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Technological Transformation and Retail Banking Competition: Implications and Measurement

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Abstract

The study analyses the effects on banking competition of the changes in banking delivery and information collection technologies and of the rivalry from outside the traditional banking sector. Key implications for monetary, regulatory and competition policies are also addressed.

Evidence is provided that liberalization increased banking competition in Europe. In a mostly deregulated environment, technology is argued to be of major importance for competition. The study argues against the prevalent spatial modelling of banking competition due to the difficulty of representing remote access and nonbank activity. Instead, a novel two-stage model (delivery capacity, then loan and deposit pricing decisions) is developed based on multi-dimensional differentiation theory. According to the results, benefits that clients derive from branch or ATM proximity, additional outlets, or superior service quality can maintain pricing power for banks. Technological development reduces these benefits and generates a permanent increase in competition. The optimal sizes of branch and ATM networks decline. Network cooperation reduces network sizes, but is not necessarily harmful, as price competition is stimulated.

An empirical implementation of the model is presented for the Finnish loan and deposit markets. Banks' pricing power is found to be entirely due to their branch network differentiation and size in the loan markets, and to exist mainly in household lending. In contrast, price coordination was found to likely characterize deposit pricing. The ability to distinguish differentiation from collusion is a new contribution. Banks' pricing advantages were found to be diminishing in all lending and especially deposit-taking activities, following the technological development, which indicates reduced significance of branches for clients.

Technological development, growing nonbank activity, deepening capital markets and weakening price coordination are found to enhance the efficiency of monetary policy transmission into lending (and deposit) rates. The results are relevant for the common euro area monetary policy, since they show the dependence of the transmission on particular structural and competitive conditions of the banking system. Finally, deregulation of deposit interest rates insulates loan rates from changes in deposit rates and, contrary to what is often argued, does not make loans more costly.

Key words: banking competition, technological change, delivery networks, monetary policy efficiency, competition policy

Tiivistelmä

Tutkimuksessa analysoidaan, miten pankkialan jakelu- ja luottotietojen käsittelytekniikan muutokset ja pankkisektorin ulkopuoliset yritykset vaikuttavat pankkikilpailuun. Lisäksi siinä tarkastellaan näiden vaikutuksia sääntelyyn, raha- ja kilpailupolitiikkaan.

Työssä havaitaan, että pankkikilpailu on tyypillisesti lisääntynyt Euroopan maissa sääntelyn purkamisen jälkeen. Nyt kun kilpailua rajoittava sääntely on pääosin purettu, tekninen kehitys on merkittävin kilpailun muutostekijä. Pankkikilpailu on yleensä mallinnettu spatiaaliseen differentiaatioon (alueelliseen kilpailuun) nojautuen. Työssä väitetään, että tämä teoria ei sovellu teknisten muutosten ja pankkisektorin ulkopuolisen kilpailun luonnehtimiseen ja esitetään uusi kaksivaiheinen kilpailumalli, joka perustuu moniulotteisen differentiaation teoriaan. Tulosten mukaan konttoreiden tai automaattien läheisyys, niiden määrä tai muut laatutekijät voivat ylläpitää pankkien hinnoitteluvoimaa. Puhelin- ja Internet-pankkitoiminnan leviäminen vähentää näitä kilpailuetuja ja johtaa pysyvään kilpailun kiristymiseen. Pankkikonttori- ja -automaattiverkostojen koko niin ikään supistuu. Pankkien yhteistoiminta pienentää jakeluverkoston kokoa, mikä ei ole välttämättä vahingollista, koska korkokilpailu kiristyy.

Suomen aineistoa käytetään teorian testaamiseen. Luotoissa pankkien hinnoitteluvoima johtuu kokonaan konttoriverkoston tuomista kilpailueduista, ja sitä esiintyy lähinnä kotitalousluotoissa. Talletuksissa pankeilla on todennäköisesti kolluusiota korkojen asetannassa. Pankkialan sovelluksissa mahdollisuutta erottaa differentiaatio ja kolluusio ei ole aiemmin ollut. Hinnoitteluvoima on vähentynyt kaikilla luotto- ja erityisesti talletusmarkkinoilla teknisen kehityksen mukana. Konttoreiden merkitys on jo olennaisesti vähentynyt.

Työssä osoitetaan, että tekninen kehitys edistää rahapoliittisten korkopäätösten siirtymistä pankkien soveltamiin korkoihin. Pankkisektorin ulkopuolisella kilpailulla, pääomamarkkinoiden kehityksellä sekä kolluusion vähentymisellä on sama positiivinen vaikutus rahapolitiikan tehokkuuteen. Tulokset ovat olennaisia euroalueen rahapolitiikan transmission kannalta, koska ne osoittavat transmission riippuvuuden markkinarakenne- ja kilpailutekijöistä. Talletuskorkojen säännöstelyn purku vaikuttaa mallin mukaan siten, että talletuskorkojen liikkeet vaikuttavat yhä vähemmän luottokorkoihin. Luottokorkoja nostavaa vaikutusta ei ole, kuten usein väitetään.

Asiasanat: pankkikilpailu, tekninen kehitys, pankkien jakeluverkostot, rahapolitiikan tehokkuus, kilpailupolitiikka

Foreword

I wish to extend my sincerest thanks to my advisers, Professor Pekka Ilmakunnas and Dr Jouko Vilmunen. I have greatly benefited from their numerous insightful comments and encouragement at various stages of the work. I am also very grateful to Dr Juha Tarkka and Dr Heikki Koskenkylä for being very supportive and providing helpful comments and suggestions. Moreover, I wish to thank my official examiners, Professor Damien Neven and Professor Hannu Salonen, for very constructive comments on the first draft of the study. Their comments and insights helped me a great deal in finalizing the thesis.

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I am indebted to the Bank of Finland for allowing me to take time for research while I was working for the Bank, and for publishing this thesis. My greatest indebtedness is to the Research Department of the Bank of Finland for providing such excellent research facilities. The bulk of the work was done while I was working in the Department. I can hardly thank Mrs Heli Tikkunen enough for providing excellent assistance in handling the data. My warmest thanks also go to Mr Glenn Harma, who skilfully revised the language of this publication, and to Mrs Päivi Lindqvist, who finalized the layout.

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This study is dedicated to my dear family – Mari, Emmi and Ida.

Helsinki, December 2000
Jukka Vesala

Contents

1 Introduction

Developments in information collection, storage, processing and transmission technologies (*IT technologies*) have strongly influenced and continue to influence all aspects of banking activity. The main effects are of two distinct types. First, IT developments lower banks' costs by substituting computers for paper-based and labour-intensive methods of accounting for customer deposits, withdrawals and other transactions and for many internal operations. This *internal wave* of technological development started already in the 1960s and 1970s, and there have been significant increases in efficiency and productivity in banking.[1]

Second, IT developments present new possibilities for customers to access banking services without direct face-to-face contact with bank personnel: kiosk-banking via automated teller machines (ATMs), telephone-banking and online PC- and Internet-banking. This *external wave* of technological development has intensified recently and can further reduce banks' costs. In addition, one can already observe that substantial changes are taking place in the nature of banking competition. First, on the demand side, customers have the possibility of more easily accessing and obtaining information on different suppliers of banking services and hence of making comparisons. As a result, customer loyalty could diminish. Second, on the supply side, a large network of branches is no longer necessary to reach a *critical mass* of customers, and smaller banks can more easily compete with the major established institution. Moreover, this development opens up competitive possibilities for a range of nonbank institutions (eg mutual funds, insurance companies, finance companies, credit card firms, supermarket chains and, prospectively, IT companies). Several examples of this development already on the scene. Particularly, the spreading of Internet-banking, seems quite strong at the moment on part of established banks and new entrants.

This study analyses the effects of IT developments on banking competition. This area has not yet been widely researched, but my contention is that IT development is the primary force for change in the context of liberalized and internationally integrating banking

[1] Suominen and Tarkka (1991) present evidence for the Finnish banking industry.

markets, as it is fundamentally changing the ways customers access banking services.[2]

The study concerns primarily *retail banking,* which refers to traditional financial intermediation (consumer credit, mortgages), asset management (mutual funds, investment accounts, securities broking) and demand deposits and associated payment services directed to private customers and small and medium-sized firms. These services typically form the core of banks' activities and are quite distinct from wholesale banking services provided for other financial firms, large companies and governments that have access to the capital markets (money and foreign exchange market operations, syndicated loans, securities underwriting, advice, large-value payment services). The initial effects of IT developments on banking delivery methods concerned wholesale banking (eg the development of electronic securities trading), but it seems that now the developments are focused more on retail banking.

Providing easy access to banking services through branches has traditionally been the most important means for retail banks to differentiate from rivals and gain local pricing power. Branching was practically the only means of competition when interest rate competition was suppressed by regulations. The ease of access continues to be, in my view, one of the key nonprice, ie quality features of retail banking competition, at least for standard services and recurring transactions that do not require much advice, but now there are other viable delivery channels in addition to branching. The basic, mostly purchased, banking services (loans, deposits and payment services) are still quite homogeneous, and there is relatively little quality differentiation across banks. On the asset side, this concerns especially low-credit risk loans extended to private customers. On the liability side, deposits and payment services directed to the 'mass' market are quite homogeneous, while there is more differentiation in asset management services, which offer various return-risk combinations, coupled with investment advice.

Hence, the instalment of *physical access* delivery networks, traditionally branches and later on also ATMs as well as new *remote access* telephone- or PC-based delivery techniques should be viewed

[2] So far EU institutions and academic economists seem to have devoted more analysis to liberalization and integration than to technological change, as regards the evolution of banking competition. The two effects may be interconnected, since free access to a larger customer base makes it more attractive to launch new services based on novel delivery techniques.

as competitive means of extending the customer base and competing on quality. Furthermore, one has to deal with combined access (delivery network) and interest rate competition to control for the link between product market competition and delivery network choices. In the industrial organization (IO) literature, this is typically modelled with help of a *two-stage model* of the capacity decision followed by the pricing decision.[3] There are, however, relatively few applications in banking.

1.1 Prevalent modelling of combined nonprice and price competition in banking

The majority of the studies that emphasise the nonprice aspects of banking competition use *spatial models* based on the concept of *horizontal (locational) differentiation* in a geographic sphere.[4] It is thought that spatial differentiation is the main source of imperfect competition in banking (in a deregulated environment), which produces a downward sloping perceived demand curve for banks in different locations.

There are some studies that argue that customers' switching costs are another important reason for imperfect banking competition (eg Vives 1991, Neven 1993, Tarkka 1995). Switching costs, originally analysed by von Weizsäker (1984) and Klemperer (1987), refer to all possible costs to a client in shifting banking affairs from one bank to another. Switching costs make customers relatively insensitive to price differentials and hence grant banks pricing power. I feel that switching costs are the highest when banks can impose penalties for transferring a loan from one bank to another, or customers incur a tax

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[3] The seminal analysis and taxonomy of strategic capacity investments is presented in Fudenberg and Tirole (1984).

[4] In their survey of the topic, Eaton and Lipsey (1989) call horizontal differentiation the 'address branch approach' to product differentiation. The term derives from the fact that different consumers have different most-preferred locations in the horizontal differentiation models, and thus can be thought of as having different addresses in the respective geographic sphere. Products and services are then differentiated from each other by address in this space. The horizontal differentiation literature stems from Hotelling's (1929) seminal work.

or some other penalty for doing so.[5] I also think that switching costs should decrease in importance with further technological development, since it is easier to shift information to other banks, concerning eg salary deposit and regular automatic payment instructions.

It is also argued that the private information that banks have concerning their customers gives them pricing power (informational rent) in the loan market. Tröge (1998) succeeds in formalizing this result, but at the same time he shows that the result is highly dependent on the structure of the banking system. It may be that there is even an informational disadvantage.

Models that apply the spatial framework are usually based on Salop's (1979) *circular city* model,[6] which has the two-stage structure of capacity decision followed by pricing decision. Besanko and Thakor (1992) use it to study the effects of relaxing entry regulations and Ciappori et al (1995) to analyse the implications of deregulation of deposit rate controls for loan rates and cross-subsidization between loan and deposit rates. Matutes and Padilla (1994) analyse the implications of banks' ATM network compatibility, ie interoperability, for price competition between banks that share the network, and Shmid (1994) considers the desirability of branching regulations. Finally, some empirical work has been done on the basis of Salop's model (eg Lamata and Fumás 1992, Schmid 1994).[7]

Freixas and Rochet (1997, ch. 3.5) present a version of Salop's model applied to the banking. In what follows I derive a somewhat simpler formulation in respect to deposit market competition[8] in order to illustrate the competition aspect of establishing delivery capacity as well as the connection between intensity of price competition and banks' delivery network choices. In the next section, the shortcomings of this approach are discussed. I will claim that the spatial framework is becoming a less and less appropriate description of the functioning of the banking market due to innovations in delivery techniques. The

[5] In Finland, the withdrawal of the stamp duty on loans in 1998 made switching loans from one bank to another significantly less costly than before. Consequently there was a visible increase in these shifts among banks' clientele and greater competition between banks.

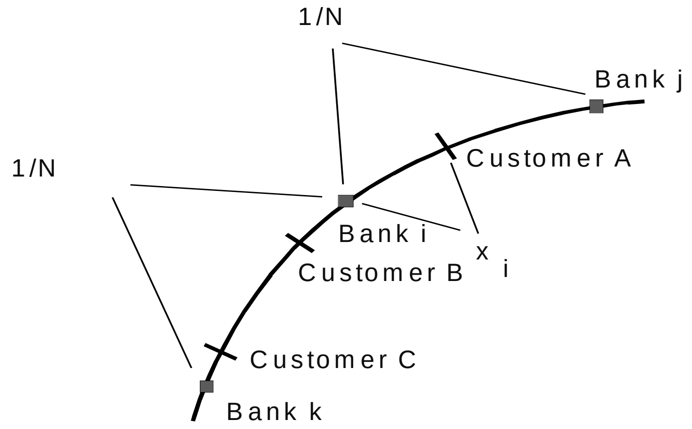
[6] A summary and discussion of Salop's model can be found in Tirole (1988, ch. 7).

[7] The usual factor distinguishing banking from other industries in these studies is that banks compete simultaneously in two markets: loan and deposit.

[8] The same framework can be applied to credit market competition. This kind of application appears eg in Besanko and Thakor (1992) and Chiappori et al (1995).

points taken up will constitute the basis for the modelling strategy applied in this study.

Exhibit 1.1 **Banks and customers in a circular city (a segment of the circle)**



Let us consider the following two-stage game. In the *first stage*, banks simultaneously choose whether or not to enter into the market, which is depicted as a circle with a circumference of one unit. There is *free entry*, so that the equilibrium profit of entering banks is brought down to zero. I do not allow for barriers to entry, in order to focus on the role of fixed entry costs and customer transaction costs in producing imperfect competition due to spatial differentiation. In the *second stage* banks compete in price (deposit rate), given their locations as established in stage one. Solving the model, and finding a subgame perfect equilibrium, requires determining the Nash equilibrium for the second-stage pricing game, given the fixed number of banks, N, and then using this equilibrium to determine the Nash equilibrium for the first-stage entry game.[9]

Let N denote the number of banks that decide to enter. Each bank can establish only one branch,[10] and the banks are assumed to be located equidistant from their neighbours in a symmetric fashion.

