing requirements should lead to massive consolidation of relationship banks at the global level.

A third implication of the model is that neither liberalization of bank entry into national markets nor of listing requirements for firms in foreign markets should change the vertical segmen-

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[39] Typically, either large or active firms are the ones that list in foreign markets, i.e., those with high v.

[40] See Moel (2001) for an analysis of ADRs and their effect on the development of emerging markets.

[41] Implicit in result 4.1 is the central role of nonexcludability in determining aggregate market structure. If α were close to λ^c then all that would be needed to sustain relationships is cooperation at the local level, and there would not be any implications for aggregate market structure. Also, note that when setup costs are not sunk or relationships are excludable, concentration can still be due to scale economies at the aggregate level. Nevertheless, these scale economies would become less important with market size and Result 4.1 would no longer hold. Hence, Result 4.1 is a testable prediction of the model.

tation of investment banking *within* each country. The reason is that fringe banks specialize in serving small firms which generate too little volume to justify establishing relationships and global banks tend to specialize in relationships. Hence, small firms and fringe banks should not be affected much by what happens in the relationship segment, at which most regulatory changes are aimed.

Last, consider how similar policies are likely to affect emerging markets. Liberalizing entry of foreign investment banks is sometimes thought to be a means of jump-starting investment banking, which should lower the cost of funds for local firms. However, even "medium sized" and "large" firms by the standards of emerging markets tend to be "small" when compared with the firms usually served by global banks. The model suggests that the size of the market, as measured by the number of firms that potentially demand investment banking services, is not a very relevant determinant of a global bank's decision of entry. What matters is the size distribution of firms. A "large" market where there are many firms but few of them are large, may be considerably less attractive than a small market with several large corporations. The reason is that the fundamental sunk cost—R—is incurred at the firm, not the market level. In other words, the relationship technology constrains the extent to which policy can shape the structure of the banking market.[42]

4.2. Antitrust and the "relevant market"

The tension between relationships and competition poses a challenge to antitrust action. On the one hand, the exercise of market power tends to reduce welfare. On the other, however, restraints on price competition are necessary for relationships to be sustainable. This section explores some implications for antitrust policy.

Consider first the usual conjecture that soft price competition is an indication of a welfare-decreasing exercise of market power. But, as seen, soft price competition is necessary to support efficient, relationship-based production technologies—an insight that emerges from the literature on commercial bank relationships as well. An additional result here is that if an implicit contract is the source of imperfect competition, then, for price norms to be self-enforcing, prices will be higher than average costs as well. Thus, excess profits by banks may not be sufficient evidence of welfare-decreasing anti-competitive behavior.[43]

A second point is that interventions aimed at increasing competition at the deal (or "local") level may have unintended consequences on fees and aggregate market concentration.[44] For

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[42]For more on this, see Anand and Galetovic (2001).

[43]This point is alluded to by Rajan [1996]: "..(I)t is unlikely that the securities business is the textbook competitive industry. (But) if indeed there are excess profits (and I am not arguing that they are), economists must understand the source of these profits."

[44]An example of this is the effect of Rule 415, better known as "shelf registration". Shelf registration was introduced in the early 1980s. It allows firms to eschew the mandatory 20-day waiting period between the registration of the issue with the SEC and the moment the issue can be brought to market. In exchange firms must file a blanket

example, regulatory interventions or technological changes may have the effect of increasing the number of banks with whom clients have relationships (an increase in k). The model illustrates the equilibrium logic that is useful to analyze these interventions. First, weakening relationships makes it more difficult to recover the sunk relationship cost R. Therefore, the number of firms served by relationship banks should fall. On the other hand, fees or concentration (or both) should increase in the relationship segment of the market, making relationships more attractive to banks. Second, if any of these measures succeed in reducing fees, one should expect a more concentrated market. Thus, measures of market concentration can be misleading as a guide to how competitive the market has become.

The example above illustrates an interesting paradox. Specifically, an increase in the number of relationships that firms have with banks leads to increased *concentration* among "bulge bracket" (relationship) banks, but an increase in the *size* of the fringe segment of the market. This tension between competition and cooperation is seen in other ways in this market as well. First, whereas competition in prices is soft, competition *for* relationships and in non-price dimensions can be intense. Second, the presence of a competitive fringe indicates fierce price competition between banks. But, as the model shows, such competition within the arms-length segment need not carry over to relationship banks.

A third issue that is relevant to antitrust analysis is the definition of the relevant investment banking market. A common argument is that the large number of small banks in this market imposes some competitive discipline on the pricing behavior of large, bulge-bracket banks. The analysis here suggests, however, that this view may be wrong. Bulge-bracket banks differ from small ones in that they use a relationship-based technology for doing deals. One consequence is that the size of clients served by each segment will be different. Moreover, as shown, differences in bank profits and fees between the two segments will not be eliminated, even with costless entry and exit. Thus, changes in one segment of the market will have no effect on the nature of competition in the other segment other than on the size distribution of clients served by each segment. The point is that, from a firm's perspective, relationship and arm's-length technologies are not substitutes at the margin.

4.3. Information technology and relationships

How will recent advances in information technology affect relationships between investment banks and firms, and the structure of the investment banking market? Wilhelm (1999) examines the

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registration document describing their financing plans over the next two years, which is made public. Auerbach and Hayes (1986) provide a thorough analysis of the effect of this change. In the terminology of our model, the effect of this change is to increase the intensity of competition by non-core banks, thus weakening relationships by decreasing the switching cost α.

impact of these advances on relationships between investment banks and investors, and consequently on the pricing and distribution of securities. Relationships between investment banks and investors exist primarily to economize on search costs between banks and investors, therefore information technology can clearly substitute for these relationships. The impact on relationships between investment banks and firms is not as clear.

To see why, notice that these changes may, on the one hand, reduce the costs of *any* bank— relationship or not—in accessing information on a company, and may also increase the ability to codify and analyze vast amounts of information that previously relied on human judgement and experience.[45] Thus, for example, computational advances may both reduce the need for trial-and-error learning, and codify financial product design. The effect of these changes is to increase the substitutability of a relationship technology by a transactional or non-relationship one, thus reducing β. On the other hand, advances in communication technology may also significantly reduce the costs of interaction between firms and banks, thus reducing R. For the same reason, this can allow firms to increase the number of banks with which they interact, thus increasing k. In other words, while the improved ability to codify information substitutes transactions for relationships, lower communication costs make it easier to have *more* relationships as well.

