On competition and banking

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Chapter 9

The commitment effect of choosing the same bank

9.1 Introduction

It is generally known that firms are better off when the markets where they obtain their inputs are less concentrated. Less concentration implies more competition, which in turn implies lower input prices. But there may be cases in which firms prefer an input sector that is less competitive. This chapter illustrates such a case. It shows that firms that want to obtain financing from a bank may prefer to go to the same bank and, in that way, induce a banking monopoly. In chapter 2 we argued that a concentrated banking sector may be desirable from a social welfare point of view, since it may promote financial stability. However, we also illustrated that more competition in banking may have macroeconomic benefits, because of the lower cost of external fund (loans). Here, we argue that firms (banks' clients) do not always prefer the lower cost of external funds associated with a less concentrated banking sector.

In a nutshell, the argument runs as follows. When a firm's marginal return to investment is positive but decreasing in the other firm's investment, the firms' investments are *strategic substitutes* and investing is a prisoner's dilemma. For both firms, it is a dominant strategy to invest. Yet, since investment increases a firm's own profits but decreases that of the competitor, both firms would be better off if they could commit

[0]This chapter is a substantially revised version of Haan, Riyanto and Toolsema (2001).

to invest less. Choosing the same bank provides such a commitment device. When a bank decides on granting a loan to a firm, it also takes into account the effects on the profits of the other firms it has in its portfolio. A monopolist bank will take the external effects on the profits of other firms in the industry into account. It will therefore grant a loan that is lower than the one granted by a bank that serves only one firm. Firms benefit from this commitment effect of having a monopolist bank. Their profits decrease since the monopolist bank is able to capture more of them, but increase because of the commitment effect. In our model, the latter effect dominates.

If a firm's marginal return to investment is increasing in the other firm's investment, so the firms' investments are *strategic complements*, we find exactly the same result: firms prefer to go to the same bank. Now, by going to the same bank firms commit to invest more, and thereby earn higher profits. In the basic model we assume that there are only two firms, and that the bank has all the bargaining power with respect to the determination of repayment conditions. These assumptions are relaxed in extensions considering bargaining over repayment conditions and the case of more than two firms. We also consider in an extension multidimensional investment, where investment projects have several dimensions or each firm can invest in more than one project. We show that the result of firms choosing the same bank carries over to these cases.

In our model we assume that once a firm has chosen its bank, it is locked in. This is a common assumption based on the observation that banks obtain a lot of private information in their relationship with a firm. Only when possessing this private information, they are able to fully evaluate its prospects and credibility. Therefore, when needing a loan, a firm is not able to go to a different bank. Effectively, it is locked in, and the bank has all the bargaining power. Alternatively, the firm may be able to switch banks but choose not to do so because it will incur a cost when switching, for example because the costs of acquiring information are passed on to the client in the form of a fee. The evidence suggests that switching costs may be substantial in banking (see Kim et al. 1999). Essentially, we assume that a firm initially has to choose a bank to do all of its business with. Then, when it wants to obtain a loan, it is stuck with this bank.

We argue that debt has a strategic effect in the sense that firms that have to resort to debt in order to finance investment can be better off by borrowing from the same bank. Firms that finance investment with internal funds evidently do not have this possibility. In general, the literature on strategic effects of debt considers an entirely different context, focusing on uncertainty and limited liability. For example, based on a model with uncertainty Brander and Lewis (1986) suggest that 'central control of financing arrangements might be an attractive collusive practice' (p. 968) - which is confirmed by our results. They show that taking on debt effectively shifts some of the risk to the lender, which makes the firms more aggressive competitors. With quantity competition, this means that each firm sets a higher quantity in equilibrium, and profits are lower. Thus, firms overinvest. Another difference between their model and ours is that in Brander and Lewis (1986) the financial market acts passively. Banks do not take into account the product market behavior of firms in the determination of the loan size and the required repayment. In our model, it is exactly the bank that decides on these issues, which in turn allows firms to use their bank relationship as a strategic device.

Spagnolo (2000) also analyzes the role of debt as a strategic device in the context of uncertainty. With limited liability of firm owners, more debt makes it more difficult to sustain tacit collusion in product markets. Above some level of debt, owners will prefer to defect on the collusive agreement, cash the short-run gains from deviating, and let the firm go bankrupt. Owners can commit against such strategic default by hiring prudent managers, who fear a loss of reputation in case of bankruptcy. This reduces conflicts with debtholders and facilitates tacit collusion in the output market. Spagnolo (2000) argues that concentrated or collusive credit markets make such commitments renegotiation proof. In this way, collusion is exported from the banking sector to product markets. Although it is based on a different model, this is in line with our result that a more concentrated banking sector implies higher profits for the client firms in general, and less aggressive competition (less investment) in the strategic-substitute case in particular.

Our model is related to that in Poitevin (1989). There, firms seek to finance a project of fixed size. When they go to the same bank, this bank takes into account that higher debt will make firms more aggressive, as argued above. Since the size of the loan is fixed here, higher debt refers to higher interest payments only. The bank will internalize the effect and offer both firms a slightly lower interest rate, in order to induce less intense competition. The mechanism in our model is much more general. Here, the bank also decides on the size of the loan, and hence on the size of the project the firms will undertake. When investing makes firms more aggressive, banks will give firms a loan that is lower than what each wants. However, this lower investment yields less aggressive competition, increasing total profits. When investing makes firms less aggressive, banks will give firms a loan that is higher than what each wants. However, this higher investment leads to less aggressive competition, again increasing total profits.

We show that in our framework firms are better off borrowing from the same bank, that is, firms prefer to have a common lender rather than different lenders. Bhattacharya and Chiesa (1995) analyze the effects of having a common lender on firms' strategic behavior in the context of R&D investment and technological knowledge disclosure. They present a model in which a common lender allows for efficient information disclosure, and in that way internalizes externalities with respect to information sharing. In our model, the monopolist bank (who is the common lender of the firms) also provides a way to internalize external effects, increasing profits. However, in our model there is no asymmetric information and the externalities refer to the effects of investment by a firm on the return to investment of its competitors.

In a sense, the equilibrium of our model for the case where investments are strategic substitutes with a monopolist bank exhibits credit rationing. When borrowing from the same bank each firm unilaterally wants to obtain a larger loan than the one offered by the bank. Doing so enables it to invest more, raising its profits, to the detriment of its competitor. Yet, the bank is not willing to give a higher loan since it also takes the effects on the competitor's profits into account. Firms are thus credit rationed, albeit in a different sense than they are in the traditional asymmetric information models of credit markets (see e.g. Stiglitz and Weiss, 1981). Credit rationing in our model more closely resembles that in Clemenz (1991), who also notes that lenders have an incentive to take the externalities of loans into account. Paradoxically, in our model firms *choose* to be credit rationed. By choosing the same bank from the outset, firms commit not to invest too much. Hence, they rationally choose to be credit rationed. With investments as strategic complements, however, we find the opposite result. There, the monopolist lets the firms invest more than they would (unilaterally) choose.