[9] This *backward induction* methodology is common to many game theoretic models and is based on the idea that firms take into account the ensuing competitive conditions when they make capacity decisions.

[10] The assumption of single locations rules out branching, and hence entry deterrence, through branch proliferation.

Hence the distance between any two banks is equal to $\frac{1}{N}$ (see Exhibit 1.1).[11]

Banks' customers are assumed to be uniformly and continuously distributed over the same circle where the banks are located. When transacting with a bank i, a customer incurs transaction costs, equal to the common *unit transaction cost*, τ, times the distance to the bank's service point, x_i. The unit transaction cost comprises the travelling cost and the opportunity cost of time. The rate on deposits offered by bank i is r_i. Therefore, the net utility of a representative customer A from the use of the deposit services provided by bank i is equal to $(r_i - \tau x_i)$.

Bank i has (in equilibrium) only two real competitors, namely the two neighbouring banks.[12] A customer located at the distance $x_i \in \left(0, \frac{1}{N}\right)$ is indifferent, in terms of net utility, between bank i and the neighbour located closer to the customer, eg bank j offering deposit rate r_j, if

$$r_i - \tau x_i = r_j - \tau\left(\frac{1}{N} - x_i\right) \qquad (1.1)$$

From this it follows that

$$x_i = \frac{r_i - r_j + \frac{\tau}{N}}{2\tau}, \qquad (1.2)$$

where x_i is now the distance of a marginal customer of bank i, indifferent between the two banks i and j. Anyone located closer to the

[11] The symmetric equidistant location of banks on the circle implies maximal horizontal differentiation. Explicit modelling of locational choices would not affect this outcome, since Economides (1984) has shown that a three-stage game, where there are also locational choices, yields the maximal differentiation result subsumed in Salop's model. In the present model, entry takes place only once, but one could in principle allow later entries by assuming that old banks would relocate instantly on the circumference so that the distance to neighbouring banks is always to same and the maximal differentiation outcome is preserved.

[12] This relies on the assumptions that no two adjacent points of service belong to the same bank (banks are unit banks) and customers' net utility is negative if they have to travel a distance longer than 1/N.

bank i will choose to be its customer. As banks serve both sides of their locations, the market share, or demand, captured by bank i is equal to

$$D(r_i, r_j) = 2x_i = \frac{r_i - r_j + \frac{\tau}{N}}{\tau}. \tag{1.3}$$

In the second stage, banks choose deposit rates to maximize profits:

$$\max_{r_i} \pi_i(r_i, r_j, N) = (i - r_i - c)\left(\frac{r_i - r_j + \frac{\tau}{N}}{\tau}\right), \tag{1.4}$$

where i represents the money market interest rate[13] and c the constant marginal operating cost of providing deposit services, assumed the same for all banks. Since banks are located symmetrically (and information is symmetric), one would expect to find an equilibrium in which all banks offer the same profit maximizing deposit rate, r*. Differentiation of (1.4) with respect to r_i and setting ($r_i = r_j = r^*$) yields

$$r^* = i - c - \frac{\tau}{N}. \tag{1.5}$$

As entry is not constrained, the first-stage entry decision, and hence the sub-game perfect equilibrium number of banks, is endogenously determined by the *zero-profit condition*

$$(i - r^* - c)\frac{1}{N} - f = 0 \quad \Leftrightarrow \quad N^* = \frac{(i - r^* - c)}{f}, \tag{1.6}$$

where f is a *fixed entry cost*.

Thus the total number of banks, N* (which can be also used to represent the total delivery capacity of the banking industry)

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[13] As usual, banks are assumed to be price takers in the money market. Hence, i equals the rate at which each bank faces a perfectly elastic demand for funds generated from deposits. Higher returns on assets funded by deposits would imply extension of credit to risky borrowers. I regard here the margin between i and actual asset returns as pure compensation for this risk, having no effect on delivery capacity choices.

1. *increases with banks' profit margin* (i – r* – c), ie decreases with the intensity of price competition,[14] since a higher margin requires a larger N to satisfy the zero-profit condition;

2. *decreases with the amount of fixed investments, f, required to set up outlets* since, with a larger f, a smaller N satisfies the zero-profit condition;

3. *increases with the unit transaction cost,* τ, since r* is a decreasing, and hence the profit margin an increasing, function of τ.

The first result shows the importance of product market competition for banks' delivery capacity choices. In the model, the intensity of price competition depends on the customer unit transaction cost (via a direct effect on the profit margin and an indirect effect on N) and the fixed set-up cost (via an indirect effect on N) so that banks have the more pricing power, the higher these costs. The fixed set-up cost is sunk in the second-stage pricing game and reduces the number of banks that will enter the market.

In the model, banks' *pricing power* is determined by the extent to which they are spatially differentiated from each other, which in turn depends on the customer unit transaction cost and the fixed set-up cost. Note, how imperfect competition due to spatial differentiation produces nonzero markups of price over marginal cost despite the zero-profit condition for the entry game. This is an important general point deriving from models of this kind. It means that firms can have pricing power even though they do not make supranormal profits, provided that entry is free and frictionless.[15]

The model can be easily extended for studying the effects of collusion or deposit rate regulation (Chiappori et al 1995) by performing constrained optimization where r* is restricted to a fixed figure stipulated by (explicit or tacit) cartel agreements or a regulatory ceiling. If the restricted deposit rate falls below what would obtain in free price competition, the resulting number of banks (or branches)

[14] The profit margin equals zero under perfect competition in the price competition stage.

[15] However, one can think of alternative to the model set-up which leads to firms earning positive profits. Allowing for a new entry stage and imposing frictions to the entry and relocation processes, ie old banks would not relocate immediately after new entry (say, it takes time to relocate), would make entry more difficult and the resulting number of banks would be lower. These banks could earn positive profits.

would be accordingly higher.[16] This can be regarded as waste of productive resources as compared to the situation of effective price competition.[17] Deregulation and the ensuing price competition would then produce an overcapacity problem, since the previously built capacity would no longer be optimal in the new environment.[18]

1.2 Motivation for the study

As said, I think that the prevalent modelling of (retail) banking competition using the spatial framework has severe shortcomings as regards the effects of new delivery technologies. The main arguments are the following:

1. *The applications of the spatial model do not yet encompass the effects of the emergence of 'remote access' technologies. The reason is that the basic spatial framework is not well-suited to analysing this issue.*[19]

Remote access to banking services via phone or PC means that customers are not restricted to banks' outlets, branches or ATMs, and deposit-related payment and other services can be obtained from customers' most convenient locations without 'physical' contact to banks. Remote access options allow customers to become significantly more mobile in the search for the best offers in the

[16] Neven (1993) presents this conclusion without reference to an explicit model.

[17] Deposit rate regulations would thus be harmful as regards the efficiency of the banking system. Deposit rate regulation would not hold down loan rates (which has been the usual argument in favour of them) unless customer tying is possible, supporting cross-subsidization of loan rates from the deposit margin (Ciappori et al 1995, Freixas and Rochet 1997, ch. 3). This would constitute a transfer from depositors to borrowers. In contrast, Salop's model favours entry regulations, which can be interpreted to mean that branching regulation would be desirable (Schmid 1994). Namely, the socially efficient solution for the number of outlets requires the maximization of the net utility of a representative consumer subject to a given level of bank profits. It can be shown that free competition generates more points of service than what is socially desirable (Tirole 1988, ch. 7, Schmidt 1994). This analysis, however, neglects the potential diversification benefits of branching that can improve the stability of the banking system, which is of social value (eg Jayaratne and Strahan 1997).

[18] The overcapacity issue is discussed more in Chapter 2 in light of European evidence.

[19] Bouckaert and Degryse (1995) and Degryse (1996) study banks' incentives to offer remote access as a means to differentiate vertically in service quality and regain pricing power. I feel that these possibilities are, however, quite limited, especially due to increasing information on competing offers, eg through the Internet.

market and enable them to change banks easily in response to price differentials. There may even emerge ‘agents’ that search for the best opportunities for customers, eg using information from the Internet. This also involves borrowing, as information for credit risk evaluation and monitoring can be disseminated by phone or e-mail via the Internet.

As a result of remote access possibilities, geographical distance to banks’ outlets diminishes its significance, and hence the underpinnings of banking competition change fundamentally. This means that the basic justification for using the spatial framework related to customer demand for geographical proximity is no longer valid. A *representative customer approach*, with anonymity and without exact customer locations, would be more appropriate.[20]

2. *The spatial models do not include ‘outside’ unit bank or nonbank competition against the banks with ‘physical’ delivery networks.[21] Nor do they allow competition among all institutions in the market.*

Branches and ATMs constitute proprietary delivery channels for banks, which makes them fundamentally different from the remote access using telephone or computer networks that are not owned by banks and are principally open to all firms that wish to expand their business. As a result, other universal banks, specialized ‘niche’ banks or even nonbanks with small ‘physical’ delivery networks (or even without them) can have access to the entire customer base and may aggressively strive to extend their market share. These new competitors have already started to emerge in many businesses traditionally dominated by universal branch banks.

The spatial models predict that price competition is the softer, the smaller the number of outlets (banks) in the market, since the closer together the banks, the more they are exposed to price competition. This fails to account for the notion that banks’ competitive position vis-à-vis outside competitors without ‘physical’ delivery networks is dependent on the extent of these networks. The fewer the bank branches or ATMs, the more the customers are inclined to use ‘outside’ options and the smaller the banks’ pricing power, to the extent that the size of a branch or ATM network is a positively valued

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[20] In most EU countries remote access is already well-established and Kalakota and Frei (1996) report of a rush in the US to invest in these delivery methods (see section 2.4).
[21] This statement refers to the banking applications of Salop’s model. Salop (1979) itself contains an ‘outside good’.

part of service quality. This aspect of 'outside' competition is not, to my knowledge, explicitly accounted for in any other formal study. Moreover, when banks' delivery networks are compatible, the total network size benefits all banks participating in the compatibility agreement.[22] In sum, remote access implies that competition should be allowed among all players in the market, banks as well as 'outside' competitors, not just between geographic neighbours.

3. *In spatial applications, competitive conditions change only after entry or exit, not because of delivery network decisions of incumbent banks. The spatial applications are based on the premise of symmetric industry structure and there is no competition or differentiation among multi-branch banks or banks with ATM networks of different size.*

Branching and ATM network decisions can naturally affect price competition among the incumbent banks, regardless of new entries. The main point for this study, however, is that by offering a relatively inexpensive delivery channel as an alternative to branching, and to some extent also to ATMs, remote access reduces the strategic value of these outlets. As a result, competitive conditions change within the banking industry across banks with different sizes of branch and ATM networks, as does banks' competitive position against the 'unit bank' or nonbank suppliers of contesting services.

There are only a few studies that explicitly address branching as a part of banks' strategic behaviour. Cerasi (1995) studies banks' branching decisions in order to find equilibrium conditions for unit banking and branch banking and hence for the industry structure.[23] Her paper also deviates from the spatial applications where additional delivery outlets only crowd out business from the existing ones by including a positive externality effect related to the total branch network size. In her model the total number of branches enters into depositors' utility function. This is related to the benefit banks obtain

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[22] Matutes and Padilla (1994) (op. cit) do not take into account the effect of ATM compatibility on banks' competitive position against outside competitors without ATM networks or access to them.

[23] According to Cerasi's results, unit banking obtains when the market is small. Nakamura and Parigi (1992) explain the coexistence of unit and branch banks with heterogeneous preferences: distance plays a role only for a fraction of banks' customers. Gehrig (1996) and Matutes and Vives (1996) use positive externalities related to the size of banks' total branch network to explain the possibility of the emergence of asymmetric industry configurations.

from networks vs 'outside' competitors here, but I allow the total network size of the banking system to generate competitive advantage only when there is compatibility so that customers can use rival banks' outlets as well. In other words, I adopt a service accessibility viewpoint on the part of banks' clients. This is the case of ATM compatibility agreements, but it could in principle involve branches as well (as can be the case eg with savings banks). Under no compatibility, customers should not derive utility from total network size.[24]

Drawing on the points 2 and 3, one should distinguish between the *network differentiation effect* among banks with asymmetric 'physical' delivery networks, and the *network size effect,* which benefits banks with large branch and ATM networks. *Total network size effects* appear under compatibility agreements. These effects produce competitive advantages for banks with 'physical' delivery networks, which depends on customer valuations of the scope of the outlets. These valuations decrease with technological development, since the alternative service access and information dissemination options become increasingly better substitutes for branches and ATMs. Consequently, the competitive benefits accruing to banks with large 'physical' delivery networks diminish with the instalment and consumer adoption of the new remote access delivery techniques.

In the industry journals and popular press, at least, (the sunk costs related to) extensive branch networks have been regarded as the primary barrier to entry and expansion for small banks and newcomers in retail banking. The emergence of remote access delivery technologies reduces the significance of this barrier, which reduces incumbent banks' pricing power and increases the contestability of banking markets. In terms of the model outlined in the previous section, the new technologies have the effect of lowering the fixed set-up cost of delivery outlets, which in turn encourages entry.

Finally, the spatial framework is not well-suited for empirical analysis, which is another reason why I have looked for alternative ways to approach the modelling of banking competition.

[24] The literature on the effects of branching on banks' pricing is also quite scant. Calem and Nakamura (1995) develop a model that suggests more diverse pricing across banks with branch rather than with unit banking. Mester (1987a) and Gale (1992) argue that branching increases competition to the extent that rivals compete at multiple locations.

1.3 Outline of the study

Chapter 2 examines major trends in bank performance in European countries in order to present evidence of the already significantly changed competitive conditions. Moreover, the technological transformation in banking, including niche and nonbank entry, is discussed and illustrated. The recent and progressive changes due to phone- and Internet-based delivery are also described. The aim is to support the relevance of the study and to provide evidence that changes in banks' delivery methods cannot be regarded merely as means to minimize costs but also as significant nonprice tools of competition.

Chapter 3 develops a two-stage model of retail banking competition that accords with the outlined opposition to the use of the spatial modelling framework. The model includes *multiple services delivery outlets, 'outside' competition, network asymmetries* and *technological progress*. Delivery network choices (first stage) and setting of loan and deposit rates (second stage) are explicitly modelled, while entry is not formally analysed. The model is an application of Feenstra's and Levinsohn's (1995) theory of multi-dimensional product differentiation. The aim of the model is to capture the effects of technological change on the nature of price competition in banking and banks' delivery network choices. This enables derivation of certain new aspects of the pricing of loans and deposits and optimal delivery network decisions.

In addition, the model serves as an improved basis for the analysis of the following policy issues relating to competitive conditions in the banking industry: (1) *efficiency of monetary policy* in terms of the pass-through of money market rates into bank lending rates (and deposit rates); (2) *effects of further deregulation of deposit rates on bank lending rates*. These issues are topical in the context of the Third Stage of EMU in Europe. First, the country-specific 'micro-level' differences in the structure of the banking system and level of banking technology significantly affect the pass-through of money market rates, as will be shown in this study. This in turn would produce varying effects of the common monetary policy on output and investment in the single currency area. Second, the continuing integration of banking markets in Europe is likely to remove the remaining differences in deposit rate regulation, meaning further deregulation in practice. Thus it is of interest to study the effects of this expected further deposit rate deregulation. Finally, the model will also be used to discuss (3) certain *competition policy implications*.