Making relationships less costly, less exclusive, and easier to substitute by arm's-length transactions might be thought to increase competition. Indeed, changes in β should reduce the size of the relationship segment of the market. And, lower costs of establishing relationships (lower R) tend to reduce fees and concentration. But there are opposite effects to consider as well. As seen, increasing k tends to reduces the revenues from any relationship. Concentration (or fees) within the relationship segment of the market must then rise to preserve the incentives to establish relationships. To summarize, advances in information technology might lead to more clients served by arms-length banks, but greater consolidation among bulge-bracket banks.

5. Conclusion

The title of this paper asks what one can learn about the tension between relationships and competition from the industrial organization of investment banking. This study suggests some answers.

One feature that becomes apparent when looking at this industry is that the term "competition" stands for many different things, and that not all forms of it affect relationships in the same way. Consider first price competition. It has been shown that as long as the technology of relationships exhibits sunk costs and intermediaries cannot charge directly for a relationship, then price competition and relationships cannot coexist. Instead, some mechanism that prevents undercutting is necessary. In investment banking, where multiple relationships are common and

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[45]See, for example, Wilhelm and Downing's (2001) account of OffRoad Capital.

switching costs are low, an implicit contract not to undercut appears to be the mechanism that softens price competition among relationships banks. In other markets, product differentiation may well be also important.

Price competition need not always kill relationships, however. For one, price competition and relationships can coexist if intermediaries can charge directly for relationships. This is true even with local scale economies from relationships. Furthermore, price competition from intermediaries doing arm's length deals does not hurt relationships with large firms, because arm's length deals are inherently more costly for these firms. Relationships are therefore sheltered from competition by arms length intermediaries by the scale economies intrinsic to relationships.

There are many other forms of competition in the face of which relationships can survive. Examples studied here include sales efforts pitched at establishing more relationships, and competition for deals from firms that have multiple relationships with banks (and can switch between them). These forms of competition are not inconsistent with relationships as long as they do not erode the source of rents. Specifically, when competition gets more intense in these dimensions (for example, firms increase the number of relationships that they establish), the endogenous adjustment in fees or in the number of banks undo their deleterious effects on the incentives to establish relationships.

The results also caution against examining the effects of different types of competition in isolation. Investment banking shows that different ways of competition interact. Specifically, as has been seen, the technology of relationships imposes restrictions on this interaction, and on the industrial organization of the industry. Understanding how this interaction affects market structure in other intermediation markets seems a fruitful area for further research.

Appendix

A. Equilibrium in the one-period game

We now rigorously describe the timing of actions, and then characterize the equilibrium of the one-period game. The time line is as follows:

1. Each firm randomly contacts k relationship banks.

2. Each bank chooses those firms with which it wants to establish relationships, and incur the corresponding sunk cost R. If k banks establish relationships with a given firm, then that is the core group of banks of the firm.

3. Firms announce deals.

4. (Fee offers) Each relationship bank i simultaneously makes a price offer $\lambda_i^c \in [0,1] \cup \{\infty\}$ to all firms with whom it has a relationship, an offer $\lambda_i^{nc} \in [0,1] \cup \{\infty\}$ to all firms in a core group that does not include i, and an offer $\lambda_i^{nr} \in [0,1] \cup \{\infty\}$ to firms that have no relationships (superscript 'c' stands for 'core', superscript 'nc' for 'non core' and superscript 'nr' for 'no relationship'). These offers are expressed as a fraction of deal volume (thus, they represent commissions or percentage fees). $\lambda = \infty$ means that no offer was made. Obviously $\lambda_i^c = \infty$ if bank i is in no core group and $\lambda_i^{nc} = \infty$ if it has a relationship with every firm.

   Simultaneously, each fringe bank j makes a price offer $\lambda_j^f \in [0,1] \cup \{\infty\}$ to all firms.

5. Each firm chooses the bank offering the lowest fee net of transaction costs. If $x > 1$ banks tie, then each bank wins the deal with probability $\frac{1}{x}$.

6. Deals are implemented, fees paid and the game ends.

To define bank strategies let $\mathcal{H}$ be the set of possible histories right before banks make fee offers. A strategy by a relationship bank i is a tuple $(\mathcal{R}_i, \Lambda_i)$. $\mathcal{R}_i : [0, \overline{v}] \to \{0, R\}$ is a function that indicates whether bank i will establish a relationship with those firms that selected i to form part of the core group. Since firms are completely described by v, bank i's decision can be conditioned on firm type. $\Lambda_i = [\lambda_i^c, \lambda_i^{nc}, \lambda_i^{nr}]$ is a three-dimensional vector function $\Lambda_i : \mathcal{H} \to [[0,1] \cup \{\infty\}]^3$. In turn, a strategy by fringe bank j is a function $\lambda_j^f : \mathcal{H} \to [0,1] \cup \{\infty\}$. Proposition A.1 characterizes the set of subgame perfect equilibria of this game. (See Appendix B for a strategy combination that is a subgame perfect equilibrium of the one-period game.)

Proposition A.1. *In any subgame perfect equilibrium, no relationships are established and $\lambda^f = 0$.*

Proof. Suppose, by way of contradiction, that bank i establishes a relationship with a firm. Suppose first that $k > 1$. In any subgame with relationships, Bertrand competition for deals between core banks drives λ^c to 0 in equilibrium. On the other hand, if $k = 1$, Bertrand competition with relationship banks drives λ^{nc} to α, and hence λ_i^c to $\alpha < \frac{R}{v}$ in equilibrium in any subgame where bank i is the firm's only relationship bank. Hence, in both cases bank i loses money if it becomes a relationship bank, therefore $\lambda_i^c = \infty$. Finally, note that since there are no variable cost of doing deals, Bertrand competition among fringe banks drives λ^f to 0 in equilibrium. ∎

Hence no relationships are established in equilibrium, only banks that do not establish relationships are active, and each deal costs βs to firms. Moreover, since there are no variable costs of doing deals, fees are driven to zero in equilibrium. For firms with v such that $\beta \leq \frac{kR}{v}$ (i.e. firms that do small and infrequent deals) this equilibrium is efficient. By contrast, firms with v such that $\beta > \frac{kR}{v}$ would want to establish k relationships and compensate banks for the incurred sunk costs. This can be summarized in the following result:

Result A.2. *The equilibrium of the one-shot game is efficient form firms that do infrequent or small deals. It is inefficient for firms that do large or frequent deals.*

A straightforward implication of Result A.2 is that low-volume firms will never establish relationships. Moreover, Result A.2 shows that establishing relationships is not efficient for every type of client. Firm volume will determine which technology is efficient.