The remainder of this chapter is structured as follows. Section 9.2 introduces the setup of the model. Section 9.3 analyzes the case where investments are strategic substitutes, that is, where the return to investment is decreasing in the other firm's investment. Section 9.4 presents an example of Cournot duopoly with cost-reducing R&D investment. Section 9.5 turns to strategic complements, and is accompanied by an example in section 9.6. Section 9.7 discusses extensions of the benchmark model as presented in sections 9.3 and 9.5. The extensions include bargaining between bank and firm, multiple firms, and multidimensional investment. Section 9.8 concludes.

9.2 Setup of the model

The basic setup of our model is the following. There are two identical firms, 1 and 2. Each firm wants to invest, but has no wealth, and we assume that in order to obtain funds they have to apply for a loan at a bank (so there is no issuing of equity). We have three stages in the model. In the first stage, firms can choose which bank to do business with. In the second stage, each firm borrows from the bank it has chosen and invests the loan it gets. In the third stage, the firms compete on the output market. After this, the firms repay their loans according to the repayment conditions set in the second stage. Since there is no uncertainty in our model, non-repayment is not an issue. In the basic model, the bank has all the bargaining power with respect to the repayment conditions of the loan. As we will show below, this implies that the repayment is set such that the payoff to the firm is equal to that of its outside option, i.e. when it rejects the loan. This assumption will be relaxed in the extension in section 9.7.1.

In the first stage, the firms can choose to go to the same bank (which becomes a monopolist then), or they can choose different banks (which we also refer to as duopolist banks). There are several ways to implement this stage. We may assume that firms choose their bank sequentially, and that the second firm can observe the choice of the first firm. Alternatively, we may simply assume that the firms cooperate in their choice of a bank. In the end, this does not matter, since there is no first mover advantage or disadvantage in choosing a bank.

Let third-stage operating profits (before subtracting the cost of investment) of firm i, $i = 1, 2$, be given by π_i. By operating profits, we refer to the *equilibrium* profits of the third stage. We use backward induction to solve the three-stage model, but do not specify the third stage explicitly in the theoretical discussion. That is, π_i is based on the outcome of some kind of output market competition. It is a function of the second and first stage strategic variables, i.e. investment sizes and bank choices of the firms. The size of the investment of firm i is denoted by $z_i \geq 0$. Let $\pi_i = \pi_i(z_i, z_j) > 0$ for $i = 1, 2$, $j = 1, 2$, $i \neq j$. The investment should not be interpreted as acquiring an indispensable input for production, since in that case we would have $\pi_i(0, z_j) = 0$. Instead, the firm may choose to invest since this will increase operating profits, but it could be in business without investing as well. Operating profits π_i are assumed to be continuously differentiable, increasing and concave in own investment z_i. We assume symmetry among firms in the sense that $\pi_i(\cdot) = \pi(\cdot)$ for $i = 1, 2$. Below, we omit the subscript i of π, and the first argument of π should be interpreted as the concerned firm's own investment, whereas the second argument represents the other firm's investment.

In the second stage, the banks (or bank) chosen in the first stage offer loans to the firms. The costs to the bank of a loan of an amount z of funds is given by $C(z)$, a linear function with $C'(z) > 0$. For example, when the bank pays an interest rate r to depositors and there are no other costs, an amount $C(z) = (1 + r)z$ is required in order for the bank to lend z. Of course, since the banks have all the bargaining power with respect to repayment conditions, they will require the largest possible repayment such that the firms will accept the loan. If the firms reject the offers, the banks get a payoff of zero. The payoffs to the firms are given in table 9.1. R_i denotes the repayment required from firm i, $i = 1, 2$. For accepting to be a (weakly) dominant strategy for firm i, we need

$$R_i \leq \pi(z_i, z_j) - \pi(0, z_j), \tag{9.1}$$

and

$$R_i \leq \pi(z_i, 0) - \pi(0, 0). \tag{9.2}$$

For (Accept, Accept) to be a Nash equilibrium in the second stage subgame, we only require condition (9.1) to hold for $i = 1, 2$, $j = 1, 2$, $i \neq j$.

In discussing the solutions to the second and the first stage of the model, we distinguish between two cases. First, we consider the situation of strategic substitutes, in which one firm's investment decreases the other firm's marginal return to investment. This is described in section

		Firm 2: Accept	Firm 2: Reject
Firm 1	Accept	$\pi_1(z_1, z_2) - R_1$ $\pi_2(z_2, z_1) - R_2$	$\pi_1(z_1, 0) - R_1$ $\pi_2(0, z_1)$
	Reject	$\pi_1(0, z_2)$ $\pi_2(z_2, 0) - R_2$	$\pi_1(0, 0)$ $\pi_2(0, 0)$

Table 9.1: Payoffs to the firms in the loan acceptance subgame (stage 2 of the model). In each case, the upper expression refers to the payoff of firm 1; the lower expression gives the payoff of firm 2.

9.3, followed by an example in section 9.4. Second, we consider strategic complements in section 9.5. Here, marginal return to investment is increasing in the other firm's investment. An example with strategic complements is presented in section 9.6. See also Bulow et al. (1985) on strategic substitutes and complements.

9.3 Strategic substitutes

First, we consider the situation in which investments by the firms are strategic substitutes and one firm's investment decreases the other firm's marginal return to investment. This is described by the following assumption.

Assumption 9.1 *The firms' investments are strategic substitutes, that is,*

$$\frac{\partial^2 \pi (z_i, z_j)}{\partial z_i \partial z_j} < 0, \tag{9.3}$$

for $z_i \geq 0$*,* $z_j \geq 0$*,* $i = 1, 2$*,* $j = 1, 2$*,* $i \neq j$*. Additionally, let*

$$\left. \frac{\partial \pi (z_i, z_j)}{\partial z_j} \right|_{z_i = 0} < 0.$$

Condition (9.3) states that the cross-derivative of the operating profit function π is negative, i.e. the investments z_i and z_j are strategic substitutes. That is, investment by a firm decreases the competing firm's marginal return to investment. This holds for example in a Cournot duopoly with investment in cost-reducing R&D. In that case, when a firm invests more it will increase its output in the competition stage. This makes investment less attractive for the other firm (see section 9.4). Under this condition, even if firm i invests only an infinitesimal amount $\varepsilon > 0$, its return to investment is lower if the other firm invests more. Therefore, it is obvious that we must have $\left.\frac{\partial \pi(z_i,z_j)}{\partial z_j}\right|_{z_i=0} \leq 0$. We assume that the inequality is strict. This condition states that if a firm does not invest at all, the other firm's investment decreases the first firm's profits.