So far, technological development seems to have had a bigger impact on the delivery of deposit-related services than on lending activities, and this situation is likely to persist in the near future. Changes in the processing and delivery of standardized low-risk consumer credits and mortgages are however accelerating, in contrast to commercial lending, which requires close credit risk evaluation and monitoring. This asymmetric development has a bearing on the short- to medium-term policy conclusions, as will be analysed in chapter 3.

Chapter 4 presents an empirical application of the model using panel data on Finnish banks. The purpose is to assess the effects of banks' differentiation in terms of branch and ATM networks on their markups (imperfect competition) and quantify the changes in these that are due to technological progress. I will derive a fairly simple empirical method to investigate this issue and apply it to the markets for corporate and household loans and deposits of the general public. A further contribution is a separation of estimates of banks' pricing power into that due to network differentiation and size vs that due to possible collusion in loan and deposit rates. Since in Finland the transformation of banking services delivery has already advanced quite far, there is a good opportunity for an empirical study of this kind. The empirical analysis produces support for the theoretical model and hence for the ensuing policy conclusions.

Finally, *Chapter 5* summarizes the main results and policy conclusions.

2 Trends in bank performance and technological transformation: a European perspective

The main feature of the liberalization of banking regulation in Europe (and elsewhere) was the abolition of *conduct regulations*, ie direct controls on pricing, allocation of funds, entry and branching. The fundamental effect of this was to foment free price competition. In this liberalized environment, the competitive changes brought about by the novel delivery technologies are now beginning to be felt.

After a review of the liberalization process, major trends in bank performance in Europe will be examined using national account and bank profitability statistics to present evidence of already significantly changed competitive conditions. A European perspective is in order, as the adoption of the single currency is deepening the integration of the European banking markets. The latter part of the chapter will examine existing and envisaged changes in banking delivery techniques, which have the potential to affect the full range of retail services. The review of the remote access methods used by various bank and nonbank institutions provides the primary motivation for the remaining parts of the study. The main argument is that the changes in delivery methods need to be regarded as a part of the competitive strategy of firms operating in the markets for banking services.

2.1 Liberalization of banking in Europe

Banking deregulation began in Europe in the late 1970s and continued into the early 1990s, as there were differences in the timing and speed of the process[25] across countries. European Community legislation,

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[25] The Mediterranean countries were generally rather late to liberalize. Spain, for example, experienced a swift deregulatory process in the late 1980s. In Denmark most of the controls were lifted at the beginning of the 1980s, somewhat earlier than in other Nordic countries. In Finland, Norway and Sweden a large number of restrictive measures were rapidly removed within a few years around 1985, with Sweden being a few steps ahead of the other two countries. Germany, the Netherlands, Switzerland, and the United Kingdom (with the exception of building societies) are countries that had traditionally few regulations compared with the previously mentioned countries. (Bröker 1989, Canals 1993, Gual and Neven 1992, Vesala 1993).

effected primarily after the White Paper of 1985, 'Completing the Internal Market', significantly contributed to the process by triggering changes in national regulations, also in the EFTA countries. The European legislation constituted a strong incentive for national legislators to deregulate and streamline banking legislation. Community legislation, in turn, was strongly influenced by the global development of banking regulation for internationally active banks driven by the Basel Committee on Banking Supervision.

First and foremost, regulations on banks' *competitive conduct* were largely eliminated. These regulations included controls on banks' deposit and lending rates, fees and commissions, as well as direct credit quotas and branching limitations.[26] There was a complete shift in regulatory thinking, as the stringent *conduct rules* that prevented free operation of market forces were replaced by indirect *prudential standards* (most importantly regulations on capital adequacy and adequate diversification of exposures), rules concerning recognized business practices, and requirements concerning the information that needs to be attached to financial services and products. This liberalization process is mostly complete, though in some countries a few controls still remain with respect to deposit rates. As a result, effective price competition has become possible, and the banking industry has lost its shielded position and publicly guaranteed margins.

Second, the *functional separation* of financial institutions, where it existed, was generally abolished. Instead, the universal banking model was adopted. This allowed banks to conduct a broad range of financial activities, including investment banking and securities intermediation, as set out in the Second Banking Coordination Directive of 1989. However, functional separation was always less pronounced in Europe than in the United States.

Banking deregulation generally refers to the removal of the two above kinds of regulations, on conduct and functional separation. In addition, the abolition of all controls on *capital movements* and

[26] There were, however, significant differences across European countries as regards the scope and mix of the particular conduct regulations. In Belgium, Spain, France and Italy banks' rates and service fees were strictly regulated and there were direct regulations on banks' assets and liabilities. Restrictive branching regulations were also in force in Spain and Italy. Denmark had credit quotas but not many explicit rate regulations. Stringent controls on bank lending were exercised via both rate regulations and quantitative controls in Norway and Sweden, while in Finland rate regulations were dominant. (Bröker 1989, Canals 1993, Gual and Neven 1992, Bank for International Settlements 1993, Vesala 1993).

foreign exchange served to promote banks' international operations, increased foreign currency-denominated intermediation, and promoted the integration of financial markets. Capital movements were completely liberalized in the EU on 1 January 1993, and on 1 January 1994 in the entire European Economic Area (EEA). However, many European countries (Germany, United Kingdom, Benelux countries) liberalized capital movements much earlier.

The European Single Market was designed to foster competition and thus to achieve efficiency gains[27] in all manufacturing and service industries, including banking and other financial services. The goal is to ensure effective *external competition*, which would limit the possibilities of financial firms to exploit market power in geographically or functionally closed areas of business. Suppliers with the best and cheapest financial products and services should be free to operate throughout the Single Market (eg Cecchini 1988, Gardener and Teppet 1992). This would then increase the contestability of markets and produce customer benefits.[28]

The Single Market is intended to be operative particularly with respect to the most extensively shielded industries, for which cross-country differences in efficiency and pricing are the greatest. Certain retail banking products and services appear to be prime cases. In these businesses, external competition may remain ineffective due to economic barriers to entry that are not related to legal or regulatory factors (such as sunk entry costs and customer switching costs), or to strategic barriers generated by the behaviour of the incumbent institutions.

To achieve its goal of effective external competition, the Single Market legislation abolished legal impediments to cross-border branching and provision of financial services without establishment (ie remote supply). All discriminatory rules against foreign institutions and prohibitive entry restrictions, like separate capital requirements

[27] Adequate competition is a necessary condition for the achievement of the three types of market efficiency (Steinherr and Gilibert 1989): (1) *allocative efficiency* goods and services meet customer demands and are priced at marginal cost, (2) *productive efficiency:* economies of scale and scope are fully exploited and X-inefficiencies (waste) are eliminated, and (3) *dynamic efficiency:* product innovation proceeds in step with the needs of the economy.

[28] *Perfect contestability* is a market paradigm under which allocative, productive and dynamic efficiency are achieved as in a perfectly competitive market. In a perfectly contestable market there are no sunk costs of entry or exit, which means that the effective threat of entry (potential competition) constrains even a monopoly to behave in a socially optimal manner (Baumol et al 1982).

for branches, had to be abolished. Traditionally, the former means of entry into foreign banking markets are more important, since provision of services requires establishment close to customers. The importance of remote supply should increase, and barriers to entry should diminish, with the diffusion of remote access methods.

To ensure free branching, the principle of the *single passport* was adopted. There is no separate licensing by the host authorities as regards branches of banks registered in other Member States. A licence granted by the home state enables banking operations throughout the Single Market area. Nor does remote supply of services require a separate licence.

Single Market legislation is also aimed at creating *equal business opportunities* and regulatory burdens for all financial institutions operating in the Single Market area, in order to ensure equal possibilities to compete against banks from other jurisdictions. This is accomplished via the harmonization of business restrictions, licensing requirements and major prudential regulations (foremost: capital adequacy requirements and asset concentration restrictions) in the respective Community Directives.[29] Moreover, harmonization of regulations is necessary for the effectiveness of the single passport principle, as it assures authorities in foreign countries that institutions operating in their territories meet certain common standards.

In addition, without harmonization, *competitive deregulation* by national authorities in support of domestic institutions could lead to prudential requirements that are excessively slack from the standpoint of financial system stability. For this reason, harmonization can also be justified as a means of reducing the risk of the spread of banking problems across the Single Market. Harmonization has, in fact, led to a tightening of prudential regulations in many countries. This is quite natural, since prudential standards are not so vital when stringent conduct regulations are in place, since banks' margins and hence solvency are largely guaranteed and risks limited. Ceilings on bank lending rates, for example, generate excess demand for loans when the ceiling is below the market equilibrium rate. Banks do not have incentives to take on credit risk in this situation but rather to extend credit to the safest customers. Moreover, based on Stiglitz's and

[29] The Basel Committee on Banking Supervision issued recommendations for internationalised banks (the 'Capital Accord') already before the Community Directives on prudential capital adequacy regulations were put in place. The Community Directives on capital adequacy follow the Basel approach quite closely but apply to all banking institutions.

Weiss' (1985) model of credit rationing, restricting interest rates on bank loans limits the adverse selection of bad credit risks for banks' loan portfolios.

More stringent prudential regulations to follow a relaxation of conduct regulations are justifiable, since there can be a tradeoff between competition and prudent risk taking by banks.[30] Merton (1977) originally presented the idea that when banks' net worth, ie the value of their charter, is low, or when they have weak business prospects, they are particularly prone to taking risks (moral hazard of excessive risk taking). This kind of behaviour is also referred to as *gambling for resurrection* and is symptomatic of limited liability firms in trouble and trying to avoid bankruptcy.[31] For example, Dewatripont and Tirole (1993) show that charter value mitigates this kind of moral hazard by aligning the incentives of equity holders and depositors. Increased competition may be one reason why banks have low net worth and hence may trigger excessive risk taking. In related terms, Furlong and Keeley (1989) demonstrate that abundant holdings of capital can also reduce moral hazard.

The Finnish experience illustrates that the transformation of the regulatory system from one based on conduct controls to another based on prudential standards can cause problems. Namely, excessive risk taking can emerge when banks, public regulators and supervisors have not yet adjusted their behaviour in line with a freer system entailing considerably more extensive risk taking possibilities. Moreover, there was a gap in Finland between liberalization of conduct regulations and efficient implementation of prudential limits on capital adequacy and risk concentration, which enabled vast growth in bank lending in the late 1980s. This, in turn, resulted in the dire banking problems of the early 1990s.[32]

In the context of the Single Market, the introduction of the euro is often regarded as a final step in the process of integrating national markets for goods and services. The national currencies were probably among the most significant remaining factors supportive of banking

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[30] Chan et al (1992), Keeley (1990) and Milgrom and Roberts (1992) present theoretical expositions of this tradeoff.

[31] Especially Kane (eg 1989) has emphasized the perverse incentives that can arise when banks are in jeopardy. He also claims that, when the stakes are high enough, banks may bribe and cajole regulators to assist them in abusing the safety net at taxpayers' expense. See also Boyd and Gertler (1993) and Calomiris (1999).

[32] Halme (1997) presents a detailed analysis of the changes in the Finnish regulatory system and Vihriälä (1997) presents an empirical account of the Finnish credit cycle and the reasons for it related to bank behaviour.

market segmentation. And hence the elimination of currency-related transaction costs and risks, together with price transparency, should enhance equal pricing of identical goods and services throughout the Single Market area. The effects of Stage Three will probably be greater in the financial industry than in other industries. Foremost, the euro and the establishment of the TARGET system for large-value payments will significantly enhance the integration of domestic securities markets. Intermediaries are able to fund their lending operations throughout the area from the common euro-denominated markets, which lowers funding costs and eliminates foreign exchange risks. The timing and scope of the pro-competitive effects of Stage Three on the retail markets, however, remain to be seen.

2.2 Indicators of banking competition after liberalization

When investigating bank pricing in loan and deposit markets, one would ideally like to compare loan and deposit contract rates directly with risk free market rates. However, comprehensive data on contract rates are not available, at least not in a harmonized manner that enables meaningful cross-country comparisons. Instead, in the following, indirect indicators of aggregated margins are constructed, based on national accounts as well as on bank profitability statistics[33] for 12 or 13 European countries, depending on data availability.

2.2.1 Analysis based on national accounts

National accounts collected by the OECD have an item, *imputed bank service charge,* which is the excess of interest and property income accruing to banks and similar credit institutions over interest accruing to depositors. Direct service charges are excluded. Hence this is a measure of *net value added* in the production of traditional financial intermediation services that generate net interest income as well as payment and ancillary services that are paid for indirectly in the interest margin by banks' depositors. The measure concerns primarily retail banking activities, since wholesale activities generate mostly fee

[33] Early versions of these analyses appeared in Vesala (1995a).

income. Before proceeding, let me first discuss the applicability of this measure.

The practice of not charging fees for payment services and transactions related to customers' own accounts has been quite widespread in most industrialized countries (Tarkka 1995, ch. 1, Humphrey et al 1996a and 1996b), although there is evidence that in some countries direct pricing of payment services has become more important of late, especially in the Nordic countries (Humphrey et al 1998). According to European Central Bank (1999), the practice of direct pricing of payment and other associated account services is still not very common in the other EU countries.

The practice of charging for payment and account transaction services by means of interest forgone by depositors who receive lower-than-market interest rates implies *cross-subsidization* between deposit and payment services. That is, in this context cross-subsidization refers to one type of banking service subsidizing the production of another type.[34] Banks typically face strong customer resistance toward any direct service charges, which thwarts banks from imposing them unilaterally. There are, however, economic reasons why this form of cross-subsidization could remain as a long-run industry-wide phenomenon, even in liberalised banking markets.

The observed persistence of cross-subsidization was not expected by the early analysts,[35] but later on two lines of explanation have emerged. Firstly, in many fiscal systems, deposit interest income is taxable while the benefit of free or under-priced services is not taxed, and direct service charges are not deductible in taxation. If this is the case, banks have incentive to compete via tax free 'implicit interest' in the form of free or under-priced payment services instead of taxable explicit interest accompanied by direct service charges (Walsh 1983 and Tarkka 1995, sec. 5.2). Second, an optimal 'two-part tariff' pricing strategy in imperfectly competitive banking markets with lump-sum fees and zero per transaction costs, where the tariff is used as a device for price discrimination, entails cross-subsidization (Mitchell 1988, Tarkka 1995, sec. 5.3). Hence, to the extent that cross-subsidization is a symptom of imperfect competition and imperfect substitutability of banks' services, intensifying price competition and emerging 'outside' competition have the effect of reducing the scope

[34] This might also imply cross-subsidization across customers, which is, however, not relevant for assessing the viability of the 'imputed bank service charge' as a measure of net value added in the banking sector.