B. A subgame perfect equilibrium with no undercutting

In this appendix, we study a symmetric subgame perfect equilibrium where all relationship banks charge the same fee $\lambda^c > 0$ period after period, all fringe banks compete and charge $\lambda^f = 0$, and relationships are profitable. The outcome of this equilibrium are the conditions examined in the text.

We start by defining a strategy combination that is a subgame perfect equilibrium of the one-period game.

Definition B.1. *Call strategy combination P (for 'punishment') the following combination of strategies*

- *For all relationship banks i*

  1. *$\mathcal{R}_i(v) = 0$ for all $v \in [0, \overline{v}]$;*
  2.

$$(\lambda_i^c, \lambda_i^{nc}, \lambda_i^{nr}) = \begin{cases} (0,0,0) & \text{if } i \text{ is member of at least one core group and not member} \\ & \text{of at least another core group;} \\ (\infty, 0, 0) & \text{if } i \text{ is member of no core group but at least one exists;} \\ (\infty, \infty, 0) & \text{if no core groups are established.} \end{cases}$$

- *For all fringe banks j, $\lambda_j^f = 0$.*

Part (i) of the strategy of relationship banks implies that no bank establishes a relationship. Part (ii) implies that i undercuts other relationship banks on all histories such that i is in a core group. Finally, part (iii) implies that bank i always undercuts when not in a core group. We are now ready to prove the following lemma:

Lemma B.2. *Strategy combination P is a subgame perfect equilibrium of the one period game.*

Proof. Consider first histories where at least one firm establishes relationships with k banks and forms its core group. According to P, for these histories we have to distinguish three cases:

$$(\lambda_i^c, \lambda_i^{nc}, \lambda_i^{nr}) = \begin{cases} (0, \infty, 0) & \text{if bank } i \text{ is member of all core groups;} \\ (0, 0, 0) & \text{if there is at least one core group where bank } i \text{ is not a member} \\ & \text{but bank } i \text{ is member of at least one core group;} \\ (\infty, 0, 0) & \text{if bank } i \text{ is member of no core group.} \end{cases}$$

In any of these three cases, any unilateral deviation by bank i setting $\lambda_i^c > 0$ or $\lambda_i^{nc} > 0$ or $\lambda_i^{nr} > 0$ as the case may be will not increase its payoff, since it would get no deals.

Consider next histories where no firm forms a core group. Then, $(\lambda_i^c, \lambda_i^{nc}, \lambda_i^{nr}) = (\infty, \infty, 0)$ according to P. Setting $\lambda_i^{nr} > 0$ will not increase i's payoff since it would get no deals.

Last, setting $\mathcal{R}_i(v) = R$ for one or more v's will not increase i's payoff because according to strategies no other firm establishes relationships. ∎

The following corollary follows from Proposition A.1 and Lemma B.2.

Corollary B.3. *All banks receive a payoff equal to 0 in the one period game.*

Thus, since playing strategy combination P forever is clearly a subgame perfect equilibrium in the infinitely repeated game, it follows that it can be used to construct a subgame perfect punishment. We now define 'undercutting.'

Definition B.4. *Let λ^c be the fee charged in an equilibrium with relationships. Then there is undercutting in period t if $\min\{\lambda_i^c(t), \lambda_i^{nc}(t) + \alpha\} < \lambda^c$ for at least some i.*

Note that λ^{nr} and λ^f are not part of the definition. We are assuming that neither "undercutting" in the fringe segment, nor fringe banks setting fees such that $\lambda^f + \beta < \lambda^c$, destroys cooperation.

We now specify a strategy combination such that cooperation is a subgame perfect equilibrium. To do so, it is useful to assign each possible history of the game into one of two disjoint sets.

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Definition B.5. *We say that the history of the game at period t is 'cooperative' if and only if no undercutting has occurred so far. That is, for all $\tau < t$, $\min\{\lambda_i^c(\tau), \lambda_i^{nc}(\tau) + \alpha\} \geq \lambda^c$. Any other history is non–cooperative.*

Notation B.6. *We denote the state of the game at period t by ϕ_t. The state of the game after a history with no undercutting is cooperative and is denoted by ϕ^c. Any other state of the game is 'non-cooperative' and is denoted by ϕ^{nc}.*

Note that this definition implies that the initial state of the game is cooperative. Next we define some notation we need to define strategies:

Notation B.7. *As in the text, η_i denotes the share of firms with $v \geq \underline{v}$ such that bank i is in their core group. Furthermore, we denote by η_{-i} the fraction of firms with $v \geq \underline{v}$ that have a core group where relationship bank i is not a member*

Note that $1 - \eta_i - \eta_{-i}$ is the fraction of firms with $v \geq \underline{v}$ who did not form a core group. Hence, if all firms formed a core group then $\eta_{-i} = 1 - \eta_i$. Furthermore, $1 - \eta_i - \eta_{-i} = 1 - \eta_j - \eta_{-j}$ for all i, j. We can now define the symmetric strategy combination C (for 'cooperative').

Definition B.8. *Call strategy combination C the following combination of strategies:*

- *For all relationship banks i*

    1. *(Establishing relationships)*
        - *If $\phi_t = \phi^c$ then play*
        $$\mathcal{R}_i(v) = \begin{cases} R \text{ for } v \geq \underline{v}, \\ 0 \text{ for } v < \underline{v}. \end{cases}$$
        - *Otherwise, play according to P.*

    2. *(Fee offers)*
        - *If $\phi_t = \phi^c$ and*
        $$\frac{\delta}{1-\delta} f^r \frac{k}{m} \left(\frac{\lambda^c V}{k} - R \right) \geq \max_j \left\{ f^r \left[\eta_j \left(1 - \frac{1}{k} \right) \lambda^c + \eta_{-j}(\lambda^c - \alpha) \right] V \right\} \tag{B.1}$$

        holds, then play
        $$(\lambda_i^c, \lambda_i^{nc}, \lambda_i^{nr}) = \begin{cases} (\lambda^c, \infty, 0) & \text{if } \eta_i > 0; \\ (\infty, \infty, 0). & \text{if } \eta_i = 0. \end{cases}$$
        - *Otherwise play according to P.*

- *For all fringe banks j play $\lambda_j^f = 0$.*

Condition (B.1) says that bank i will not undercut in period t provided that continued cooperation is more profitable than undercutting, given period's t ex ante fee offers. Lemma B.9 characterizes the outcome path induced by C:

Lemma B.9. *Along the path induced by C*
(i) all relationship banks i play $(\lambda_i^c, \lambda_i^{nc}, \lambda_i^{nr}) = (\lambda^c, \infty, 0)$ for all t;
(ii) all relationship banks have the same market share;
(iii) all fringe banks play $\lambda_j^f = 0$ for all t.