In the second stage, with strategic substitutes, (9.1) is sufficient for (9.2). Thus, under assumption 9.1, (Accept, Accept) is the unique Nash equilibrium of the game whenever (9.1) is satisfied. Consider firm i, $i = 1, 2$, and the bank that lends to it (this may either be the same bank which lends to firm $j \neq i$, or a different bank). Since the bank is assumed to have all the bargaining power, it will set

$$R_i = \pi\left(z_i, z_j\right) - \pi\left(0, z_j\right) \tag{9.4}$$

and the firm will accept its offer. This implies that the firm will end up with

$$\pi\left(z_i, z_j\right) - R_i = \pi\left(0, z_j\right), \tag{9.5}$$

which is its outside option given z_j. Note that when firm j gets no offer or, equivalently, a zero contract ($z_j = 0$), firm i's outside option is $\pi(0,0)$. Under assumption 9.1, this may occur when a single bank lends to both firms. The monopolist bank may prefer to offer a loan to a single firm over lending to both firms, as we will discuss below. We focus on the symmetric case in which both firms get a loan. At the end of this section, after presenting the main results, we discuss when a monopolist bank prefers to give a loan to a single firm only.

Consider firm i, $i = 1, 2$, and the bank lending to it. The repayment is set according to (9.4). In the second stage of the model, the bank thus maximizes

$$\pi\left(z_i, z_j\right) - \pi\left(0, z_j\right) - C\left(z_i\right).$$

Of course, the monopolist bank determines both z_i and z_j. Imposing symmetry, the monopolist thus maximizes

$$\pi\left(z, z\right) - \pi\left(0, z\right) - C\left(z\right).$$

We assume this expression for the bank's profits to be concave. Denoting the equilibrium investment choice by the monopolist bank by $x > 0$, the first-order conditions (FOCs) are

$$\pi^1(x,x) + \pi^2(x,x) - \pi^2(0,x) - C'(x) = 0, \tag{9.6}$$

where the superscripts 1 and 2 of π refer to the partial derivatives with respect to the first and second argument of π, respectively, and C' denotes the first derivative of C. For duopolist banks, however, the FOCs are given by

$$\pi^1(z_i, z_j) - C'(z_i) = 0.$$

Note that this is exactly the same FOC as we would obtain if firm i had internal funds available and it were to choose the level of investment z_i itself, facing the same (opportunity) cost function $C(z)$. Imposing symmetry and denoting the duopolist banks' equilibrium investment choice by y, this can be rewritten as

$$\pi^1(y,y) - C'(y) = 0. \tag{9.7}$$

Proposition 9.1 *Under assumption 9.1, a monopolist bank rations credit. That is, the loans offered by a monopolist bank are smaller than the loans offered by different banks, which equal the optimal investment size from the point of view of the firms.*

Proof In order to compare x and y, that is, to see that the monopolist firm lends a smaller amount, substitute y into the monopolist's FOC:

$$\pi^1(y,y) + \pi^2(y,y) - \pi^2(0,y) - C'(y) = \pi^2(y,y) - \pi^2(0,y).$$

This expression is negative because of assumption 9.1, thus $x < y$. ■

Now consider the first stage of the model. According to (9.5), by going to the same bank the firms earn $\pi(0,x)$, whereas by going to different banks they get $\pi(0,y)$.

Proposition 9.2 *Under assumption 9.1, firms prefer to borrow from the same bank.*

Proof Since $\left.\frac{\partial \pi(z_i,z_j)}{\partial z_j}\right|_{z_i=0} < 0$, $x < y$ implies $\pi(0,x) > \pi(0,y)$. ■

Intuitively, this proposition states that if investment by one firm hurts the other firm, the firms prefer to go to the same bank. Summarizing, under assumption 9.1, the increment in operating profits from investing (more) is smaller if the other firm invests more. This negative external effect implies overinvestment if the level of investment is determined either by each firm itself, or by two different banks that lend to the two firms. A monopolist bank lending to both firms internalizes the effect and 'rations' credit. This increases total operating profits. Note that if the condition $\left.\frac{\partial \pi(z_i,z_j)}{\partial z_j}\right|_{z_i=0} \leq 0$ holds with equality in equilibrium, the firms weakly prefer to borrow from the same bank. Further, note that there is again a kind of prisoner's dilemma in this setup. Both firms would be better off when not borrowing at all than when borrowing from the same bank.

The monopolist bank may find it optimal to lend to a single firm only. Suppose the monopolist offers $z_2 = 0$ to firm 2 (or, alternatively, sets repayment conditions R_2 such that firm 2 will reject the offer). Then we must have $R_1 = \pi(z_1, 0) - \pi(0, 0)$. The bank now maximizes

$$\pi(z_1, 0) - \pi(0, 0) - C(z_1),$$

so the FOC is

$$\pi^1(z_1, 0) - C'(z_1) = 0. \tag{9.8}$$

Under assumption 9.1, a monopolist bank may prefer to offer a single contract of size $z_1 = w$ that satisfies this condition. In the Cournot example in the next section, this happens for specific parameter values. In special cases, this may even result in a drastic innovation, i.e. the firm that gets the (single) contract may become a monopolist in the output market. In the equilibrium of the Cournot example, this is not the case.

For simplicity, we assume here that product market duopoly prevails. Then the bank will offer a single contract whenever

$$\pi(w, 0) - \pi(0, 0) - C(w) > 2(\pi(x, x) - \pi(0, x) - C(x)).$$

It can be shown that $w > y > x$. In this case, firm 1 ends up with $\pi(0, 0)$ and firm 2 gets $\pi(0, w)$. Comparing to the situation with two banks, it is clear that $\pi(0, w) < \pi(0, y) < \pi(0, 0)$. If we assume that a firm has probability $\frac{1}{2}$ of being offered the single contract, the expected payoff is $\mathrm{E}(\pi(w)) = \frac{1}{2}\pi(0, 0) + \frac{1}{2}\pi(0, w)$. In general, this can be either larger or smaller than $\pi(0, y)$. In our Cournot example below, this expression turns out to be strictly larger than $\pi(0, y)$. So, based on expected payoffs, proposition 9.2 carries over and the Cournot firms will choose the same bank in the first stage of the model, even if the monopolist bank would offer a single contract. There may however be other examples in which the opposite is true and firms prefer to go to different banks when they know that a monopolist bank will offer a single contract.

More generally, firms evidently do not always prefer a more concentrated credit market. If the firms have access to a perfectly competitive credit market where they can obtain funds at a fixed interest rate, they may well prefer to go there. As in the case with different banks described above, they borrow an amount y but now they get all the profits. There is no bank that captures a part of the total profits.

An example in which firms' investments are strategic substitutes is that of Cournot competition with cost-reducing R&D investment as in d'Aspremont and Jacquemin (1988). This model will be discussed in the next section. Similar results can be obtained for Bertrand competition with heterogeneous products and the same kind of R&D investment.