[35] Fischer (1983) and Tarkka (1995) present literature reviews.

for cross-subsidization. For example, banks started to implement some service charges in Finland in 1988 when effective competition in certain deposit rates was anticipated.

Against this background, the 'imputed bank service charge' still constitutes a reasonably good measure of banks' net value added. There is also evidence that, when there are direct service charges, they generally do not fully cover the associated costs of payment services[36] and are quite small compared to banks' net interest income. However, the importance of this measure could decline in the future with increased use of direct fees and a shrinking of the share of traditional 'on-balance-sheet' intermediation.

By relating the 'imputed bank service charge' to GDP, one obtains a scaled measure of *the scope of bank intermediation,* taking into account both the volume of intermediation and the size of banks' *rents*.[37] The latter effect can be identified by comparing the 'imputed bank service charge' to banks' total assets, which measures the volume of intermediation business.

Table 2.1 addresses the changes in these measures over the ten-year period, 1984–1994. The GDP share of 'imputed bank service charge' has fallen in 5 countries in the sample, and the other countries show rather small increases, apart from Portugal and to lesser extent Spain.[38] Since intermediation services do not generate direct consumer satisfaction as do consumption goods, a decreasing GDP share might suggest a socially desirable, welfare-increasing development. Banks' rents appear to have shrunk substantially in all countries, except again for Portugal and Spain. This implies narrowing margins and falling effective prices for banking services and hence efficiency gains, due to increasing price competition. Competition narrows banks' margins,

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[36] Robinson and Flaatraker (1995) present detailed calculations for Norway producing this result, although direct pricing of payment services has recently increased substantially in Norway.

[37] The analysis does not concern the social value of banking services. The economic significance of financial intermediation and payment services is indeed quite high for the other sectors of the economy (eg Baltensberger and Dermine 1987 and Santomero 1984). Bank dominance in financial systems traditionally distinguishes countries in continental Europe from the UK and US, where private capital markets have been much more developed. This affects the absolute size of banks' net value added. Moreover, the nature of corporate relations, also varying between the 'Anglo-Saxon' and 'German-Japanese' models (eg Mayer 1990, Bisigano 1992 and Benston 1993), has important implications for competition and efficiency, which however are beyond the scope of this study.

[38] The increase of the GDP share in Spain and especially Portugal, to well above the average European level, suggests that banks' intermediation margins have been extraordinarily high in these countries.

given their operating costs, but there is also a longer-term indirect effect as competition tends to generate increases in cost efficiency and productivity.[39] This would result in further welfare gains. There is some evidence that significant productivity growth has indeed taken place in banking.[40]

Table 2.1 **Ratios for 'imputed bank service change', banks' total assets and GDP**

	'Imputed bank service charge' / GDP (%)		Banks' total assets / GDP (%)		'Imputed bank service charge' / Banks' total assets (%)	
	1984	1994	1984	1994	1984	1994
Belgium	4.0	2.8	1.9	3.0	2.1	0.9
Denmark	2.7	2.7	0.9	1.0	3.0	2.7
Finland	2.4	2.8	0.8	1.4	3.0	2.0
France	4.0	3.6	1.3	1.9	3.1	1.9
Germany	4.8	4.5	1.3	1.9	3.7	2.4
Italy	4.1	4.5	0.9	1.4	4.6	3.2
Netherlands	4.0	3.6	1.2	2.3	3.3	1.6
Norway	3.6	3.6	0.6	0.8	6.0	4.5
Portugal	4.3	7.1	1.2	1.9	3.6	3.7
Spain	5.1*	6.4	1.3	1.7	3.9	3.8
Sweden	3.4	3.6	0.8	0.9	4.3	4.0
United Kingdom	3.9	4.5	0.7	1.1	5.6	4.1
Simple average	3.9	4.1	1.1	1.6	3.6	2.6

Data sources: OECD, National Accounts; OECD, Bank Profitability Statistics.
Notes: Denmark: commercial and savings banks; Portugal: commercial banks; United Kingdom: commercial banks; other countries: all banks. *1985 figure.

Whether the traditional banking intermediation should be regarded as a growth industry depends on the evolution of its GDP contribution as income grows. To examine this issue, the following equation for the

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39 Competition produces efficiency and productivity gains, eg since according to a well-known result monopolies tend to be inefficient and to apply too many productive resources relative to the level of output (eg Steinherr and Gilibert, 1989).

40 Suominen and Tarkka (1991) report that in Finland the same amount of labour could produce 4.5 times more banking services in 1990 than in 1981, indicating substantial growth in labour productivity. The growth in capital productivity was slower than labour productivity growth, but still quite significant. Substantial growth in total factor productivity was the result. Technological development in the banking sector has been very rapid in Finland, which was reflected in these findings. Lannoo and Van Tilborg (1995) argue in favour of increased labour productivity in most EU countries, based on increased gross banking income per employee.

12 European countries listed in table 2.1 is estimated, to capture the *income* and *price effects* on industry-level demand for intermediation services

$$\ln\left(\frac{B}{GDP}\right)_{it} = \alpha_0 + \alpha_1 \ln\left(\frac{GDP}{POP}\right)_{it} + \alpha_2 \ln\left(\frac{NI}{ATA}\right)_{it} + \varepsilon_{it}, \qquad (2.1)$$
$$i = 1,\ldots,13, \quad t = 1980 - 1994$$

where B is 'imputed bank service charge', GDP is nominal gross domestic product, POP is population, NI is total net interest income of banks, and ATA is the average (of year-start and year-end) for banks' total assets. ε represents the error term. Hence equation (2.1) relates the GDP share of the monetary value of banks' service production, B, to the income per capita and to an independent accounting-based measure of the average interest margin (NI/ATA).[41]

The '*income elasticity'* with respect to per capita income growth, ε_I, is defined as $\dfrac{d\ln\left(\frac{B}{POP}\right)}{d\ln\left(\frac{GDP}{POP}\right)}$, which equals $1 + \alpha_1$.[42] The absolute value of the *price elasticity* can be approximated as $1 - \alpha_2$.[43]

(2.1) is estimated by exploiting both cross-sectional and time series information. In the former case the effect of income

[41] (NI/ATA) is an indirect measure of the contractual margin charged by banks. (NI/ATA) is used instead of (B/ATA), since it is a cleaner and independent measure of the price of intermediation services.

[42] Write $\ln\left(\frac{B}{POP}\right)$ as $\ln\left(\frac{B}{POP}\cdot\frac{GDP}{GDP}\right) = \ln\left(\frac{B}{GDP}\right) + \ln\left(\frac{GDP}{POP}\right)$, and divide by $\ln\left(\frac{GDP}{POP}\right)$.

[43] $\alpha_2 = \left(\dfrac{d\ln(B)}{d\ln\left(\frac{NI}{ATA}\right)}\right)$ (expressing the left-hand side of (2.1) as ln(B) – ln(GDP)) equals 1 minus the absolute value of the *price elasticity*, ε_P, since B can be written as $\left(\frac{NI}{ATA}\cdot ATA\right)$, where ATA represents the volume of intermediation.

development on the demand for banking services is inferred from the different income levels in different countries, and in the latter case from the changes over time in income levels in individual countries. The estimation results are reported in table 2.2a for pooled yearly cross-sections (panel 1) over the five-year periods 1980–1984, 1985–1989, 1990–1994; and in table 2.2b for time series cross-sections (panel 2) over the period 1980–1994.[44]

Table 2.2a **Pooled cross-section (panel 1) OLS-estimation results of equation (2.1); dependent variable: 'imputed bank service charge' per GDP (ln(B/GDP))**

	1980–1984	1985–1989	1990–1994
α_0	–1.44	0.09	2.12**
	(0.81)	(0.52)	(0.77)
α_1	–0.20**	–0.23**	–0.42**
	(0.064)	(0.061)	(0.083)
α_2	0.01	0.30**	0.33**
	(0.13)	(0.089)	(0.090)
income elasticity, ε_I $(1+\alpha_1)$	0.80**	0.77**	0.58**
absolute price elasticity, ε_P $(1-\alpha_2)$	0.99	0.70**	0.68**
R-squared	0.17	0.45	0.49
Number of observations	60	60	60

[44] Panel 1 consists of pooled annual cross-sections, and the estimation is based on cross-country differences smoothed over the respective time periods. Panel 2 has the country-specific time series put together and the estimation smoothes the time series information from each country across countries, generating average income and price elasticities for the countries included in the sample.

Table 2.2b **Time series cross-section (panel 2) OLS-estimation results of equation (2.1); dependent variable: 'imputed bank service charge' per GDP (ln(B/GDP))**

	1980–1994
α_0	–0.69
	(0.39)
α_1	–0.16**
	(0.040)
α_2	0.28**
	(0.063)
income elasticity, ε_I $(1+\alpha_1)$	0.84**
absolute price elasticity, ε_P $(1-\alpha_2)$	0.72**
R-squared	0.22
Number of observations	180

Data sources (tables 2.2.a and b): OECD, National Accounts; OECD, Bank Profitability Statistics.

Notes (tables 2.2.a and b): Countries included in yearly cross-sections: Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom.

Net interest income and bank balance sheet data: Denmark: commercial and savings banks; Portugal: commercial banks; United Kingdom: commercial banks; other countries: all banks.

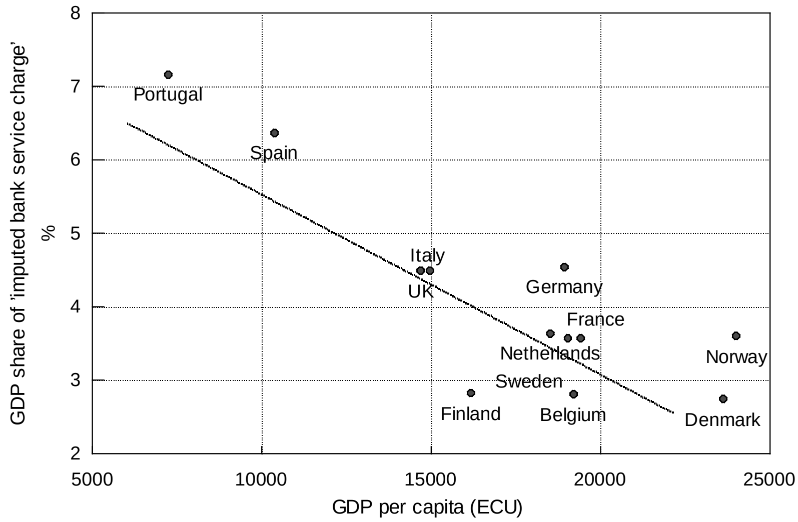
** Significant at 1% level. Standard errors in parentheses.

First, the estimated income elasticity is always less than one, regardless of the mode of estimation and panels 1 and 2 produce quite similar results. The use of panels generates significant and more reliable estimates than the single cross-sections, because the sample size is larger. The estimate being less than one suggests that the traditional intermediation services are not luxury goods and have a decreasing share in gross expenditures.[45] Secondly, the cross-sectional estimations (panel 1) indicate that the income elasticity is falling over time. This represents a trend-like deterioration of demand for traditional banking with respect to economic growth. Figure 2.1 presents the relation between per capita incomes and the GDP shares of the imputed bank service changes for 1994, and shows a significant negative correlation in the cross-country comparison.

[45] The estimates of income elasticity remain less than one even if Spain and Portugal are excluded from the sample.

The absolute price elasticity estimates are positive, as expected, and correspond to the low values typically obtained in industry-level studies (Vesala 1995b, ch. 5). The industry-level elasticity may differ from the perceived elasticity of the individual banks and hence does not constitute a measure of imperfect competition in the banking industry.

Figure 2.1 **Relation between per capita income and 'imputed bank service charge', 1994**



Data source: OECD, National Accounts.
Note: t-statistics for the slope coefficient 5.06.

One might predict that banks will have to adjust to slower demand growth in their traditional operations than that in the other sectors of the economy. One important reason for this seems to be that the demand for higher yielding and more sophisticated investment products than ordinary bank deposits grows with peoples' income. For banks, this means more pressure on performance, tightening competitive conditions and increasing importance of efficient operations and productivity growth.

Furthermore, the adverse demand trend could foster the structural change in banking from production of traditional financial intermediation services towards securities trading, capital market funding, asset management and other activities that offer better growth prospects. The importance of these activities has already significantly increased. Banks have, for example, securitized loans by selling them off in packages (eg Berger and Udell 1992), supported lending indirectly by providing back-up credit lines, increased underwriting of the securities issued by firms and offered increasingly complex investment products for private individuals, such as various mutual funds.

In the United States, these developments have proceeded farther than in Europe. There, even the securitization of small-business loans has already started (Crane and Bodie 1996). Smaller value corporate loans can be even more difficult to securitize than mortgages, because they represent very heterogeneous assets and require close credit risk evaluation and monitoring. Europe is expected to catch up with the United States, since the introduction of the Single Currency will increase the liquidity of the capital markets and hence lower the cost of capital market funding.[46] Nevertheless, banks' traditional on-balance sheet intermediation will probably remain strong in Europe, at least in the foreseeable future. The share of intermediated assets in total financial assets has been often substantial compared with the United States (table 2.3). In addition, the role of banks among financial intermediaries is generally quite strong in Europe. The use of capital market funding is reducing the share of banks in financing of the corporate sector, but this concerns only large corporate borrowers with access to domestic and global capital markets. Banks have a central position everywhere in the provision of external credit and liquidity to small and medium sized companies and households (eg Petersen and Rajan 1994), since these borrowers face overwhelming information and contracting costs associated with capital market transactions.

[46] According to the April 2000 Monthly Bulletin of the European Central Bank, bond issues by private sector corporations doubled during 1999, which reflects the favourable impact of the euro on the area's private capital markets.

Table 2.3 **Financial intermediation in selected European countries and the United States**

	Financial intermediation ratio		Bank intermediation ratio	
	1983	1993	1983	1993
Finland	0.50	0.52	0.67	0.64
France	0.49	0.39	0.92	0.75
Germany	0.49	0.52	0.87	0.84
Italy	0.42	0.37	0.78	0.63
Spain	0.43	0.49	0.87	0.77
Sweden	0.48	0.52	0.47	0.35
United States	0.38	0.45	0.46	0.29

Data source: OECD, Financial Accounts of OECD Countries.

Notes: *Financial intermediation ratio* is the ratio of the combined assets of all financial institutions to total financial assets (degree of institutionalized intermediation in the financial process).

Bank intermediation ratio is the share of banks, including all deposit taking credit institutions, in the total assets of financial institutions. Outstanding stocks of financial assets are used to construct both indicators.

These structural changes increase the importance of banks' fee income, reduce that of their net interest income, and increase the share of activity that is conducted off the balance sheet. Banks can replace some of their income losses from intermediation by providing investment banking and asset management services. If these changes are taken into account one might not reach the same conclusion as in the above analysis based on traditional intermediation, which is that banks' activity is in decline relative to economic development.[47] Moreover, new statistical measures are used to better gauge banks' role in the economy.

[47] Boyd and Gertler (1994) argue that, if one takes into account the shift toward fee-earning businesses, banking will be viewed as an industry able to alter its operations in line with changes in financial markets and to maintain its growth in step with other industries. This contrasts with the view that banking is a passive 'sunset' industry.