Proof. The proof is straightforward and we leave it to the reader. ∎

We now state and prove the main result of this appendix:

Proposition B.10. *Let $(\lambda^c, m) \in \mathcal{L}$. Then, strategy combination C is a subgame perfect equilibrium in the infinitely repeated game.*

Proof. To prove this Proposition, we show that players' strategies are optimal after any history. Since this is a repeated game with bounded payoffs, it suffices to show that one-step unilateral deviations from strategies are not profitable after any history.

Now according to C histories can be classified into two groups, cooperative and non cooperative. Consider, then, histories after which the state of the game is non-cooperative ($\phi_t = \phi^{nc}$). We know that when all other relationship banks are playing according to P in the one-period game, it is optimal for bank i to do the same. Since all relationship banks will play according to P forever after, it is also optimal for relationship bank i to play according to P in any period of the repeated game.

Next consider histories after which the state of the game is cooperative ($\phi_t = \phi^c$), relationship banks must make fee offers and condition (B.1) does not hold. Then all relationship banks play according to P, from which we know it is optimal not to deviate.

Now consider histories after which the state of the game is cooperative ($\phi_t = \phi^c$), relationship banks must make fee offers, $\eta_i > 0$ and condition (B.1) holds. Then bank i can not gain by undercutting (as condition [B.1] implies). On the other hand, if bank i would set $\lambda_i^c > \lambda^c$ or $\lambda_i^{nc} \in (\lambda_1^a + \alpha, \infty)$ it would not get any further deals; and setting $\lambda_i^{nr} > 0$ would not get any further deals either. Thus, playing $(\lambda_i^c, \lambda_i^{nc}, \lambda_i^{nr}) = (\lambda^c, \infty, 0)$ is optimal. Moreover, if $\eta_i = 0$ but $\eta_{-i} > 0$ it would not gain deviating from setting $(\lambda_i^c, \lambda_i^{nc}, \lambda_i^{nr}) = (\infty, \infty, 0)$. Last, if $\eta_i = \eta_{-i} = 0$ relationship bank i cannot gain by undercutting.

Next consider histories after which the state of the game is cooperative ($\phi = \phi^c$) and banks must decide whether to establish relationships. Clearly a relationship bank cannot gain by deviating and setting $\mathcal{R}(v) = 0$ for firms such that $v \geq \underline{v}$ (it would lose $\left(\frac{\lambda^c v}{k} - R\right)$ per firm in the current period according to strategies) or by sinking the relationship cost with a firm such that $v < \underline{v}$ (since such a firm will not be successful in establishing a core group according to strategies because $\left(\frac{\lambda^c v}{k} - R\right) < 0$). Hence setting $\mathcal{R}(v) = R$ for $v \geq \underline{v}$ and $\mathcal{R}(v) = 0$ for $v < \underline{v}$ is optimal.

Last, note that playing $\lambda_j^f = 0$ is optimal for fringe banks in the one-period game, hence it is also optimal to play so in the repeated game. This completes the proof. ∎

C. Comparative equilibria

In this appendix we obtain the comparative equilibria derivatives that are presented in the text. All are obtained by totally differentiating the identity

$$\frac{\delta}{1-\delta} k \left(\frac{\lambda^c V}{k} - R\right) - \left[(m-1)\lambda^c - (m-k)\alpha\right] V \equiv 0$$

which is derived from the no undercutting condition (3.4). Totally differentiating this identity with respect to λ^c, m, k and α, recalling that $\varepsilon_{V,\lambda} \equiv -\frac{\partial V}{\partial \lambda^c}\frac{\lambda^c}{V}$, and simplifying yields

$$\left\{\left[\frac{\delta}{1-\delta} - (m-1)\right](1 - \varepsilon_{V,\lambda^c}) - \frac{\alpha}{\lambda^c}(m-k)\varepsilon_{V,\lambda^c}\right\} V \mathrm{d}\lambda^c - (\lambda^c - \alpha)V\mathrm{d}m$$

$$- \left\{\left[(m-1)\lambda^c - (m-k)\right]\frac{\partial V}{\partial k} + \alpha V - \frac{\delta}{1-\delta}\left(\lambda^c \frac{\partial V}{\partial k} - R\right)\right\} \mathrm{d}k + (m-k)V\mathrm{d}\alpha \equiv 0,$$

which can be rewritten as

$$A\mathrm{d}\lambda^c - B\mathrm{d}m - C\mathrm{d}k + D\mathrm{d}\alpha \equiv 0. \tag{C.1}$$

It will be useful to sign the coefficients in identity (C.1). Clearly $B > 0$ (since $\lambda^c > \alpha$) and $D > 0$ (since $m > k$). To sign C note first that $(m-1)\lambda^c - (m-k) = k - \lambda^c > 0$. Moreover, since $\frac{\partial V}{\partial k} = \frac{R}{2\lambda^c} = \frac{v}{2k} > 0$ it follows that

$$\lambda^c \frac{\partial V}{\partial k} - R = \lambda^c \frac{v}{2k} - R < 0$$

since $\lambda^c \frac{v}{k} - R = 0$ by the definition of $\underline{v}$. It follows that $C > 0$. Finally, noting that $\varepsilon_{V,\lambda^c} = \frac{v}{v + \underline{v}}$, A an be rewritten as

$$\frac{1}{\overline{v} + \underline{v}} \left\{\left[\frac{\delta}{1-\delta} - (m-1)\right]\overline{v} - \frac{\alpha}{\lambda^c}(m-k)\underline{v}\right\},$$

whose sign is ambiguous but positive if α is sufficiently small. Now if $A > 0$ then the following result follows.

Proposition C.1. *If $A > 0$ then:*

$$\frac{\mathrm{d}m}{\mathrm{d}\underline{\lambda}^c} = \frac{A}{B} > 0;$$

$$\frac{\mathrm{d}\underline{\lambda}^c}{\mathrm{d}k} = \frac{C}{A} > 0;$$

$$\frac{\mathrm{d}\underline{\lambda}^c}{\mathrm{d}\alpha} = -\frac{D}{A} < 0;$$

$$\frac{\mathrm{d}\overline{m}}{\mathrm{d}k} = -\frac{C}{B} < 0;$$

$$\frac{\mathrm{d}\overline{m}}{\mathrm{d}\alpha} = \frac{D}{B} > 0.$$

Proof. By direct substitution. ∎

D. Nonprice competition

To analyze nonprice competition we replace the first stage of the one period game. Instead of firms randomly choosing k relationship banks, we have relationship banks choosing sales effort E_i.