9.4 Example: Cournot duopoly with R&D investment[1]

In this section we present an example to illustrate the above results in a setup based on d'Aspremont and Jacquemin (1988). In their model, spending on R&D implies that the marginal costs of a firm will be lowered with certainty. The higher the amount spent on R&D, the higher the decrease in cost. Yet, d'Aspremont and Jacquemin (1988) assume that firms can self-finance their R&D and focus on the possibility of R&D cooperation. They assume R&D spillovers, that is, a firm benefits from its competitor's R&D investments. D'Aspremont and Jacquemin argue that cooperating in R&D (and possibly in production as well) may imply R&D and output levels that are closer to the welfare-maximizing levels in the presence of (sufficiently large) spillovers. We turn to the issue of spillovers in the next section.

Here we assume instead that there are zero spillovers, and firms possess no wealth, so they have to take a loan to invest in R&D. In a Cournot duopoly with investment in cost-reducing R&D, when a firm

[1]For an extensive discussion of this example, see Haan et al. (2001).

invests more, it will set a higher equilibrium quantity in the competition stage. This makes investment for the other firm less attractive. That is, the cross-derivative of the operating profit function π is negative, the investments of the two firms are strategic substitutes and the arguments of the previous section apply. Thus, we will show below that in a Cournot duopoly where firms can invest in cost-reducing R&D, but have to resort to a bank to obtain funding, the firms prefer to borrow from the same bank. This common bank incorporates the negative effects of one firm's investment on the competing firm's profits, and avoids overinvestment in R&D.

Suppose the two firms $i = 1, 2$ compete in quantities à la Cournot and investment is in cost-reducing R&D. Marginal cost is originally at the level c. By spending $z_i = \frac{1}{2}\gamma\delta_i^2$ on R&D in the second stage of the model, firm i's marginal cost is reduced by an amount δ_i in the third stage (as in d'Aspremont and Jacquemin, 1988). A bank's cost function is given by $C(z) = (1 + r) z$, where r is the cost of funds to the bank (say, the deposit or money market rate). Let inverse demand in the output market be given by $p = a - Q$ where p denotes market price and $Q = q_1 + q_2$ refers to total quantity.

In the third stage, firm i's Cournot profits are $(p - c + \delta_i) q_i$. The optimal quantities are given by $q_i = (a - c + 2\delta_i - \delta_j)/3$, yielding equilibrium operating profits

$$\pi_i(\delta_i, \delta_j) = \frac{1}{9}(a - c + 2\delta_i - \delta_j)^2 .$$

Using $\delta(z) = \sqrt{2z/\gamma}$, π_i can be rewritten as a function of (z_i, z_j). This specification of $\pi(z_i, z_j)$ satisfies assumption 9.1 (strategic substitutes). We assume that $\gamma(1 + r) > 8/9$ since the second-order conditions (SOCs) require this condition (or a stronger condition in one case, see below).

For the second stage, it can be shown that

$$\delta(x) = \frac{4}{9}\frac{a - c}{\gamma(1 + r)} < \delta(y) = \frac{4(a - c)}{9\gamma(1 + r) - 4},$$

so $x < y$, where the SOCs require $\gamma(1 + r) > 16/9$ for x i.e. when the monopolist lends the same amount x to both firms. This result corresponds to that of d'Aspremont and Jacquemin (1988), who show that in their setup with small spillovers R&D cooperation (which corresponds to our monopolist bank) lowers R&D expenditures as compared to the noncoooperative case (in our setup: different banks).

The monopolist can also choose to offer a single contract, either inducing an output market duopoly or an output market monopoly (the latter is feasible only for $8/9 < \gamma(1+r) \leq 1$). However, the former turns out to be more profitable than the latter for the relevant parameter values. Therefore, in equilibrium there will always be a duopoly in the output market. For $\gamma(1+r) > 16/9$, the monopolist finds it optimal to offer a loan to both firms, whereas for $8/9 < \gamma(1+r) < 16/9$, this is not feasible and she will offer a single contract (to one of the firms) which satisfies

$$\delta(w) = \frac{4(a-c)}{9\gamma(1+r)-8},$$

so $w > y > x$.

The corresponding (expected) payoffs for the firms are given by

$$\begin{aligned}
\pi(x) &= \frac{1}{9}(a-c)^2 \left(\frac{9\gamma(1+r)-4}{9\gamma(1+r)}\right)^2 \\
\pi(y) &= \frac{1}{9}(a-c)^2 \left(\frac{9\gamma(1+r)-8}{9\gamma(1+r)-4}\right)^2 \\
\mathrm{E}(\pi(w)) &= \frac{1}{9}(a-c)^2 \frac{(9\gamma(1+r)-10)^2+4}{(9\gamma(1+r)-8)^2}.
\end{aligned}$$

It can be shown that $\mathrm{E}(\pi(w)) > \pi(x) > \pi(y)$. That is, in the first stage of the model the firms prefer to choose the same bank for any admissable parameter values ($\gamma(1+r) > 8/9$), as predicted by proposition 9.2.

In a noncooperative setup (that is, when borrowing from different banks) R&D expenditures generally are below the optimal levels from a social welfare point of view. We showed above that with strategic substitutes, borrowing from the same bank limits R&D expenditures even further. Thus, we find the standard result that having only one firm in the (banking) market is bad for social welfare. However, we will illustrate below that with strategic complements - for example when there are large R&D spillovers from one firm to another - having a monopolist bank might increase investment and thus may play a positive role (see also d'Aspremont and Jacquemin, 1988).

9.5 Strategic complements

Now we return to the theoretical framework and consider the case of strategic complements. Here, marginal return to investment is increasing in the other firm's investment.

Assumption 9.2 *The firms' investments are strategic complements, that is,*

$$\frac{\partial \pi^2 (z_i, z_j)}{\partial z_i \partial z_j} > 0, \tag{9.9}$$

for $z_i \geq 0,\ z_j \geq 0,\ i = 1, 2,\ j = 1, 2,\ i \neq j$. *Additionally, let*

$$\left. \frac{\partial \pi (z_i, z_j)}{\partial z_j} \right|_{z_i = 0} > 0.$$

Condition (9.9) states that the cross-derivative of the operating profit function π is positive, i.e. the investments z_i and z_j are strategic complements. That is, investment by a firm increases the competing firm's marginal return to investment. This may occur with competing firms who advertise their products (for certain parameter values), where advertising by one firm increases the other firm's demand; see section 9.6. Under this condition, even if firm i invests only an infinitesimal amount $\varepsilon > 0$, its return to investment is higher if the other firm invests more. Therefore, it is obvious that we must have $\left. \frac{\partial \pi (z_i, z_j)}{\partial z_j} \right|_{z_i = 0} \geq 0$. We assume that the inequality is strict. This condition states that if a firm does not invest at all, the other firm's investment increases the first firm's profits.

In the second stage, under assumption 9.2, condition (9.1) does *not* imply that (9.2) is satisfied. Again, since the bank has all the bargaining power, we require

$$R_i = \pi (z_i, z_j) - \pi (0, z_j).$$

Therefore, (9.2) is violated and (Reject, Reject) is a Nash equilibrium as well. We are interested in the equilibrium in which the firms do borrow from banks and invest in R&D, however. Note that although there is a coordination problem, the Nash equilibrium (Reject, Reject) is Pareto dominated by the other Nash equilibrium (Accept, Accept), since $\pi (0, z) > \pi (0, 0)$ for any $z > 0$. We focus on the latter case and assume below that both firms choose to accept the loan offered to them.