2.2.2 Analysis based on bank profitability statistics

In this section, data from OECD Bank Profitability Statistics[48] are used to analyse banks' margins. The most commonly employed volume indicator is the balance sheet total (BST) when calculating margins as ratios of income to business volume. However, its use causes systematic bias in international comparisons, since banks' business mixes vary significantly across countries. These differences are apparent in the differences in bank asset structures (table 2.4). For example, the share of interbank assets varies from over 30 per cent in France and Belgium to only 6 per cent in Finland and Norway. Interbank assets generate little revenue compared to other higher-yield assets and do not represent financial intermediation carried out by banks vis-à-vis the rest of the economy. To correct this bias, an alternative volume indicator, adjusted balance sheet total (ABST), is constructed by subtracting from the BST the amount of outstanding interbank assets and assets held with central banks.[49]

Although the ratios using ABST are preferable for analytical purposes, all ratios are also given in terms of BST in order to facilitate comparisons with other studies and data sources. In order to highlight longer-term trends and smooth out annual (cyclical) variation, average values for 1980–1984, 1985–1989 and 1990–1995 are reported. Although the data seem fairly reliable and consistent across countries, one would still view the indicated trends for individual countries with more confidence than the cross-country comparisons.

The abolition of conduct regulations seems to have significantly narrowed banks' *intermediation margins,* calculated as net interest income per ABST (table 2.5a). The intermediation margins for the early 1990s are, in most countries, significantly smaller than those for the early 1980s. The most substantial reduction took place in France. Only Portugal, Denmark and Sweden diverged from the trend.[50] Countries, where conduct regulations were less stringent (Germany, Switzerland, the Netherlands) generally experienced less narrowing of margins, which supports the pro-competitive effect of liberalization.

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[48] These data cover quite satisfactorily the entire banking system in each country, except for the United Kingdom, as building societies are excluded.

[49] De Boissieu (1993) used this correction in examining the profitability of French banks via international comparisons in the early 1980s.

[50] In Denmark and Sweden banks' margins apparently widened at the time of the dire banking problems in the early 1990s. This helped banks to recover from their asset quality problems. Portugal appears again as the most significant outlier.

Table 2.4 **Banks' balance sheet structure: average ratios, per cent**

	Total loans /BST			Securities held as current and investment assets / BST			Interbank and central bank assets /BST			Nonbank deposits / BST			Annual asset growth		
	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995
Belgium	34	27	34	23	28	29	39	40	32	32	31	34	19	8	6
Denmark	39	41	47	24	23	24	18	18	22	54	48	53	20	13	–1
Finland	67	63	57	7	12	20	8	8	6	69	58	52	20	21	–2
France	43	37	40	3	7	13	44	46	39	36	33	25	17	11	3
Germany	60	56	55	14	15	18	24	25	24	54	54	50	7	8	11
Italy	27	30	44	24	19	15	15	19	12	55	51	40	18	10	8
Netherlands	57	55	63	7	10	12	31	28	23	47	50	45	8	13	7
Norway	62	72	78	30	18	12	7	6	5	76	58	68	18	15	4
Portugal	62	46	37	6	12	23	14	22	29	76	76	60	28	18	22
Spain	52	43	45	15	23	19	18	22	21	72	66	58	20	12	11
Sweden	52	55	53	27	18	27	15	18	14	61	52	50	14	14	–1
Switzerland	56	57	63	11	11	12	27	26	19	53	51	50	10	7	5
United Kingdom	57	60	57	6	7	13	28	21	16	Na	Na	Na	21	14	17
Simple average	*51*	*49*	*52*	*15*	*16*	*18*	*22*	*23*	*20*	*57*	*52*	*49*	*17*	*13*	*7*

Data source: OECD, Bank Profitability Statistics.

Notes: BST = balance sheet total. Denmark: commercial and savings banks; Portugal: commercial banks; United Kingdom: commercial banks; other countries: all banks.

Table 2.5a **Banks' income structure: average ratios, per cent of adjusted balance sheet total (ABST)**

	Net interest income (intermediation margin)			Net noninterest income			Net banking income (overall gross margin)			Net noninterest income / net interest income (%)		
	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995
Belgium	2.8	2.7	2.0	0.6	0.8	0.6	3.5	3.5	2.6	22	30	31
Denmark	3.8	3.0	4.3	2.7	1.4	0.5	6.5	4.4	4.8	72	47	13
Finland	2.4	1.9	1.9	1.6	1.7	1.4	4.0	3.6	3.3	66	88	73
France	4.5	4.2	2.4	0.8	0.8	1.3	5.3	4.9	3.7	18	18	55
Germany	2.9	2.9	2.6	0.7	0.8	0.8	3.6	3.6	3.3	23	27	30
Italy	3.4	3.7	3.2	1.3	1.4	0.9	4.7	5.2	4.1	38	39	29
Netherlands	3.2	3.0	2.3	1.0	1.1	1.0	4.2	4.1	3.3	32	36	44
Norway	3.9	3.4	3.6	1.0	1.1	1.1	4.9	4.5	4.6	26	33	30
Portugal	2.4	3.9	4.7	1.3	0.9	1.3	3.7	4.7	6.0	55	23	28
Spain	4.8	4.9	4.1	0.8	1.0	1.1	5.6	5.9	5.2	17	20	26
Sweden	2.6	3.3	3.1	0.9	1.3	2.0	3.6	4.6	5.1	35	39	65
Switzerland	1.7	1.8	1.8	1.5	1.8	1.9	3.2	3.6	3.7	87	100	106
United Kingdom	4.3	3.8	3.3	2.0	2.2	2.4	6.3	6.0	5.7	47	57	73
Simple average	*3.3*	*3.3*	*3.0*	*1.2*	*1.3*	*1.3*	*4.5*	*4.5*	*4.3*	*41.4*	*42.8*	*46.4*

Data source: OECD, Bank Profitability Statistics.

Notes: ABST = balance sheet total – interbank and central bank assets. Sweden: 1990–1994 instead of 1990–1995.

Denmark: commercial and savings banks; Portugal: commercial banks; United Kingdom: commercial banks; other countries: all banks.

Table 2.5b **Banks' income structure: average ratios, per cent of balance sheet total (BST)**

	Net interest income (intermediation margin)			Net noninterest income			Net banking income (overall gross margin)		
	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995
Belgium	1.7	1.6	1.4	0.4	0.5	0.4	2.1	2.1	1.8
Denmark	3.1	2.5	3.3	2.2	1.1	0.4	5.3	3.6	3.7
Finland	2.2	1.7	1.8	1.4	1.5	1.3	3.6	3.2	3.1
France	2.5	2.3	1.5	0.5	0.4	0.8	3.0	2.7	2.2
Germany	2.3	2.1	1.9	0.5	0.6	0.6	2.8	2.7	2.5
Italy	2.9	3.0	2.8	1.1	1.2	0.8	4.0	4.2	3.6
Netherlands	2.2	2.2	1.7	0.7	0.8	0.8	2.9	3.0	2.5
Norway	3.6	3.1	3.4	0.9	1.1	1.0	4.6	4.2	4.4
Portugal	2.0	3.0	3.4	1.1	0.7	0.9	3.1	3.7	4.3
Spain	3.9	3.8	3.2	0.7	0.8	0.8	4.6	4.6	4.1
Sweden	2.2	2.7	2.7	0.8	1.0	1.7	3.0	3.7	4.4
Switzerland	1.2	1.3	1.5	1.1	1.3	1.6	2.3	2.6	3.0
United Kingdom	3.1	3.0	2.7	1.4	1.7	2.0	4.5	4.8	4.8
Simple average	*2.5*	*2.5*	*2.4*	*1.0*	*1.0*	*1.0*	*3.5*	*3.5*	*3.4*

Data source: OECD, Bank Profitability Statistics.

Notes: Sweden: 1990–1994 instead of 1990–1995. Denmark: commercial and savings banks; Portugal: commercial banks; United Kingdom: commercial banks; other countries: all banks.

Moreover, reductions in intermediation margins constitute evidence in favour of so-called *regulatory* capture (Neven 1993) whereby regulation shields banks' margins above the level that would prevail in effective price competition. The persistence of old margins in the liberalized environment would suggest that banks have been able to replace regulatory protection by (explicit or tacit) collusive arrangements limiting the degree of price competition, or that rate regulations were not, in fact, binding.

However, other factors have also contributed to the narrowing of the intermediation margins. First, in order to facilitate credit expansion, banks have generally been forced to seek supplementary sources of funds in addition to traditional deposit funding. The share of nonbank deposits in banks' liabilities has decreased trend-wise in most countries (table 2.4). This shift from deposits toward purchased funds has the effect of increasing banks' cost of funds and hence narrowing their intermediation margins when BST is used as preference. There is a negative cross-country correlation between changes in the share of nonbank deposits and changes in intermediation margins from 1980–1985 to 1990–1995 also when ABST is used, but this correlation is not significant.

Secondly, the level and term-structure of interest rates exerts a significant impact on intermediation margins. In the 1980s, market interest rates declined gradually in most countries until 1988, in association with the disinflation process. A positive *re-pricing gap* between banks' assets and liabilities, which develops when the average yield on loans increases more than the average cost on deposits as market interest rates rise, is claimed to have characterized most European banking systems (Neven 1993, de Boissieu 1993). Hence falling market interest rates would have contributed to the fall in intermediation margins. Similarly, a part of the decline in margins in the mid-1990s could be explained by the fall in market interest rates.

In the early 1980s, intermediation margins were wider in France, Italy and Spain than in most other European countries. In these countries, also inflation and market interest rates were significantly higher than elsewhere and an *inflation rent* was apparently accruing to banks in addition to the rent resulting from the regulatory protection. In the late 1980s and early 1990s, market interest rates started to climb and, in some countries, banks' margins indeed widened to some extent, suggesting the persistence of the positive re-pricing gap, but the margins generally remained at a significantly lower level than in the early 1980s. This is likely due to increased price competition. The

Table 2.6 **Money market interest rates**

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Belgium	11.2	11.5	11.4	8.2	9.5	8.3	6.6	5.7	5.0	7.0	8.3	9.4	9.4	8.2	5.7	4.8
Denmark	16.9	14.8	16.9	12.8	11.8	10.3	9.2	10.2	8.5	9.7	11.0	9.8	11.4	11.5	6.3	6.2
Finland	12.4	11.5	11.7	14.7	16.5	13.5	11.9	10.0	10.0	12.6	14.0	13.1	13.3	7.8	5.4	5.8
France	11.9	15.3	14.9	12.5	11.7	9.9	7.7	8.0	7.5	9.1	9.9	9.5	10.4	8.8	5.7	6.4
Germany	9.1	11.3	8.7	5.4	5.5	5.2	4.6	3.7	4.0	6.6	7.9	8.8	9.4	7.5	5.3	4.5
Italy	17.2	19.6	20.2	18.4	17.3	15.3	13.4	11.5	11.3	12.7	12.4	12.2	14.0	10.2	8.5	10.5
Netherlands	10.1	11.0	8.1	5.3	5.8	6.3	5.8	5.2	4.5	7.0	8.3	9.0	9.3	7.1	5.1	4.2
Norway	Na	Na	15.4	13.3	13.0	12.5	14.4	14.7	13.5	11.4	11.5	10.6	11.8	7.3	5.9	5.5
Portugal	9.9	9.2	12.4	18.2	21.3	20.2	14.5	13.7	12.3	12.8	13.7	15.8	17.5	13.3	10.6	8.9
Spain	15.5	16.6	17.2	19.4	12.6	11.6	11.5	16.1	11.3	14.4	14.8	13.2	13.0	Na	Na	Na
Sweden	12.2	14.4	13.3	10.9	11.8	13.9	10.2	9.2	10.1	11.5	13.5	11.8	18.4	9.1	7.4	8.5
Switzerland	2.3	2.9	1.3	1.8	3.3	3.8	3.2	2.5	2.2	6.5	8.3	7.7	7.5	4.9	3.9	2.9
United Kingdom	15.6	13.1	11.4	9.1	7.6	10.8	10.7	9.7	10.3	13.9	14.7	11.7	9.6	5.5	4.8	6.0
Simple average	*12.0*	*12.6*	*12.5*	*11.5*	*11.4*	*10.9*	*9.5*	*9.2*	*8.5*	*10.4*	*11.4*	*11.0*	*11.9*	*8.4*	*6.2*	*6.2*

Data source: IMF, International Financial Statistics.

stickiness of loan and deposit rates vs money market rates will be more closely examined in chapter 3.

Finally, rapid increases in nonperforming loans that do not generate interest income but remain on the balance sheet affect the intermediation margin as defined here. This concerns mainly Denmark, Finland, Norway, and Sweden, where banks' nonperforming loans mounted in the early 1990s. In these countries, by contrast, a fall in the level of market interest rates after 1992 probably enhanced banks' interest income because of the improved debt servicing capacity of banks' customers.

In sum, the qualifications do not seem to be powerful enough to alter the basic conclusion of generally increased price competition since liberalization. Moreover, abstracting from annual variation, this seems to be a trend-like phenomenon. European Central Bank (2000) provides unique evidence based on newly established interest rate data and indicates a further trend-like tightening of competition in the European banking systems in the late 1990s.

2.2.3 Other features of bank profitability development

Banks' income composition differs significantly across countries (table 2.5a). While net noninterest income has risen relative to net interest income in most countries, the rise has not generally been strong enough with respect to asset growth to offset the fall in intermediation margins, and banks' *overall gross margins* have also trended downward. The growth in the share of noninterest income reflects the tendency to convert balance sheet assets to off-balance sheet items and the trend toward fee-oriented banking. Judging by the income structures, this process has advanced at quite different speeds in different countries.

Staff expenses per ABST have been on a clear downward trend and there has been a notable fall in the ratio of staff expenses to total operating expenses in all the countries (table 2.7a). This reflects technological change and reorganization of the production and delivery of banking services, which has increased the use of nonstaff inputs and reduced that of the labour input. In Finland, Norway and Sweden the relative importance of staff expenses has declined faster than in the other countries, indicating more active substitution of new banking technologies for labour.

The instalment of new technologies seems to have generally maintained the level of the nonstaff operating expenses in the late 1980s, but a simultaneous reduction in the staff expenses has produced a decline in total operating expenses per ABST. In the early 1990s, the increase in relative nonstaff operating expenses generally came to a halt. This reflects, in many countries, maturing – and even declining – branch networks and instalment of more cost efficient information and payment technology (see the next section).

The ratio of total operating expenses to ABST represents a measure of *productive* (or operating) *efficiency* as it relates the costs of service production to a proxy for production volume. Based on this figure, efficiency has improved in all but three countries (Portugal, Sweden and Switzerland) since the early 1980s.

The degree of productive efficiency is related to competitive pressures in the banking industry, as well as to banks' delivery capacity strategies and use of other productive resources. In countries where conduct regulations have been least stringent – Germany, the Netherlands and Switzerland – this measure of productive efficiency has been historically high by international standards. Thus regulation seems to protect inefficient operation and to affect banks' competitive strategies in a way that has an impact on their efficiency. This is in line with the predictions of the spatial model presented in chapter 1, ie that rate regulation generates excessive delivery networks and produces inefficiencies compared to freely operating competitive markets.[51]

A catch-up effect can be observed, as countries like Finland, France, Italy and Spain, which previously had strict conduct rules, have witnessed bigger improvements in efficiency than the above countries with traditionally freer banking conditions. It is impossible to say which part of this convergence can be explained by the external competition generated by the Single Market.