It is easy to show that in the one-period game relationship banks will not spend anything in sales efforts and that no relationships will be established. Thus, as before, the equilibrium in the one period game can be used as a subgame perfect punishment. Call again this subgame perfect punishment P. Next define 'undercutting' and 'cooperative' and 'non-cooperative' states exactly as in the previous section.[46] Last, we need one piece of additional notation to keep track of the fraction of firms that contact relationship bank i in response of i's sales effort:

Notation D.1. *We denote by* γ_i *the fraction of firms with* $v \geq \underline{v}$ *that contact relationship bank* i *after* i *has chosen* E_i.

Recall that, by definition, $E_1 \geq E_2 \geq ... \geq E_m$. Hence, our assumptions imply that γ_i is a function $\gamma_i : \mathsf{R}_+^m \to [0,1]$ such that

$$\gamma_i(E_1, ..., E_i, ..., E_m) = \begin{cases} 0 & \text{if } E_i < \underline{E} \text{ or } E_i < E_k; \\ \frac{1}{y} & \text{if } E_i = E_k \geq \underline{E} \text{ and } y \text{ banks make the } k\text{th largest sales effort}; \\ \frac{1}{m} & \text{if } E_1 = E_m \geq \underline{E}; \\ 1 & \text{if } E_i > E_k \text{ and } E_i \geq \underline{E}. \end{cases} \tag{D.1}$$

Function γ_i summarizes how banks sales efforts bring about contacts with firms. Note that $\sum_{i=1}^m \gamma_i = k$ if $E_k \geq \underline{E}$. We can now define a strategy combination that is a subgame perfect equilibrium in the game with sales effort.

Definition D.2. *Call strategy combination* C *the following combination of strategies:*

- *For all relationship banks* i

1. 1. *(Sales effort)*

   - *If* $\phi_t = \phi^c$ *then play* $E_i = E \geq \underline{E}$;
   - *Otherwise, play* $E_i = 0$.

   2. *(Establishing relationships)*

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[46]Note that this implies that the state of the game is determined only by the pricing behavior of relationship banks, and not by their sales efforts.

- If $\phi_t = \phi^c$ and

$$\frac{\delta}{1-\delta} f^r \left[\frac{k}{m} \left(\frac{\lambda^c V}{k} - R \right) - E \right] \geq \max_j \left\{ f^r \left[\gamma_j \left(1 - \frac{1}{k} \right) \lambda^c + (1 - \gamma_j)(\lambda^c - \alpha) \right] V \right\} \qquad \text{(D.2)}$$

then play

$$\mathcal{R}_i(v) = \begin{cases} R & \text{for } v \geq \underline{v}, \\ 0 & \text{for } v < \underline{v}. \end{cases}$$

- Otherwise, play $\mathcal{R}_i(v) = 0$ for all $v \in [\underline{v}, \overline{v}]$

3. (Fee offers)

- If $\phi_t = \phi^c$ and

$$\frac{\delta}{1-\delta} f^r \left[\frac{k}{m} \left(\frac{\lambda^c V}{k} - R \right) - E \right] \geq \max_j \left\{ f^r \left[\eta_j \left(1 - \frac{1}{k} \right) \lambda^c + \eta_{-j}(\lambda^c - \alpha) \right] V \right\} \qquad \text{(D.3)}$$

then play

$$(\lambda_i^c, \lambda_i^{nc}, \lambda_i^{nr}) = \begin{cases} (\lambda^c, \infty, 0) & \text{if } \eta_i > 0; \\ (\infty, \infty, 0) & \text{if } \eta_i = 0. \end{cases}$$

- Otherwise play according to P.

- For all fringe banks j play $\lambda_j^f = 0$.

Like in the previous section, condition (D.3) says that bank i will not undercut in period t provided that continued cooperation is more profitable than undercutting.. Note that this no–undercutting condition is exactly the same as condition (B.1) in the previous section, except for the fact that sales effort expenditures E are included in the left-hand side of condition (D.3). Lemma B.9 characterizes the outcome path induced by C.

Lemma D.3. *Along the path induced by C*
(i) *all relationship banks i select $E_i = E$;*
(ii) *all relationship banks i play $(\lambda_i^c, \lambda_i^{nc}, \lambda_i^{nr}) = (\lambda^c, \infty, 0)$ for all t;*
(iii) *all relationship banks have the same market share;*
(iv) *all fringe banks play $\lambda_j^f = 0$ for all t.*

Proof. The proof is straightforward and we leave it to the reader. ∎

We now state and prove the main result of this section:

Proposition D.4. *Let $(\lambda^c, m) \in \mathcal{L}^E$. Then strategy combination C is a subgame perfect equilibrium in the infinitely repeated game with sales effort. Moreover,*

$$\underline{\lambda}^c \leq \lambda^c < \overline{\lambda}^c = \frac{\frac{\delta}{1-\delta} \left(\frac{k}{m} R + E \right) - \frac{1}{m}(m - k\rho)\alpha V}{\frac{V}{m} \left[\frac{\delta}{1-\delta} - (m - \rho) \right]},$$

with $\rho \equiv \frac{m}{k} \frac{k-1}{m-1}$.

Proof. To prove this proposition, we show that the players' strategies for the repeated game are optimal after any history. Again, since this is a repeated game with bounded payoffs, it suffices to show that one-step unilateral deviations from strategies are not profitable after any history.

Now as before, according to C histories can be classified in two groups, cooperative and non-cooperative. Consider, then, histories after which the state of the game is non-cooperative ($\phi_t = \phi^{nc}$). We know that when all other banks are playing according to P in the one-period game, it is optimal for bank i to do the same. Since all banks will play according to P forever after, it is also optimal for bank i to play according to P in any period of the repeated game.

Now consider histories after which the state of the game is cooperative ($\phi_t = \phi^c$) and relationship banks must make fee offers. Then, with the exception of the sales effort E on the left-hand side of (D.3), the continuation

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game's strategies look exactly as in the game without sales effort. Hence, one-shot deviations from strategies are unprofitable.

Next consider histories after which the state of the game is cooperative and relationship banks must decide whether to establish relationships with firms. If condition (D.3) holds, and all relationship banks conform to strategies, then $\gamma_j = \eta_j$ (that is, all relationship banks establish relationships with all firms they contacted) and $1 - \gamma_j = \eta_{-j}$ for all j. Hence condition (D.3) also holds and cooperation continues. A unilateral deviation by relationship bank i not establishing relationships is therefore unprofitable (see the proof of Proposition B.10). On the other hand, if condition (D.2) does not hold, then no relationship bank establishes relationships, and so it is optimal for i not to establish them either.