We require an additional assumption here to obtain results similar to those for strategic substitutes (section 9.3).

Assumption 9.3 *Utilization by the firm of the loan is verifiable by the bank.*

Under this assumption, the loan contract can be written conditional on utilization. This assumption is required for the firms to invest the *entire* loan given by the monopolist bank in R&D, although the firms themselves would unilaterally choose to invest a smaller amount. That is, we assume that firms cannot leave part of the loan unused. Without this assumption the firms would invest the (smaller) amount that is optimal from their point of view and end up in the prisoner's dilemma again. As we will argue below, this condition allows the monopolist bank to avoid underinvestment by the firms and to fully exploit the positive externalities of investment by one firm on its competitor. Using this assumption together with assumption 9.2, we arrive at the following proposition.

Proposition 9.3 *Under assumptions 9.2 and 9.3, firms invest more with a monopolist bank than with different banks (or with internal financing).*

PROOF The maximization problems and the corresponding FOCs (9.6) and (9.7) are the same as before. However, the expression obtained by substituting the duopolist bank's choice y into the monopolist bank's FOC, $\pi^2(y,y)-\pi^2(0,y)$, is now positive because of assumption 9.2. This indicates that $x > y$. ■

The monopolist bank now offers loans that are *larger* than the loans offered by different banks. In fact, since the firms would choose to invest an amount y if they had funds themselves, the firms get more from the monopolist than they would want to invest in the first place. Assumption 9.3 guarantees that the firms invest the entire loan obtained from the monopolist bank. This is required for them to reap the benefits of going to the same bank, which internalizes the positive externalities of investment. Now consider the first stage of the model.

Proposition 9.4 *Under assumptions 9.2 and 9.3, firms prefer to borrow from the same bank.*

PROOF Since $\left.\frac{\partial \pi(z_i,z_j)}{\partial z_j}\right|_{z_i=0} > 0$, $x > y$ implies $\pi(0,x) > \pi(0,y)$. ■

Comparing this proposition to proposition 9.2, we now have the case where a firm's investment is good for the other firm, and we see that firms also prefer to choose the same bank in this case. The monopolist bank now internalizes the positive external effects, which imply under-investment with two different banks as well as with internal finance. By doing so, the monopolist bank increases total operating profits. Note that if the condition $\left.\frac{\partial \pi(z_i,z_j)}{\partial z_j}\right|_{z_i=0} \geq 0$ may hold with equality in equilibrium, the firms weakly prefer to borrow from the same bank.

With strategic complements, a monopolist bank will never want to offer a single contract in the second stage of the model. This can be seen as follows. When offering a single contract, say to firm 1, the monopolist solves

$$\max_z \pi(z,0) - \pi(0,0) - C(z).$$

Let the solution to this maximization problem be given by $z = w$. Then we have

$$\begin{aligned} & \pi(w,0) - \pi(0,0) - C(w) < \pi(w,w) - \pi(0,w) - C(w) \\ \leq \; & \max_z \; \pi(z,z) - \pi(0,z) - C(z) < \max_z \; 2\left(\pi(z,z) - \pi(0,z) - C(z)\right) \end{aligned}$$

where the first inequality comes from assumption 9.2, and the final expression is the amount that can be earned by the monopolist bank by offering a contract to both firms. Intuitively, because of positive external effects, it is always beneficial to lend to both firms.

Marginal return to investment may be increasing in the other firm's investment if there are (large) spillovers of R&D investment from one firm to another in the example of section 9.4. Another example is advertising, where a firm's advertising expenses increase this firm's demand, but also the demand of the other firm. This example is discussed in more detail in the next section. We show in a simple setup that this type of advertising may result in equilibrium profit functions in which investments are strategic complements.

9.6 Example: Advertising

This section illustrates a situation in which firms' investments are strategic complements and the results of the previous section apply. Suppose we have a differentiated product duopoly in which the firms can advertise for their products. Demand for the products of both firms, $i = 1, 2$, is given by

$$\begin{aligned} q_1 &= \gamma_1 - p_1 + p_2 \\ q_2 &= \gamma_2 + p_1 - p_2, \end{aligned}$$

where q_i refers to firm i's quantity and p_i to its price. The parameters γ_1 and γ_2 are determined by

$$\begin{aligned} \gamma_1 &= 1 + \sqrt{z_1} + \alpha\sqrt{z_2} \\ \gamma_2 &= 1 + \alpha\sqrt{z_1} + \sqrt{z_2}. \end{aligned}$$

Now, z_1 and z_2 can be interpreted as advertising expenses. When z_1 increases, γ_1 increases, so the demand curve shifts outwards. The parameter α measures the effect of a firm's advertising expenses on the competitor's demand. In general, advertising can have two opposite effects on the demand for the competitor's product. On the one hand, advertising increases the size of the market, which benefits both firms. This is a positive effect. On the other hand, advertising of firm 1 will increase firm 1's share of the market, which hurts firm 2. This is a negative effect. With $\alpha > 0$, we have that advertising of firm 1 increases demand for firm 2's product, and vice versa. In that case, the positive effect dominates. With $\alpha < 0$, the negative effect dominates.

This advertising game has two stages. First, the advertising expenses are determined. Then, firms compete in prices. In our general framework, the advertising expenses would be determined by the loans offered by the banks, in the second stage. Applying backward induction, we first solve the final stage, which corresponds to stage 3 in our setup (see section 9.2). Operating profits of firm 1 are given by

$$\pi_1 = p_1 \left(\gamma_1 - p_1 + p_2\right).$$

Maximizing with respect to p_1 yields the reaction curve

$$p_1 = \frac{\gamma_1 + p_2}{2}.$$

The reaction curve for firm 2 is similar. In equilibrium, we have

$$\begin{aligned} p_1 &= \frac{2\gamma_1 + \gamma_2}{3} \\ p_2 &= \frac{2\gamma_2 + \gamma_1}{3}. \end{aligned}$$

Focusing on firm 1, equilibrium profits are

$$\pi_1 = \left(\frac{2\gamma_1 + \gamma_2}{3}\right)^2.$$

Moving back to the advertising stage and plugging in the definitions of γ_1 and γ_2, we have

$$\pi_1 = \left(\frac{3 + (2+\alpha)\sqrt{z_1} + (1+2\alpha)\sqrt{z_2}}{3}\right)^2.$$

So applying our model of sections 9.2 and 9.5 to advertising, this expression describes the third-stage equilibrium operating profits for firm 1. We have

$$\frac{\partial \pi_1}{\partial z_2} = \frac{1}{9}\left(3 + (2+\alpha)\sqrt{z_1} + (1+2\alpha)\sqrt{z_2}\right)\frac{1+2\alpha}{\sqrt{z_2}}$$

and

$$\frac{\partial^2 \pi_1}{\partial z_2 \partial z_1} = \frac{1}{18}(2+\alpha)\frac{1+2\alpha}{\sqrt{z_1}\sqrt{z_2}}.$$

This suggests that we have strategic complements ($\frac{\partial^2 \pi_1}{\partial z_2 \partial z_1} > 0$) whenever $\alpha > -1/2$ or $\alpha < -2$, and strategic substitutes for $-2 < \alpha < -1/2$. We will show below that for the case of internal financing, and thus for the case in which the firms borrow from different banks, the SOC requires $\alpha > -\frac{4}{5}$. Thus, the case $\alpha < -2$ is not relevant. We have strategic substitutes for $-\frac{4}{5} \leq \alpha \leq -\frac{1}{2}$ and strategic complements for any $\alpha > -\frac{1}{2}$.