Net income per total operating expenses, including depreciation allowances characterizes banks' *underlying profitability* (table 2.8). Provisions for credit losses and other value adjustments are excluded, since normal or expected credit losses should be accounted for by appropriate risk premiums within the intermediation margins. One cannot observe a secular deterioration in banks' underlying profitability, although intermediation margins have narrowed. Increases in noninterest income and/or savings in operating costs seem to have restored profitability.

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[51] Based on Berger's and Humphrey's (1995) literature review, productive efficiency is found to vary substantially across banks within national industries. Thus individual banks may receive good efficiency ratings in international comparisons even if the efficiency of the entire industry appears to be low.

Table 2.7a **Banks' cost structure: average ratios, per cent of adjusted balance sheet total (ABST)**

	Staff expenses			Nonstaff operating expenses			Total operating expenses			Staff expenses / total operating expenses (%)		
	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995
Belgium	1.7	1.5	1.1	0.8	0.8	0.7	2.5	2.3	1.8	69	65	60
Denmark	2.2	1.6	1.8	1.2	0.9	1.2	3.4	2.5	3.0	66	63	60
Finland*	2.0	1.5	1.1	1.7	1.6	1.3	3.7	3.1	2.4	54	49	45
France	2.4	2.1	1.4	1.2	1.2	1.1	3.6	3.3	2.5	67	63	55
Germany	1.5	1.5	1.3	0.7	0.8	0.8	2.2	2.3	2.1	67	64	62
Italy	2.2	2.4	1.7	0.8	0.9	0.9	3.0	3.3	2.7	73	72	65
Netherlands	1.8	1.6	1.2	0.9	1.1	1.0	2.7	2.7	2.2	66	60	56
Norway	1.9	1.5	1.4	1.5	1.6	1.7	3.4	3.1	3.1	56	48	46
Portugal	1.6	1.8	1.8	0.6	0.9	1.3	2.2	2.7	3.1	72	68	57
Spain	2.5	2.5	1.9	1.2	1.2	1.2	3.8	3.8	3.1	67	67	62
Sweden*	1.1	1.2	Na	1.0	1.3	Na	2.1	2.5	2.8	52	47	Na
Switzerland	1.2	1.3	1.3	0.6	0.7	0.7	1.8	2.0	2.0	68	66	64
United Kingdom	2.8	2.3	2.1	1.6	1.6	1.7	4.4	3.9	3.8	64	59	55
Simple average	*1.9*	*1.8*	*1.5*	*1.1*	*1.1*	*1.1*	*3.0*	*2.9*	*2.7*	*64.7*	*60.8*	*57.3*

Data sources: OECD, Bank Profitability Statistics; Bank of Finland; Statistics Finland; Sveriges Riksbank.
Notes: ABST = balance sheet total – interbank and central bank assets. *OECD statistics corrected in line with other countries (credit losses removed from operating expenses). Sweden: 1990–1994 instead of 1990–1995. Denmark: commercial and savings banks; Portugal: commercial banks; United Kingdom: commercial banks; other countries: all banks.

Table 2.7b **Banks' cost structure: average ratios, per cent of balance sheet total (BST)**

	Staff expenses			Nonstaff operating expenses			Total operating expenses		
	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995
Belgium	1.1	0.9	0.7	0.5	0.5	0.5	1.6	1.4	1.3
Denmark	1.9	1.3	1.4	1.0	0.8	0.9	2.8	2.1	2.4
Finland*	1.8	1.4	1.0	1.6	1.5	1.3	3.4	2.9	2.3
France	1.3	1.1	0.8	0.7	0.7	0.7	2.0	1.8	1.5
Germany	1.1	1.1	1.0	0.6	0.6	0.6	1.7	1.7	1.6
Italy	1.9	1.9	1.5	0.7	0.8	0.8	2.6	2.7	2.4
Netherlands	1.2	1.2	1.0	0.6	0.8	0.8	1.8	1.9	1.7
Norway	1.8	1.4	1.3	1.4	1.5	1.6	3.2	2.9	2.9
Portugal	1.4	1.4	1.3	0.5	0.7	0.9	1.9	2.1	2.2
Spain	2.1	2.0	1.5	1.0	1.0	0.9	3.1	3.0	2.5
Sweden*	0.9	1.0	Na	0.8	1.1	Na	1.7	2.1	2.4
Switzerland	0.9	0.9	1.0	0.4	0.5	0.6	1.3	1.4	1.6
United Kingdom	2.0	1.8	1.7	1.1	1.3	1.4	3.2	3.1	3.1
Simple average	*1.5*	*1.3*	*1.2*	*0.8*	*0.9*	*0.9*	*2.3*	*2.2*	*2.1*

Data sources: OECD, Bank Profitability Statistics; Bank of Finland; Statistics Finland; Sveriges Riksbank.
Notes: *OECD statistics corrected in line with other countries (credit losses removed from operating expenses).
Sweden: 1990–1994 instead of 1990–1995. Denmark: commercial and savings banks; Portugal: commercial banks; United Kingdom: commercial banks; other countries: all banks.

Table 2.8 **Banks' profitability: average ratios, per cent**

	Operating income / ABST (operating margin)			Operating income / BST (operating margin)			Net banking income / total operating expenses			Profit before tax / ABST			Profit before tax /BST		
	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995	1980–1984	1985–1989	1990–1995
Belgium	0.9	1.2	0.8	0.6	0.7	0.5	1.4	1.5	1.4	0.5	0.6	0.4	0.3	0.4	0.3
Denmark	3.1	1.9	1.7	2.5	1.5	1.3	1.9	1.8	1.6	1.8	1.0	0.1	1.5	0.8	0.0
Finland*	0.8	1.0	0.9	0.8	0.9	0.8	1.2	1.3	1.4	0.3	0.4	–1.1	0.3	0.4	–1.0
France	1.7	1.6	1.2	1.0	0.9	0.7	1.5	1.5	1.5	0.7	0.6	0.3	0.4	0.3	0.2
Germany	1.4	1.3	1.2	1.1	1.0	0.9	1.6	1.6	1.6	0.7	1.1	0.7	0.6	0.9	0.6
Italy	1.7	1.8	1.4	1.4	1.5	1.3	1.6	1.6	1.5	0.6	0.9	0.7	0.4	0.7	0.6
Netherlands	1.5	1.4	1.0	1.0	1.0	0.8	1.6	1.5	1.5	0.6	0.9	0.8	0.4	0.7	0.6
Norway	1.5	1.4	1.6	1.4	1.3	1.5	1.4	1.5	1.5	0.9	0.3	0.0	0.8	0.2	0.0
Portugal	1.5	2.1	2.9	1.3	1.6	2.0	1.6	1.8	1.9	0.6	0.7	1.4	0.5	0.6	1.0
Spain	1.9	2.1	2.1	1.5	1.7	1.6	1.5	1.6	1.7	0.6	0.7	1.1	0.5	0.6	0.9
Sweden*	1.5	2.0	2.3	1.3	1.7	2.0	1.7	1.8	1.8	0.3	1.1	Na	0.3	0.9	Na
Switzerland	1.4	1.6	1.7	1.0	1.2	1.4	1.8	1.8	1.9	0.9	0.9	0.7	0.6	0.7	0.6
United Kingdom	1.9	2.1	1.9	1.4	1.7	1.6	1.4	1.5	1.5	1.2	1.0	1.0	0.9	0.8	0.9
Simple average	*1.6*	*1.7*	*1.6*	*1.3*	*1.3*	*1.3*	*1.6*	*1.6*	*1.6*	*0.7*	*0.8*	*0.5*	*0.6*	*0.6*	*0.4*

Data sources: OECD, Bank Profitability Statistics; Bank of Finland; Statistics Finland; Sveriges Riksbank.

Notes: BST = balance sheet total. ABST = adjusted balance sheet total = balance sheet total – interbank and central bank assets. Operating income = net banking income – total operating expenses. Profit before tax = operating income – provisions (net).

*OECD statistics corrected in line with other countries (credit losses removed from operating expenses). Sweden: 1990–1994 instead of 1990–1995. Denmark: commercial and savings banks; Portugal: commercial banks; United Kingdom: commercial banks; other countries: all banks.

As the total banking income of Finnish banks has been low by inter-country comparison, the relatively high operating costs have historically resulted in weak underlying profitability. This has recently changed, as the significant restructuring of the Finnish banking industry has generated significant cost savings.

2.3 Technological change and reorganization of delivery in banking

The key feature of the ongoing reorganization of banking delivery methods is that clients are increasingly serviced through automated means without *face-to-face* contact with bank personnel at a branch office. Any displacement of services traditionally provided at branches is called *remote banking*, which refers to the following distribution channels:

– *cash dispensers (ATMs),* which can be only used for cash withdrawals and account enquiries,
– *(multi-purpose) payment ATMs,* which can be used for payment transfers and other account transactions, not just for cash withdrawals,
– *phone banking* (sometimes called *direct banking*) where voice communication with the supplier of services is done over the telephone to execute banking transactions and obtain information,
– *PC banking* where data-messages to execute banking transactions are sent to the supplier of services via the telephone network with the help of some, usually supplier-specific, software, or via the Internet with the help of software available on the Internet.

The first two forms of remote banking, involving ATMs, are distinct from the latter two. Namely, ATMs constitute a proprietary delivery channel for banks, as do branches, which makes them fundamentally different from the telephone networks and Internet, which are not owned by banks and are principally open to all firms that wish to enter the market. Moreover, when obtaining phone or PC banking services, customers are not at all constrained by the location of banks' service outlets. Henceforth, phone and PC banking are called *remote access,* to distinguish from ATM and branch-based services that are still tied to the location of banks' service outlets.

The major emphasis was initially on ATM and phone-based services, while PC banking has started to develop more recently.

However, banks seem to be currently adjusting their technology investments on a larger scale particularly toward Internet applications for transactions, and not just for information purposes. At present, standardized products and low-margin businesses are considered most suitable for promotion via the Internet, but in the future the degree of sophistication of the services offered via the Internet should increase.

In what follows, the earlier developments related to the diffusion of ATM networks are examined, after which more recent phenomena related to the expansion of phone and PC banking are discussed.

2.3.1 Substitution of ATMs for branches

The rapid expansion of banks' ATM networks over the second half of the 1980s constitutes a major change in the delivery of payment and other deposit-related services. ATMs provide many of the most often demanded services, namely cash withdrawals and account enquiries (cash dispensers), and increasingly transfers and payments between deposit accounts (payment ATMs). The latter type of more 'intelligent' multi-purpose ATMs started to emerge in the late 1980 and have since increased their share in the total number of machines and transactions, although cash dispensers still dominate by both measures. The range of services offered through ATMs is constantly expanding with, however, significant differences across countries. Extra services include cheque dispensing, withdrawal of foreign currencies, information on services and financial market events, and loading electronic cash (e-cash) on a chip card. In the United States, even the first automated loan machines have been installed. These offer automated credit, based on entered personal and financial information. Also the sale of nonbanking products, like travel insurance, is fairly commonplace.

Tables 2.9 and 2.10 depict banks' branch and ATM capacities in selected European countries. Population served represents a measure of service proximity through these 'physical' delivery outlets. The statistics exclude postal banking institutions, since services provided by them differ importantly across countries. Payment system surveys of the Bank for International Settlement (1993, 1994, 1998) and European Monetary Institute (1996) are used as the primary data sources.

Table 2. 9 **Banks' branch networks (excluding post offices and postal giros)**

	Number of branches per 10000 inhabitants						
	1983	1989	1991	1992	1993	1994	1995
Belgium	7.7	Na	Na	7.3	Na	7.8	7.6
Denmark	7.1	6.2	5.1	4.8	4.5	4.3	4.2
Finland	7.2	7.1	6.2	5.6	4.3	3.6	3.2
France	3.9	4.5	4.5	4.4	4.4	4.4	4.4
Germany	6.5	7.1	6.1	6.2	5.6	6.0	6.3
Italy	2.3	2.7	3.3	3.6	3.8	4.0	4.1
Netherlands	3.0	3.7	3.7	3.4	3.2	3.2	2.8
Norway	4.8	4.4	4.2	3.8	3.6	3.6	3.6
Portugal	1.4	1.8	2.6	2.7	3.0	3.2	3.5
Spain	8.1	8.9	9.0	9.1	9.0	9.1	9.2
Sweden	4.3	3.9	3.6	3.4	3.3	3.1	4.4
Switzerland	7.8	6.2	6.2	6.0	5.8	5.4	5.3
United Kingdom	2.9	2.3	2.3	2.3	2.3	2.2	2.1
Simple average	*5.2*	*4.9*	*4.7*	*4.8*	*4.4*	*4.6*	*4.7*

Data sources: BIS's and EMI's Payment System statistics (various issues); Bank of Finland; Finnish Bankers' Association. Belgium: Commercial and saving banks.

Table 2.10 **Banks' ATM networks (both cash dispensing and payment ATMs)**

	Number of ATMs per 10000 inhabitants									ATM/branch ratio		
	1983	1989	1991	1992	1993	1994	1995	1996	1997	1983	1992	1995
Belgium	0.6	0.9	1.1	1.1	2.8	3.1	3.6	4.1	4.9	0.1	0.2	0.5
Denmark	0.5	Na	0.7	1.0	1.1	1.4	2.1	2.4	2.5	0.1	0.2	0.5
Finland	0.8	5.5	7.2	7.5	8.3	8.4	9.0			0.1	1.3	2.8
France	0.9	2.3	2.8	3.0	3.2	3.6	3.9	4.2	4.6	0.2	0.7	0.9
Germany	0.3	1.1	1.8	2.4	3.1	3.6	4.4	4.6	5.1	0.0	0.4	0.7
Italy	0.3	1.4	2.0	2.4	2.6	3.2	3.8	4.2	4.2	0.1	0.7	0.9
Netherlands	0.0	1.2	2.2	2.6	2.9	3.2	3.6	3.7	4.1	0.0	0.8	1.3
Norway	0.8	4.2	4.1	4.0	3.8	3.9	3.9			0.2	1.1	1.1
Portugal	Na	0.5	1.3	2.0	2.8	3.4	3.7	5.4	6.3	Na	0.7	1.1
Spain	Na	2.9	4.4	5.1	5.6	6.0	6.8	7.6	8.6	Na	0.6	0.7
Sweden	1.4	2.3	2.6	2.5	2.6	2.6	2.7	2.7	2.7	0.3	0.8	0.6
Switzerland	Na	3.0	3.5	3.9	4.4	4.8	5.3			Na	0.6	1.0
United Kingdom	1.0	2.7	3.1	3.2	3.3	3.4	3.6	3.8	3.9	0.3	1.0	1.7
Simple average	*0.7*	*2.3*	*2.8*	*3.1*	*3.6*	*3.9*	*4.3*			*0.1*	*0.7*	*1.1*

Data sources: BIS's and EMI's Payment System statistics (various issues); Bank of Finland; Finnish Bankers' Association.