Next consider sales effort decisions when the state of the game is cooperative. According to strategies all relationship banks play $E_j = E$. Hence, a unilateral deviation is to play $E_1 \neq E$. If $E_1 > E$ then $E_1 > E_2 = ... = E_m$. It follows from (D.1) that $\gamma_1 = 1$ and $\gamma_2 = ... = \gamma_m = \frac{k-1}{m-1}$. Such unilateral deviation is unprofitable if

$$\frac{\delta}{1-\delta} f^r \left[\frac{k}{m} \left(\frac{\lambda^c V}{k} - R \right) - E \right] < \frac{f^r}{m} \left[(m - \rho)\lambda^c - (m - k\rho)\alpha \right] V, \tag{D.4}$$

otherwise it would pay to deviate to increase market share for one time. Now some straightforward algebra shows that condition (C.4) holds if and only if $\lambda^c < \overline{\lambda}^c$.

Last, consider playing $E_m < E$. Then $\gamma_m = 0$ and clearly condition (D.3) does not hold, since it holds with equality with $\lambda^c = \overline{\lambda}^c$ and $\min_j \gamma_j = \frac{k-1}{m-1}$. Hence, if relationship bank m deviates selecting $E_m < E$, then no relationships are established in that period and profits are foregone. This completes the proof. ∎

E. Proof of Proposition 3.10

To prove this result, let condition (3.6) hold as an identity and then totally differentiate with respect to λ^c, m and E. This yields

$$A d\lambda^c - (\lambda^c - \alpha + \frac{\delta}{1-\delta} E) dm - \frac{\delta}{1-\delta} m dE = 0,$$

where A is defined as in Appendix B. Setting $dm = 0$, straightforward manipulations yield

$$\frac{d\lambda^c}{dE} = \frac{\delta}{1-\delta} \frac{m}{A} > 0.$$

Similarly, setting $d\lambda^c = 0$ and rearranging yields

$$\frac{dm}{dE} = -\frac{\delta}{1-\delta} \frac{m}{\lambda^c - \alpha + \frac{\delta}{1-\delta}} < 0.$$

This completes the proof. ∎

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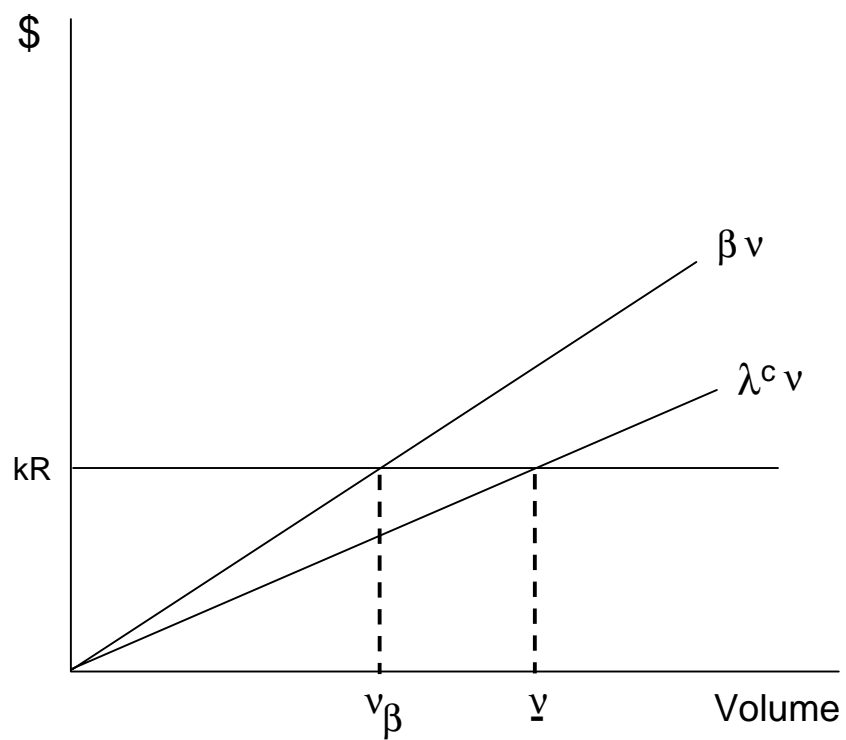
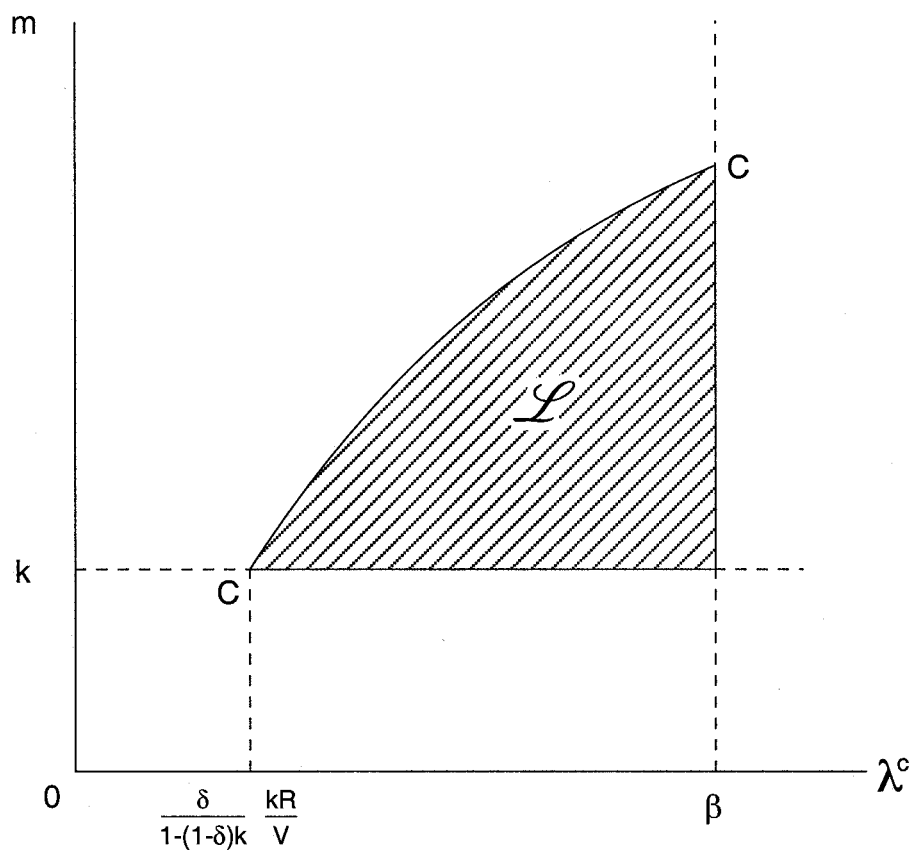**Figure 1. The cost of doing a deal with alternative intermediation technologies.**