The intuition is as follows. For $\alpha > 0$, advertising increases your competitor's demand. This makes advertising more attractive for him. For mildly negative α, your competitor faces lower demand if you advertize, but since you increase your price, advertising is still made more attractive for him. For lower α, the demand effect dominates, and advertising is made less attractive to him.

The above shows that for certain parameters ($\alpha > -1/2$), the advertising model results in investments as strategic complements, and the results from the previous section apply. The firms will choose to obtain funding for advertising from the same bank if assumption 9.3 is satisfied. We will not analyze the determination of advertising expenses in detail, but as an illustration we consider the case of self-financing. For expositional convenience we set the marginal opportunity cost equal to zero. The FOC for firm 1 is

$$\frac{\partial \pi_1}{\partial z_1} = \frac{1}{9}\left(3 + \sqrt{z_1}\,(2+\alpha) + \sqrt{z_2}\,(1+2\alpha)\right)\frac{2+\alpha}{\sqrt{z_1}} = 0.$$

Firm 2's FOC is similar. Imposing symmetry we find

$$z = \frac{1}{(\alpha+1)^2},$$

which is always feasible as long as $\alpha \neq -1$. However, the SOC requires

$$-\frac{1}{18}\frac{2+\alpha}{\left(\sqrt{z_1}\right)^3}\left(3 + \sqrt{z_2} + 2\alpha\sqrt{z_2}\right) < 0.$$

Evaluating this in the equilibrium, the SOC is satisfied whenever

$$-(2+\alpha)\left(3\left|\alpha+1\right| + 1 + 2\alpha\right) < 0$$

which is the case for $\alpha > -\frac{4}{5}$. This illustrates that although we can have strategic substitutes in our simple advertising model, this only occurs for a limited parameter range ($-\frac{4}{5} \leq \alpha \leq -\frac{1}{2}$ in this simple example).

Summarizing, we considered the case where firms invest in advertizing, which increases not only their own demand but also the demand faced by the rival firm. We have shown that at least in some cases (i.e. for some parameter values in the simple model above), marginal return to advertizing is increasing in the other firm's advertizing effort. That is, advertizing investments can be strategic complements. In that case, the results of the previous section apply. If firms have to resort to a bank to obtain funding, the firms prefer to borrow from the same bank, which avoids underinvestment in advertizing.

9.7 Extensions

In this section we discuss some extensions to the basic model described in sections 9.2, 9.3, and 9.5.

9.7.1 Bargaining over repayment conditions

In the previous sections, we have assumed that the banks have all the bargaining power with respect to the repayment conditions. Now suppose that the firms have some bargaining power as well. In this section, we reformulate the benchmark model using the *generalized Nash-bargaining* framework.[2] The bargaining problem can be expressed formally as a pair of convex sets of feasible gains (losses) from the lending relationship for the bank and the firm, and their disagreement payoffs (payoffs in the case of no lending relationship). The solution to this generalized Nash-bargaining problem is a unique pair of gains for both parties that solves the maximization of $(U_1 - d_1)^{\beta_1}(U_2 - d_2)^{\beta_2}$, where U_i denotes the payoff to player i, d_i denotes the disagreement payoff to player i, and β_i denotes player i's bargaining power, $i = 1, 2$, $\sum_{i=1}^{2} \beta_i = 1$.

Following Muthoo (1999), we can express the resulting division of the surplus (s) between the bank and the firm (U_b and U_f) as

$$\begin{aligned} U_b &= d_b + \beta (s - d_b - d_f), \\ U_f &= d_f + (1 - \beta)(s - d_b - d_f). \end{aligned}$$

Thus, the bank and the firm are bargaining over the partition of surplus s, and they agree first of all to give each other their disagreement payoffs (d_b and d_f), and then they respectively obtain a fraction β and $(1 - \beta)$ of the remaining surplus $(s - d_b - d_f)$. Note that β and $(1 - \beta)$ can be interpreted as their respective bargaining power. We obtain the Nash-bargaining solution when $\beta = \frac{1}{2}$.

Applying this surplus division rule in our model yields

$$\begin{aligned} U_b &= \beta (\pi(z, z) - C(z) - \pi(0, z)), \\ U_f &= \pi(0, z) + (1 - \beta)(\pi(z, z) - C(z) - \pi(0, z)). \end{aligned}$$

The bank earns nothing ($d_b = 0$) in case of a bargaining breakdown, while the firm earns $d_f = \pi(0, z)$. The surplus (s) to be divided is $\pi(z, z) - C(z)$.

Under assumption 9.1 as well as under assumptions 9.2 and 9.3, the last term in the expression for U_f is larger for $z = x$ than for $z = y$ in our model. Similarly, $\pi(0, z)$ is larger for $z = x$ than for $z = y$. Summarizing, even with bargaining over the repayment conditions, our results continue to hold and firms prefer to choose the same bank in our setup.

[2] For a more extensive discussion on bargaining theory, see Muthoo (1999).

9.7.2 Multiple firms

Suppose there are $n \geq 2$ firms and two or more banks. In this case, do the firms also choose to all go to the same bank? We show below that indeed it is an equilibrium of this extended model for all firms to borrow from the same bank. We do so by translating our arguments to the more general case with $n \geq 2$ and showing that if all firms go to the same bank, none of them has an incentive to deviate, i.e. to borrow from a different bank. Therefore, choosing the same bank is a Nash equilibrium for any $n \geq 2$.