Significant substitution of ATMs for branches seems to have taken place in all the banking systems under study, as indicated by the ratio of the number of ATMs to branches. The United Kingdom, and especially Finland, have made significant progress in the substitution process, while in Belgium, Denmark and Germany the role of branches has remained strong. ATM expansion seems to have advanced the furthest in Finland, Norway and Sweden, as growth has stopped or the number of machines has started to fall.

Overall, the ATM network density increased by a factor of ten between 1983 and 1994, while the branch network remained practically unchanged until the early 1990s. Since then the number of branches has started to decrease, except in the Mediterranean countries,[52] with Finland showing the biggest reductions.

2.3.2 ATM scale economies

If ATMs have a significant effect on the cost of deposit service production, the impact on banks' profits would be substantial, since deposit services, especially payment services, consume a considerable part of banks' total labour and physical capital input expenditures.[53] Naturally, the realization of these savings requires that idle labour be reduced accordingly.

The potential savings in operating costs from the substitution of ATMs for branches follow from the apparently existing scale economies. The fixed costs of setting up and maintaining an ATM network make up a considerable share of the total cost of operating it. And, the variable cost of a one-transaction increase in a given network is quite small, much smaller than that associated with transactions managed by human tellers at branch offices. Also the variable costs of maintaining ATMs are considerably smaller than those associated with branches. Therefore, the average cost of a transaction at the level of an individual ATM falls as the volume increases. This applies to the entire network of ATMs as well. Berger (1985) estimates that the fully allocated cost of an ATM transaction is about 50% of the

[52] In Italy banks significantly expanded their branch network during the late 1980s and early 1990s, after the lifting of restrictive branching regulations (partly in 1987 and fully in 1990).

[53] Berger and Humphrey (1992) report that in the United States the deposit production and the ancillary payment services account for roughly 50 per cent of banks' total operating expenses. De Boissieu (1993) presents a similar figure for the French banking industry.

corresponding cost at a branch office. Anderton et al (1995) provide more recent calculations for US banks, with quite similar results.

There are only a few empirical studies, all apparently dealing with the United States, which attempt to measure the degree of ATM scale economies. By relating total ATM costs to ATM transactions, Walker (1978) arrives at a cost elasticity measure of 0.5 for total ATM costs with respect to a unit increase in transaction volume. These figures should have improved over time, since especially the operating costs of the machines and per transaction data processing costs should have decreased. Accordingly, Humphrey (1994) uses data from a detailed cost survey to derive an elasticity of 0.32. Hence, ATM scale economies appear to be of a substantial magnitude and to be increasing over time, thus widening the cost-gap between manual and ATM transactions.[54]

However, the operating cost savings may be eroded to a significant extent if (1) transaction frequency rises considerably relative to volumes prevailing when branches represent the only delivery method and the lower cost per transaction is offset by higher usage or (2) if the machines are 'oversupplied' to extend market shares above the level where operating costs are minimized (Humphrey 1994). The first effect is primarily related to the demand for cash balances by bank customers, and the second to banks' overall profit maximization and use of ATM network density as a competitive strategy. The following two sections examine these issues in turn.

2.3.3 ATMs and frequency of banking transactions

International evidence from the 1980s indicates that ATMs had a positive effect on currency demand.[55] This is explained by the increased ease of making cash withdrawals. However, the Baumol-Tobin model[56] of transaction demand for money predicts the opposite. Namely, ATMs should lower the transaction cost of cash withdrawals compared to the traditional over-the-counter withdrawal of cash from branch offices, since ATMs are typically open 24 hours a day, the

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[54] One might expect that the substitution of ATMs for branches, and hence human tellers, is more extensive in countries where relative labour costs are high. Unfortunately, the lack of reliable data on banks' relative input costs hinders verification of this hypothesis.

[55] See Paroush and Ruthenberg (1986) and Boeschoten (1992) for cross-country estimates.

[56] See eg Niehans (1978) for a review of the properties of the model.

number of service points is greater, and less time is required per transaction. ATMs should therefore increase the number of withdrawals but decrease the amount of money withdrawn per withdrawal, which would lead to a negative effect on transaction currency demand.

One could explain the failure to detect this from the early cross-country data by the time needed for people to become accustomed to making full use of ATMs to economize on cash holdings. Table 2.11 supports this contention, as ATM transactions per one ATM have generally increased in step with ATM expansion, albeit at a decreasing rate. This indicates growth in the frequency of cash withdrawals, which reduces average cash holdings and implies that there indeed exists a learning period for people to adjust to the use of ATMs.

In order to see whether this conclusion holds once income and interest rate effects and the impact of retail payment practices on currency demand per person are properly accounted for, I estimated a demand model for currency balances using cross-country data from ten European countries over a ten-year period, 1987–1996[57]

$$\ln\left(\frac{C}{POP}\right)_{it} = \beta_0 + \beta_1 \ln\left(\frac{GDP}{POP}\right)_{it} + \beta_2 \ln i_{it} + \beta_3 \ln\left(\frac{ATM}{POP}\right)_{it} + \beta_4 \ln\left(\frac{EFT-POS}{POP}\right)_{it} + \beta_5 \ln\left(\frac{CARD}{POP}\right)_{it} + \varepsilon_{it}, \qquad (2.2)$$

$$i = 1,...,10, \quad t = 1987-1996$$

where C is the amount of currency outside banks, POP population, GDP nominal gross domestic product, i nominal money market rate, and ATM, EFT-POS and CARD the respective numbers of ATMs, (electronic funds transfer at point of sale) EFT-POS-terminals and debit and charge cards outstanding. C and GDP are expressed in a common currency, the euro. ε is the error term.

[57] This is a standard model of demand for money balances, defined here narrowly as currency, in which the demand is determined by nominal income, the nominal interest rate, and variables that affect payment practices (and hence the transaction demand for currency).

Table 2.11 **ATM transactions**

	ATM transactions per capita									ATM transactions / ATMs (thousands per year)						
	1983	1989	1991	1992	1993	1994	1995	1996	1997	1983	1989	1991	1992	1993	1994	1995
Belgium	2	7	8	9	12	13	14	15	16	42.6	74.4	76.8	80.6	41.0	41.7	39.7
Denmark	Na	3.0	2.9	5.2	5.2	Na	Na	Na	Na	Na	Na	40.5	50.9	47.8	Na	Na
Finland	2	21	31	36	40	46	50			21.4	37.5	43.6	48.0	48.1	54.4	56.2
France	2	9	11	12	13	14	16	18	20	21.2	38.0	39.3	39.8	40.9	40.0	40.0
Germany	Na	Na	Na	Na	Na	12	14	15	Na	Na	Na	Na	Na	Na	31.8	30.8
Italy	0.2	1.4	2.3	2.8	3.2	3.6	4.3	6	7	6.0	10.3	11.3	11.7	12.3	11.3	11.3
Netherlands	Na	6	14	17	21	24	27	29	33	Na	47.9	61.7	66.1	70.4	73.5	76.8
Norway	2	13	16	16	17	18	20			29.0	31.1	37.7	41.0	44.2	46.3	50.5
Portugal	Na	3	6	8	10	12	14	18	21	Na	64.0	43.7	37.9	33.7	34.9	37.2
Spain	Na	7	10	10	12	13	14	15	15	Na	24.8	21.7	20.2	21.1	21.7	21.2
Sweden	8	20	24	25	28	31	32	34	35	62.2	90.2	93.7	99.0	111.0	118.4	119.1
Switzerland	2	5	7	8	8	9	10			Na	17.0	19.2	19.3	18.8	18.9	18.7
United Kingdom	4	15	18	20	21	23	25	27	30	41.3	56.1	60.0	62.7	65.0	66.8	70.4
Simple average	*3*	*9*	*13*	*14*	*16*	*18*	*20*			*31.9*	*44.7*	*45.8*	*48.1*	*46.2*	*46.6*	*47.7*

Data sources: BIS's and EMI's Payment System statistics (various issues); Bank of Finland; Finnish Bankers' Association.

Since cash is used mainly in small-value payments for retail goods and services, payments by debit (immediate payment) and charge card (deferred payment) are its closest substitutes. (CARD/POP) measures the availability of card payment alternatives to cash and (EFT-POS/POP) the development stage of the ‘card payment’ infrastructure. The diffusion of EFT-POS-terminals in retail stores and other outlets, which makes the use of cards significantly faster and more reliable, is the most important infrastructural means of facilitating the substitution of card payments for cash. When terminals operate on-line with real-time linkages to account data, the use of magnetic cards provides immediate settlement of transactions at the moment of exchange. Hence payment by card then enables both the finality advantage of legal tender and the efficiency advantages of deposit money. These cards are thus close substitutes for cash (legal tender) in the sense that the party accepting payment takes no risk, since the financial cover is provided immediately, and the need to check the quality of the payment instrument is eliminated (eg Whitehead 1990a and b).

(2.2) is estimated using the previous panel 1 type data consisting of pooled annual cross-sections for European countries. The results are reported in table 2.12.

The coefficient of ATMs per capita is significantly negative, implying that the earlier obtained opposite results no longer hold. Indeed, ATMs seem to have reduced the public’s demand for cash balances, implying more frequent withdrawals, in line with the theory. For banks, this means that the substitution of ATMs for branches increases the volume of one of the most often demanded services, which could have an unexpected impact on costs. The general lesson is that the cost impact of new technology may not be only determined by the impact on per-transaction or investment costs, since customer behaviour may also be affected.

Table 2.12 **Pooled cross-section OLS-estimation results of equation (2.2); dependent variable: currency outside banks per population (ln(C/POP))**

	1987–1996
β_0	–15.75**
	(1.69)
β_1	1.65**
	(0.17)
β_2	–0.24**
	(0.09)
β_3	–0.20**
	(0.07)
β_4	–0.091**
	(0.03)
β_5	–0.09
	(0.06)
R-squared	0.59
Number of observations	94

Data sources: BIS and EMI Payment System Statistics (various issues); IMF, International Financial Statistics.
Notes: Countries included in yearly cross-sections: Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Sweden, Switzerland and United Kingdom.
** Significant at the 1% level. Standard errors in parentheses.

The coefficients of per capita GDP and the level of money market interest rates have the expected signs and reasonable values. EFT-POS terminals significantly reduce outstanding cash balances, as expected, but the number of cards outstanding is not significant, though it has the expected negative sign.[58]

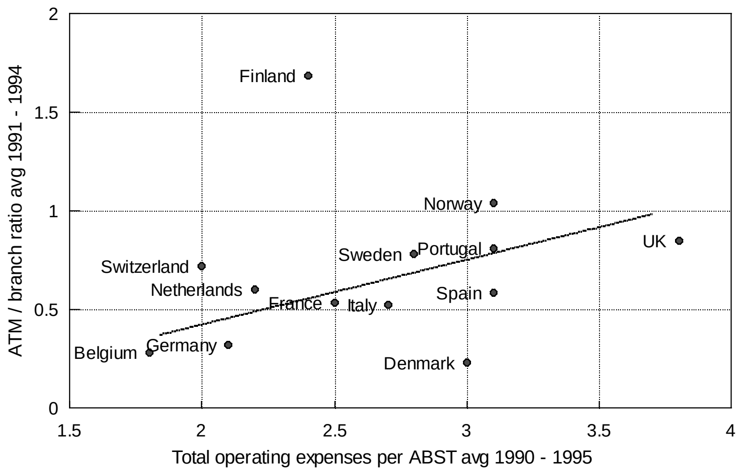
ATMs clearly increase banks' need for cash if not offset by a reduction in the number of branches. Additional cash is needed for inventories in machines and additional inventories at branches to fill

[58] ATM and EFT-POS densities are positively correlated across countries and thus somewhat collinear exogenous variables. The exclusion of ln(EFT-POS/POP) from the model has little effect on the coefficient of ln(ATM/POP).

the machines. This represents an additional cost to banks, which includes the interest forgone on idle cash balances.[59]

In order to get a handle on the effects of ATM use on banks' operating costs, figure 2.2 plots the industry-level relationship between average operating cost, defined as total operating expenses per ABST, and the ATM/branch ratio, representing the degree of substitution of ATMs for branches. Taken at face value, figure 2.2 indicates that a high level of ATM utilization is associated with high, rather than low, average operating costs in cross-country comparison, implying a heavy cost burden on banks that have invested the most in revamping their delivery methods. This positive correlation is significant when Finland is excluded. Indeed, the Finnish ATM/branch ratio seems to be an outlier.

Figure 2.2 **Relation between ATM utilization and total unit costs**



Data sources: BIS and EMI Payment System Statistics (various issues); OECD, Bank Profitability Statistics.
Note: t-statistics for the slope coefficient 0.83 (2.09 excluding Finland).

[59] The amount of cash held by banks differs markedly across the countries under study, from 0.37% of GDP in Norway to 1.14% in Finland at the end of 1991 (Virén 1993). Factors influencing the level of banks' cash balances include, in addition to branch and ATM networks, the currency distribution system (central bank network) and the amount of interest forgone on balances, which is affected by the institutional details of banks' cash and reserve management and monetary authorities' requirements. Thus a detailed study is needed to measure the net impact of ATMs on banks' own cash balances. Boeschoten (1992) reports a significant and positive effect for a group of industrialized countries in the late 1980s.

This suggests that the cost-raising effect of an increase in transaction volumes brought about by ATM expansion is quantitatively significant. However, care is warranted here, since other determinants and country-specific factors affecting costs are not controlled for. Banks have probably not yet fully adjusted their operations to exploit the possibilities of the new technology, ie there are additional costs due to ‘double capacity’, which they also need to service customers who do not wish to use remote banking. There are also many transitional expenses associated with branch network restructuring. The Finnish case is illustrative, as banks there have been able to realize cost savings only with significant lags after reductions in the number of branches.