Figure 2. L is the set of pairs (λ^c, m) such that the no undercutting condition (3.3) is satisfied. $\overline{m}$ is the number of relationship banks, and λ^c is the fee charged by these banks in an equilibrium with relationships. λ^c cannot exceed β because firms would switch to fringe banks charging $\lambda^f = 0$. Locus CC traces the maximum number of relationship banks, $\overline{m}$, for any given admissible fee λ^c; or, conversely, the lower bound on the fee, $\underline{\lambda}^c$, for any admissible number of relationship banks.
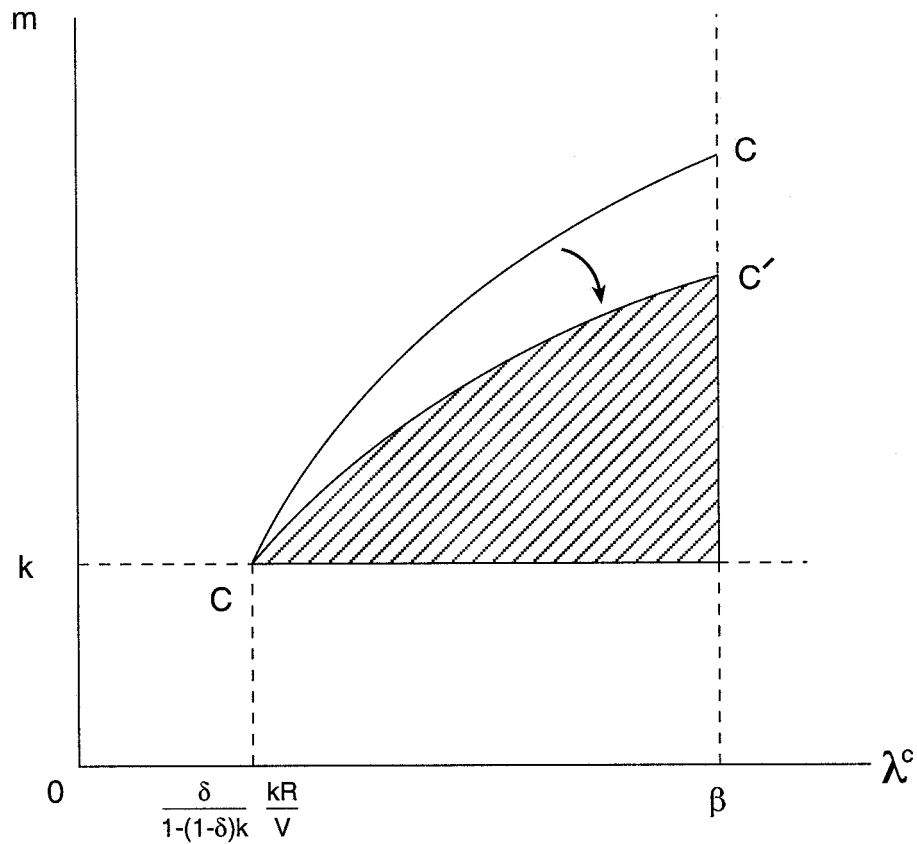
Figure 3. The effect on the no-undercutting locus CC of a smaller switching cost from a core bank to a non-core relationship bank. Locus CC′ traces the effect of a smaller switching cost on the maximum number of relationship banks, $\overline{m}$, for any given admissible fee λ^c. The shaded region indicates the set of pairs (λ^c,m) such that the no-undercutting condition (4.1) is satisfied after a firm's cost to switch from a core to a non-core bank falls.
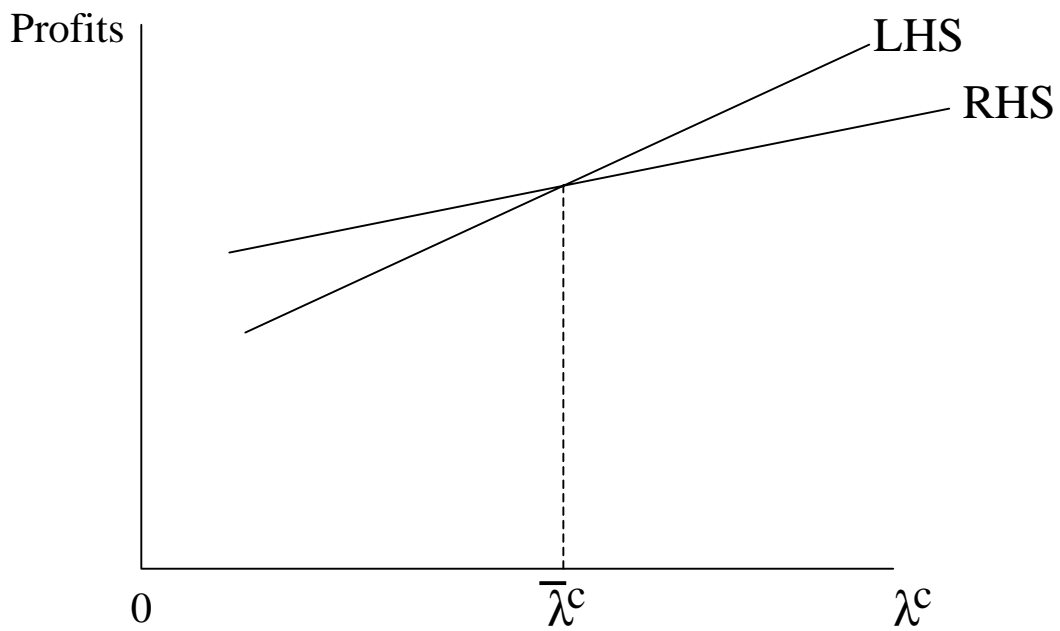
Figure 4. Non-price competition and the upper bound on fees. Locus LHS plots a relationship bank's long-run profits from continued cooperation as a function of the fee λ^c. Locus RHS plots a relationship bank's