Operating profits π are now a function of $z_1, ..., z_n$. Let $Z_{-i} = \{z_1, ..., z_n\} \backslash \{z_i\}$. Again, we let the first element of π refer to the firm's own investment, so $\pi(z_i, Z_{-i})$ refers to the operating profits of firm i. Consider the case of strategic substitutes. Assumption 9.1 should now be replaced by:

Assumption 9.4 *The firms' investments are strategic substitutes, that is*

$$\frac{\partial \pi(z_i, Z_{-i})}{\partial z_i \partial z_j} < 0, \tag{9.10}$$

for $z_i \geq 0$, $i = 1, ..., n$, $j = 1, ..., n$, $j \neq i$. *Additionally, let*

$$\left. \frac{\partial \pi(z_i, Z_{-i})}{\partial z_j} \right|_{z_i = 0} < 0.$$

In the second stage, under assumption 9.4, the condition

$$R_i \leq \pi(z_i, Z_{-i}) - \pi(0, Z_{-i}) \tag{9.11}$$

is sufficient for any condition of the same form but with one or more elements of Z_{-i} replaced by zeros. Thus, under assumption 9.4, for all firms to accept is the unique Nash equilibrium of the game whenever (9.11) is satisfied. The bank lending to firm i will set $R_i = \pi(z_i, Z_{-i}) - \pi(0, Z_{-i})$ and each firm i will accept its offer. This implies that the firm ends up with $\pi(z_i, Z_{-i}) - R_i = \pi(0, Z_{-i})$, which is its outside option given Z_{-i}. We focus here on the symmetric case in which all firms do obtain a loan.

We want to show that choosing the same bank is an equilibrium of this extended model. Suppose that all firms except for firm k go to the same bank. We will show that firm k prefers to go to this bank as well, rather than choosing a different bank. This means that if all firms borrow from the same bank, no firm has an incentive to move away and go to a different bank. In the second stage of the model, the bank lending to firm i maximizes

$$\pi\left(z_i, Z_{-i}\right) - \pi\left(0, Z_{-i}\right) - C\left(z_i\right)$$

for any $i = 1, ..., n$. If firm k chooses to go to the same bank as the other $n - 1$ firms, this bank becomes a monopolist. Imposing symmetry this bank maximizes

$$\pi\left(z, z, ..., z\right) - \pi\left(0, z, ..., z\right) - C\left(z\right).$$

Denoting the equilibrium investment choice by the monopolist bank by $x > 0$, for each $i = 1, ..., n$ the FOC becomes

$$\begin{aligned} \pi^1(x, x, ..., x) + ... + \pi^n(x, x, ..., x) - \pi^2(0, x, ..., x) & \\ - ... - \pi^n(0, x, ..., x) - C'\left(x\right) &= 0, \quad (9.12) \end{aligned}$$

where the superscript m in π^m refers to the partial derivative of π with respect to its mth argument, and C' denotes the first derivative of C.

If firm k chooses to go to a different bank, however, the FOCs are given by

$$\pi^1(z_k, v, ..., v) - C'\left(z_k\right) = 0 \quad (9.13)$$

for the bank lending to firm k itself and

$$\begin{aligned} \pi^1(v, v, ..., v, z_k) + ... + \pi^{n-1}(v, v, ..., v, z_k) & \\ -\pi^2(0, v, ..., v, z_k) - ... - \pi^{n-1}(0, v, ..., v, z_k) & \\ -C'\left(v\right) &= 0, \quad (9.14) \end{aligned}$$

for the bank lending to firm i, $i - 1, ..., n$, $i \neq k$. Note that we have imposed symmetry here for all firms who borrow from the same bank, and v denotes this bank's equilibrium investment choice. For notational convenience we let z_k be the last element in $\pi\left(\cdot\right)$ here.

Proposition 9.5 *Under assumption 9.4, with $n \geq 2$ firms, a monopolist bank rations credit. That is, the loans offered by a monopolist bank are smaller than the loans offered by different banks.*

Proof In order to compare x to z_k and v, that is, to see that the monopolist bank lends a smaller amount, substitute z_k and v into the monopolist's FOC (9.12). Using (9.13), for firm k we obtain

$$\begin{aligned} & \pi^1(z_k, v, ..., v) + ... + \pi^n(z_k, v, ..., v) - \pi^2(0, v, ..., v) \\ & -... - \pi^n(0, v, ..., v) - C'(z_k) \\ = \ & \pi^2(z_k, v, ..., v) - \pi^2(0, v, ..., v) + ... + \pi^n(z_k, v, ..., v) - \pi^n(0, v, ..., v) \end{aligned}$$

which is negative by assumption 9.4. Similarly, for the other firms, using (9.14) we get

$$\begin{aligned} & \pi^1(v, v, ..., v, z_k) + ... + \pi^n(v, v, ..., v, z_k) - \pi^2(0, v, ..., v, z_k) \\ & -... - \pi^n(0, v, ..., v, z_k) - C'(v) \\ = \ & \pi^n(v, v, ..., v, z_k) - \pi^n(0, v, ..., v, z_k). \end{aligned}$$

This expression is also negative because of assumption 9.4, thus we must have $x < z_k$ and $x < v$. That is, loans are smaller when firm k chooses the bank that serves all other firms than when firm k chooses a different bank. Also, with a monopolist bank, loans are smaller than when all firms go to different banks. In the latter case we have the FOCs $\pi^1(y, ..., y) - C'(y) = 0$ and by substituting y in the monopolist's FOC we obtain

$$\pi^2(y, y, ..., y) - \pi^2(0, y, ..., y) + ... + \pi^n(y, y, ..., y) - \pi^n(0, y, ..., y),$$

which is negative by assumption 9.4. This implies $x < y$. ■

Now consider the first stage of the model. If firm k chooses to go to the same bank as the other firms, all firms earn $\pi(0, x, ..., x)$. If firm k chooses a different bank, it earns $\pi(0, v, ..., v)$ and the others get $\pi(0, v, ..., v, z_k)$.

Proposition 9.6 *Under assumption 9.4, with $n \geq 2$ firms, there exists an equilibrium in which all firms choose the same bank.*

Proof In the above, if $\left.\frac{\partial \pi(z_i, Z_{-i})}{\partial z_j}\right|_{z_i=0} < 0$, $x < z_k$ and $x < v$ imply $\pi(0, x, ..., x) > \pi(0, v, ..., v)$ and $\pi(0, x, ..., x) > \pi(0, v, ..., v, z_k)$. Firm k prefers to borrow from the bank that serves all other firms, and the other firms prefer firm k to do so as well. So assuming that all firms except firm k go to the same bank, this shows that firm k will choose that same bank as well. Note that if the condition $\left.\frac{\partial\pi(z_i,Z_{-i})}{\partial z_j}\right|_{z_i=0} \leq 0$ may hold with equality in equilibrium, firm k weakly prefers to go to the same bank as the other firms. This proves that it is an equilibrium of the model for all firms to choose the same bank. ■

From this proposition, it is clear that our main result holds true for $n > 2$ firms with strategic substitutes: firms may prefer to all go to the same bank, inducing a monopoly in the banking sector. For strategic complements, the analysis is similar (not presented here).

9.7.3 Multiple dimensions of investment

What if investment projects have multiple dimensions, or alternatively firms can invest in several, say P, projects? That is, suppose a firm can invest in different aspects that improve the production process, or more generally, that increase profits. For example, focusing on the strategic-complements case, a firm may invest in cost-reducing R&D with spillovers as well as in advertizing. Generalizing our assumptions we show below that the main results carry over to this case of multiple dimensions as well, and the firms prefer to borrow from the same bank. We focus again on the case of two firms and suppose that each firm obtains financing from one bank only. The bank lending to firm i sets the loan size z_i, $i = 1, 2$. Firm i can divide the funds z_i over P projects, investing z_{pi} in project p, $p = 1, ..., P$, $z_{1i} + ... + z_{Pi} = z_i$. Define $Z_{-pi} = \{z_{1i}, ..., z_{Pi}, z_{1j}, ..., z_{Pj}\}\backslash\{z_{pi}\}$. To extend the analysis with strategic substitutes (section 9.3) to this case, we require the following assumption.