one-time profits when unilaterally undercutting after another relationship bank has unilaterally escalated sales efforts. The intersection of LHS and RHS is the upper bound on the fee that can be charged in any cooperative equilibrium.
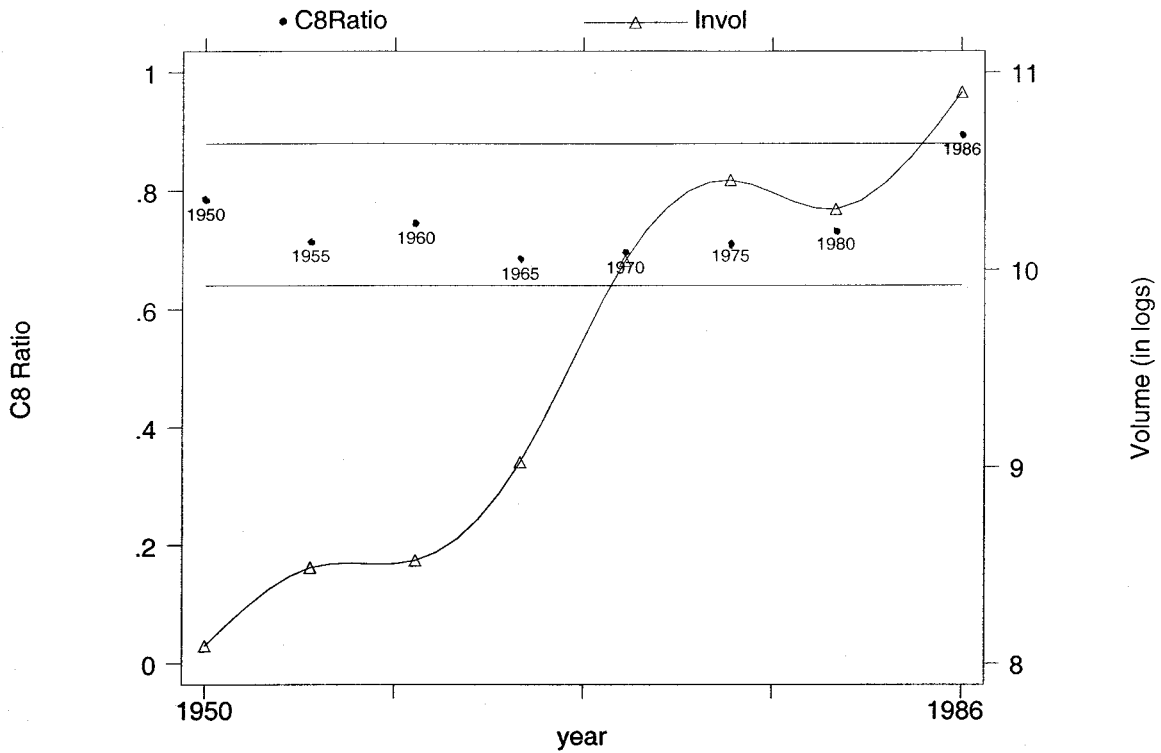
Figure 5a. Concentration and Volume in Underwriting
Source: Hayes, Spence, and Marks (1983), table 1, and Eccles and Crane (1988),
table 5.4.
"C8-Ratio" is the share of total volume of securities underwritten in any given
year by the top eight investment banks. Full credit is given to lead manager.
"Volume" is the logarithm of total volume of securities underwritten in any
given year (volume data is in real terms). Volume increased seventeen-fold
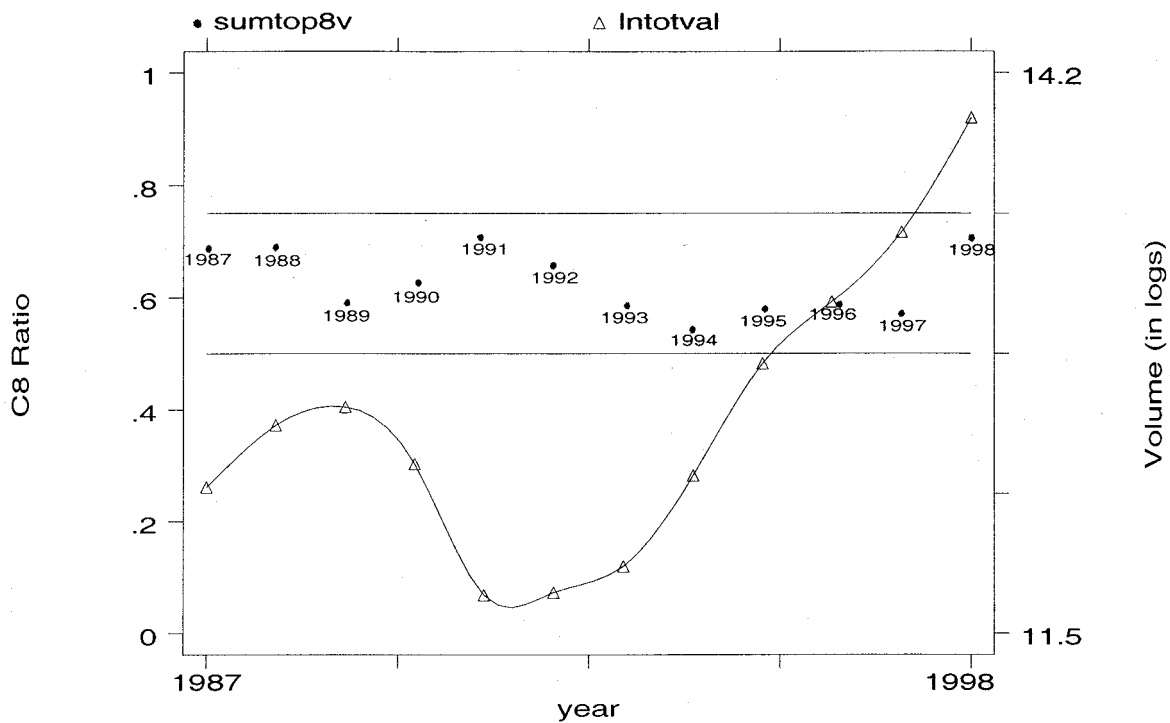between 1950 and 1986.

Figure 5b. Concentration and Volume in Mergers and Acquisitions
Source: Author's processing of data from Securities Data Company.
"C8-Ratio" is the share of total deal value of mergers and acquisitions brokered
by the top eight investment banks in any given year. Full credit is given to the
acquiror's lead bank. The sample of M&A deals is restricted to those made by
firms that do at least three such deals in the 12-year period 1987-1998.
Maximum and minimum volume over this time period differ by a factor of eight.