Assumption 9.5 *The firms' investments z_{pi} and z_{kj} are strategic substitutes, that is,*

$$\frac{\partial\pi\left(z_{pi}, Z_{-pi}\right)}{\partial z_{pi}\partial z_{kj}} < 0, \tag{9.15}$$

for $z_{pi} \geq 0$, $z_{kj} \geq 0$, $i = 1, 2$, $j = 1, 2$, $i \neq j$, $p = 1, ..., P$, $k = 1, ..., P$. Additionally, let

$$\left.\frac{\partial\pi\left(z_{pi}, Z_{-pi}\right)}{\partial z_{kj}}\right|_{z_{pi}=0} < 0.$$

Intuitively, each project investment z_{kj} of firm j has a negative effect on the return to investment of each project p of firm i. It is important to note that basically, this assumption is too strong and we only require that some combinations of investments $(z_{pi}; z_{kj})$ are strategic substitutes for the firms to choose the same bank in the first stage of the model. This illustrates the difference between this case and the one discussed in the previous subsection, where we required any combination of two 'projects' to be strategic substitutes. Note also that this assumption does not refer to the effects of a firm's own investment projects on each other. More precisely, z_{pi} and z_{ki} may well be strategic complements for $i = 1, 2$, $p = 1, ..., P$, $k = 1, ..., P$, $p \neq k$.

We assume that the bank lending to firm i only decides on the size of the loan z_i, and the firm itself determines how to spend the loan on the P projects. However, because of backward induction, when determining the optimal loan size the bank takes into account how the firm will do this. Note that operating profits π are assumed to refer to third stage *equilibrium* profits. Writing firm i's operating profits in terms of the bank's (or banks') strategic variables, we obtain $\pi(z_i, z_j)$. If we assume that an increase in loan size z_i does not decrease the amount invested by firm i in any of its projects, then the above assumption can be rewritten as assumption 9.1. Therefore, the results of section 9.3 apply to this case, interpreting z_i as the loan size or total funds available to firm i, which can be divided over various projects. The firms will choose the same bank, and this monopolist bank will ration credit. For investment projects with multiple dimensions in case of strategic complements, similar arguments confirm the results of section 9.5.

9.8 Conclusion

In this chapter we presented a three-stage model in which firms must obtain external funds in order to invest. They first choose whether to go to the same bank, or to go to different banks. Once they have chosen a bank, they are locked in. In the next stage, the size of the loan and thus the level of investment is determined. Finally, firms compete in the output market.

We considered several cases. The firms' investments were assumed to be either strategic substitutes or strategic complements. That is, a firm's investment either decreases or increases the other firms marginal profitability of investment. In our benchmark model, there are only two firms; the banks have all the bargaining power; and investment has only one dimension. In the extensions, we covered the cases of bargaining over repayment conditions, multiple firms, and multidimensional investment.

In all cases, we showed that firms prefer to go to the same bank. If there are several banks that compete for clients and banks can somehow 'pay' the firms in the first stage of the model to borrow from them in the second stage, this result continues to hold. Suppose banks compete for clients by giving them money and each firm borrows from the bank that offers the largest total payoff. By backward induction, each bank realizes what it could earn if the firm(s) were locked in with it. This is exactly the amount that the bank is willing to pay ex ante. Although the banks will outbid each other and thus end up with zero payoffs, a bank that will lend to both (or all) firms in the second stage is able to pay more to each firm than a bank that will lend to a single firm only. This does not imply, however, that firms in our model always prefer a more concentrated credit market structure. When a perfectly competitive credit market where funds can be borrowed at a fixed rate is feasible, firms would often prefer to go there, rather than to a monopolist bank.

The model and its implications seem particularly relevant for small, innovative firms which borrow from only one bank at each point in time. In the real world large firms commonly have several bank relationships, i.e. borrow from a number of banks (Ongena and Smith, 2000). This possibility is not included in our framework. Nonetheless, the model might apply to such firms as well. Consider a large firm that operates on several submarkets. If the competitors in the various submarkets go to different banks (that is, in market A the competitors borrow from bank A and in market B they borrow from bank B) our model predicts that the firm chooses the same bank as its competitors, i.e. bank A for projects related to market A and bank B for projects in market B.

Our model has important empirical implications. Compare for example Weinstein and Yafeh (1998) who analyze the effects of close ties between main banks and their client firms in Japan. In our model, we have assumed that the firms are locked in with the bank they choose in the first stage. Interpreting this situation as a close bank-firm relationship, we can describe Weinstein and Yafeh's empirical findings in terms of our results. Weinstein and Yafeh argue that close bank-firm relationships improve firms' access to capital. They conclude that main banks are able to capture most of the benefits that client firms enjoy from this improved access. This can be seen from higher interest payments for client firms as compared to independent firms. Indeed, this is what our model predicts. Our monopolist bank captures (most of) the incremental operating profits from avoiding overinvestment or underinvestment, respectively. Considering the extension on bargaining over repayment conditions, Weinstein and Yafeh's results suggest that for the case of Japan, the bank's share of the pie β is relatively high.

Our model also provides an explanation of why we observe banks specializing in one or more industries. If there are multiple independent industries, in each of which several firms (say, two firms, as in our basic model) compete, our model predicts that a bank prefers to lend to a firm in an industry where it is already active. Furthermore, the firm that applies for a loan prefers to borrow from an active bank rather than from another bank that is not currently active in the industry. When there is competition in banking and banks can 'pay' firms to borrow from them, a bank is willing to pay more to a firm in an industry where it is currently active than to other firms. A firm, however, requires a lower payment from such a bank than from another bank. Summarizing, our model predicts that banks will specialize in specific industries and can earn strictly positive profits.

The reason why firms choose to go to the same bank in our model is that it provides a commitment device. In general, from a long-run perspective a blunt collusive agreement may be hard to sustain. It simply may not be credible. In that case borrowing from the same bank may work as a commitment tool or disciplinary device to sustain such collusive behavior. When a bank decides on granting a loan to a firm, it also takes into account the effects on the profits of the other firms it has in its portfolio. A monopolist bank will thus take the external effects on the profits of the other firms into account. In this way, by choosing the same bank firms can commit not to over- or underinvest. This is not possible when they choose different banks, since a bank that serves only one firm in the industry has exactly the same incentives as the client firm itself. Firms benefit from the commitment effect of having a monopolist bank. The monopolist bank is able to capture more of the firms' operating profits, but the operating profits increase because of the commitment effect. In our model, the latter effect dominates and firms are better off choosing the same bank.