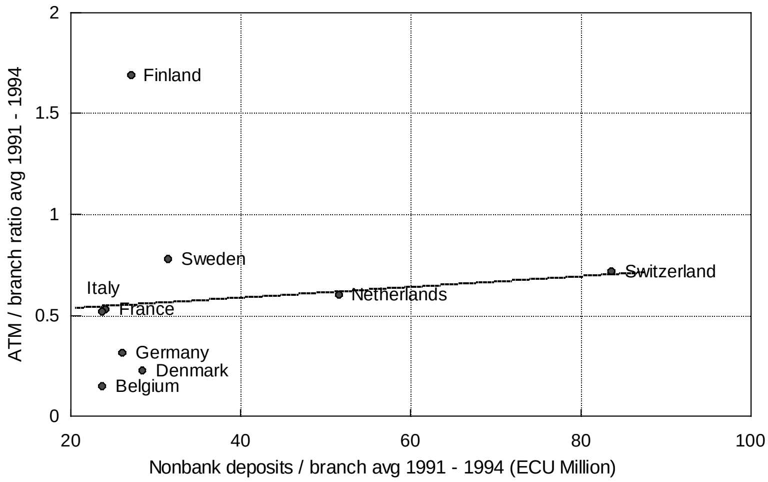
2.3.4 ATMs as a part of competitive strategy

ATM density may be used as a competitive strategy, since it is a positively valued part of banks’ service quality. Since ATM transactions are often provided free of charge,[60] the customer benefits resulting from increased convenience, reduced transaction costs (including the opportunity cost of time) and increased interest earnings are quite substantial. Customers gain in interest as average demand deposit balances rise, and a part of the reduction in average cash balances is likely to be transferred into time and savings deposits or other assets that earn higher interest. If ATM expansion brings new depositors, which lowers banks’ funding costs and generates additional revenue from other services, it can be optimal for a bank to ‘oversupply’ ATMs in the sense that total operating costs are not minimized (see Humphrey 1994). Then a part of the customer value is recaptured in higher deposit market share or revenues. Figure 2.3 lends some support to the use of ATMs as a means to increase deposit balances. An increase in ATM usage appears to lead, in our sample of countries, to a rise in the average deposit balances banks can maintain

[60] In some cases fees are charged for withdrawals from ATMs, which – even if part of a compatible interbank network – are not the bank’s own machines. However, at least in Norway and the Netherlands, banks have charged ATM withdrawal fees for all transactions.

at a given branch capacity. Humphrey (1994) obtains a similar result for the United States.[61]

Figure 2.3 **Relationship between ATM utilization and deposit balances**



Data sources: BIS and EMI Payment System Statistics (various issues); OECD, Bank Profitability Statistics.
Note: t-statistics for the slope coefficient 0.29 (1.58 excluding Finland).

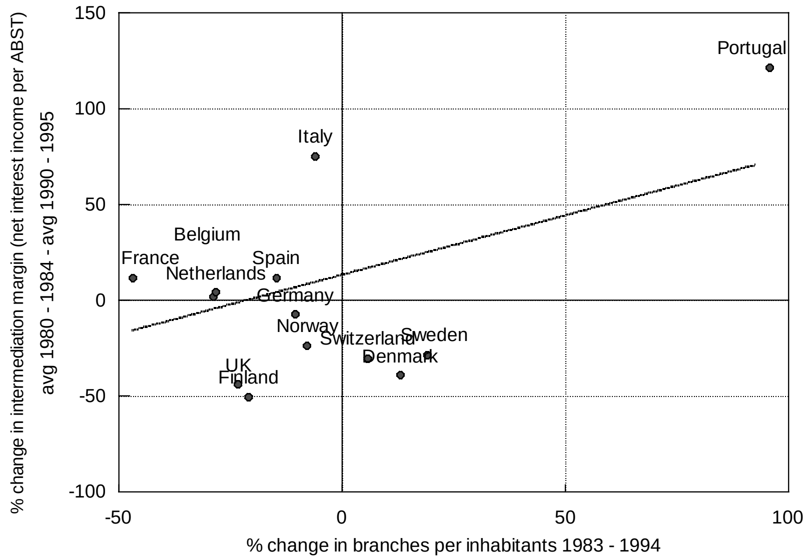
The competitive use of ATMs was probably more pronounced in the early phase of ATM establishment, when network cooperation between banks was minor, and the establishment of ATMs was apparently not subject to collusive agreements. For example Belgium, France, the United Kingdom and Finland experienced strong competition between isolated networks. However, after a competitive start, there has been extensive linking between networks in most European countries, and now the banks in many countries maintain a single joint network. A single ATM network in which all domestic banks participate is now in operation, for example, in Denmark, Finland, the Netherlands and Norway.

The competition aspect of setting up delivery capacity was highlighted in chapter 1 with the help of the simple spatial model. Here, I wish to make some additional points, drawing on the model outcomes. First, the number of branches should be positively

[61] The above discussion leads one to expect banks' average interest costs to be lower when banks have a large number of ATMs relative to branches. Again, a rigorous analysis holding other influences on costs constant would be needed to determine the relationship between total costs and ATM usage.

correlated with intermediation margins (supported by conduct regulations), and so intensifying price competition after liberalization would be a potential source of overcapacity problems in the countries that extended branch capacity farthest. This could be a fundamental reason for the branch network restructuring that has started in many European countries. Some weak evidence of this is shown in figure 2.4, which shows the correlation between percentage change in branch density and percentage change in intermediation margin (net interest income per ABST) from the early 1980s to the mid-1990s, using the sample of European countries. In the Mediterranean countries widening or relatively stable intermediation margins seem to have supported the width of branch network expansion, in addition to the effect of liberalizing branching restrictions. A caveat seems to be in order especially here, as many other factors affecting branch expansion are not accounted for and the detected correlation is not robust, eg leaving Portugal out of the sample changes the sign of the correlation.

Figure 2.4 **Relationship between changes in intermediation margins and branching**



Data sources: BIS and EMI Payment System Statistics (various issues); OECD, Bank Profitability Statistics.
Note: t-statistics for the slope coefficient 2.20 (-0.77 excluding Portugal).

Second, by lowering the fixed cost of setting up additional delivery capacity the adoption of ATMs tends to increase the total number of points of service. This has usually been the case in the European countries (tables 2.9 and 2.10). Moreover, the model predicts that the lower-fixed-cost ATM technology will be used instead of branches, to the extent possible. This substitution was shown to have progressed significantly in European countries.

Finally, the model predicts that the ATM/branch ratio would increase with income, as income is positively correlated with customers' transaction costs through the opportunity cost of time. Higher income would thus be correlated with demand for ATM–based services. This effect is not, however, clearly visible from the data and hence the other effects discussed here seem to play a more important role in ATM establishment than the demand-increasing effect of higher incomes.

The establishment of compatible or jointly supported ATM networks by merging the networks of individual banks or groups of banks reflects the attempt to cut costs by deleting overlapping functions (computer systems and networks) and services and exploiting the related scale economies. In fact the widespread cooperation supports the existence of significant ATM scale economies. This kind of cooperation, however, also enhances customer satisfaction by extending the availability of services. Thus, by merging ATM networks, banks can increase their competitiveness vs 'outside' competitors that do not have ATMs or access to ATM networks. The benefits from reaping scale economies and providing interoperable systems have also resulted in cooperation among banks in other important areas, such as compatible payment instruments (debit cards accepted on a country-wide basis) or compatible technical standards (eg digital security arrangements).

There is a *free-rider problem*[62] in network cooperation in the sense that small banks may be able to obtain greater benefits from participating in a joint network than large banks that are themselves able to provide widely available services and so exploit ATM scale economies, due to higher transaction volume. This aspect, however, now seems to be generally outweighed by the benefits of operating joint ATM networks.

In countries where the ATM network is maturing, network cooperation may lead to a decrease in network density if in the competitive phase several banks install machines in places where a single machine would suffice. The extra machines can naturally be transferred to locations where no ATMs have been installed. In

[62] See Katz and Shapiro (1986) for a general treatment of the problem.

countries where ATM density is growing, network cooperation might slow the growth rate, since a high ATM density would not constitute a competitive advantage to any individual bank in the event a single network is supported in the country in question. The network cooperation issue is discussed more in depth in chapter 3, drawing on the model developed there.

Customer resistance toward all direct service charges makes it hard for banks to impose fees on ATM transactions, although declining possibilities for cross-subsidization and the apparent cost disadvantages of 'excessive' use of ATMs increase pressures for direct charging. Network cooperation could facilitate the introduction of these fees, although the pricing of services remains in principle uncoordinated.

2.3.5 Use of phone and PC banking methods

As noted, remote access options already exist for a wide range of retail banking services in many countries.[63] It seems fair to conclude that remote access possibilities are more advanced and more frequently used for deposit-related saving and payment management services than for lending activities, though phone banks often offer also consumer and mortgage credits. Companies typically have a longer history of using computers for making banking transactions than do private customers.

According to data collected by the Bank for International Settlement, the market share of phone banking varied between 3% and 11% in the European G10 countries in 1997–1998. In the United States the market share is considerably higher. In Finland roughly 30 per cent of banks' private customers have made either phone or PC banking contracts. This figure might overestimate the share of remote banking, since some customers with contracts may not make phone transactions. Phone and PC or Internet banking currently have similar market shares in Finland, but PC banking is growing much faster.[64] In the other EU countries, the level of PC banking use is lower but is

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[63] Anderton (1995), Crane and Bodie (1996), Kalakota and Frei (1996) present descriptions and categorizations of the products that are available in the market. See also European Central Bank (1999) for EU developments.

[64] Finnish data appearing in this section are from the Finnish Bankers' Association.

increasing as well (European Central Bank 1999).[65] A large number of banks have already established websites for information purposes, whereas websites for transaction purposes are starting to be introduced in most EU countries on a larger scale (European Central Bank 1999).

As regards future developments, some observers still stress the comparative advantage of telephones, while an increasing majority expects that the Internet will become the main channel for private customers' account transfers. The growth of phone and PC banking will curtail the use of payment ATMs, since these substitute for payment and account services offered through ATMs (not yet effectively for cash distributions, as electronic money is not very widespread). The significance of branches has already decreased considerably for depositors. In Finland this development has proceeded quite far, and branches have generally lost ground for deposit customers, since the most common banking transactions are usually effected without visiting branches.[66]

The development of credit scoring techniques could significantly foster the remote supply of standardized, low risk loans, eg consumer credits and mortgages (eg Avery et al 1997). There can be significant benefits from centralized and systematic processing of borrower information in the credit evaluation process. Loans that involve extensive credit risk taking (commercial lending) will probably continue to require close customer contacts and proximity for credit risk evaluation and monitoring. The processing of private information on borrowers is, according to the theoretical contributions (eg

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[65] Data on the diffusion of Internet banking have recently become available from certain private market sources, while official data are not available. According to SchroderSalomonSmithBarney (SSSB), Internet banking penetration rates (defined as the ratio of online customers to the total customer base) ranged in June 2000 in the EU from 22% in the Nordic countries to 1–2% in Italy, Spain and Portugal. The average for the EU was 4%. There has been a rapid expansion as the penetration rates were in June 1999 11% in the Nordic countries, and 2% in the EU total. According to JP Morgan Securities, the penetration rate was around 15% in the United States in July 2000. The diffusion of the use of the Internet has been swifter for brokerage than banking, as the penetration rates in Internet brokerage already ranged in July 2000 to over 30% in the United States, and to over 10% in the United Kingdom and Germany (sources: JP Morgan Securities and SSSB). In contrast, payments and insurance have apparently taken off less rapidly over the Internet.

[66] The use of the Internet has apparently spread significantly faster in savings and demand deposits and similar services than loans. For example, in the United States less than 1% of mortgages or personal consumer loans were generated online in 1999 (source: JP Morgan Securities, July 2000). The quoted reason is that customers have so far used the Internet basically for getting information, not actually for effecting transactions. However, loan transactions are expected by many to spread swiftly as well.

Diamond 1984, Diamong and Dybvig 1986 and Fama 1985), the most important aspect of financial intermediation.[67] Even in this field, however, the new techniques for assessing credit risk (eg neural networks) can replace close physical presence in the future.

There are a number of *demand-side* factors that argue for a rapid diffusion of remote access technologies, or break-through, as a banking method for the ‘masses’. Consumers increasingly demand more convenient 24-hour services to effect transactions. ATMs deliver that, but remote access transactions can be carried out where there is access to a phone or the Internet.[68] In general, there seems to be increasing demand for a higher ‘comfort level’ with respect to banking transactions.[69]

Perhaps more importantly, consumers are increasingly computer literate, and the younger generation is much more apt to change their banking habits. Kennickell and Kwast (1997) find that US household heads below 35 are considerably more likely than the older ones to use PCs for making payments. Increasing communication speed should also encourage the use of remote access options.

In sum, there should already exist a ‘critical mass’ for growth, in terms of both the number of customers who have experienced electronic banking and the number of PC-user households, with access to the Internet.[70] The adoption of payment innovations through different groups of people, early adopters, followers, masses, late-comers, generates an S-shaped logistic diffusion curve (Humphrey et al 2000). This pattern has been found to depict well the adoption of also many other innovations (eg Meade and Islam 1995). Remote access is clearly still in the phase of attracting early adopters, but has the potential to increase rapidly and to revolutionize service delivery and competition in banking.

On the *supply side*, there are, first, cost-based incentives to invest in remote-access technologies. Deregulation and opening up of markets forces banks to cut costs, and there is evidence that remote access is significantly cheaper to supply than branch-based and even

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[67] See also the survey by Battacharya and Thakor (1993).

[68] The percentage of population having access to the Internet ranged in September 2000 in Europe from 10% in Spain to over 40% in Sweden and Finland. The figure for the United States was over 50% (source: Nua Internet Surveys).

[69] The potentially perceived lack of safety is reportedly the main hindrance for the use of the remote access by banks’ retail clients.

[70] Kalakota and Frei (1996) state that home banking with PCs failed to grow earlier on in the United States due to the absence of a ‘critical mass’ of PCs and PC-friendly population.

ATM-based services.[71] As noted, electronically executed transactions exhibit apparently much stronger economies of scale than manual transactions, since the fixed cost component is much more significant than the variable one. The rapidly falling costs of data communication, including hardware costs, is widening the cost-wedge between automated and manual transactions.

Second, the competitive aspect of technology is apparently quite strong, as will be evidenced in the next section. Namely, remote access offers new and more powerful possibilities for those seeking ways to expand. A competitive advantage of the newcomers is that they do not have the cost burden associated with the traditional banking infrastructure. In this environment, where there is also increasing customer demand for remote banking, banks that do not make such investments face the threat of loosing market share. One of the main results of Bouckaert and Degryse (1995) and Degryse (1996) is that the incentive to invest in remote access increases with price competition in banking. Hence integration could boost technological change in banking, not only by increasing the attractiveness of launching new services, but also indirectly by increasing the contestability of the banking markets.

For small banks and new entrants, the reason to invest in remote access is clearly to gain market share and challenge the incumbent institutions with large branch networks. For the incumbents the incentives are also increasingly strong and often also defensive, as most major institutions at least have adopted strongly advertised Internet strategies. First, almost all market participants expect the rapid spread of Internet banking. Second, there is a need to remain viable in competition and to forestall the threat of new entrants. Third, the incumbents need to improve efficiency and adopt new tools to compete against their old rivals, the other branch-banks. As a result of the demand- and supply-related factors, remote access is already offered in the EU by a wide range of institutions (European Central Bank 1999). The major established banks often consider phone banking already as an integral part of their overall distribution

[71] Anderton et al (1995) estimate cost savings up to 80% of overheads. Robinson and Flaatraker (1995) find that in Norway the total cost of branch-based transactions is around three times greater than that of automated transactions. Frei et al (1997, table 4) cite survey information for the United States which indicates the following costs per transaction in US dollars: human teller (1.4), telephone (human operator) (1.0), ATM (0.4), telephone (automated) (0.15) PC/Internet (0.1).

strategy, and PC, especially Internet banking is rapidly gaining importance.

2.3.6 New competition based on remote access

The United States has led the EU in terms of the establishment of Internet banks, either as subsidiaries of the incumbents or entry by new rivals. The US example indicates that the new players outside the traditional banking sector can rapidly become important players in significant lines of activity. Several independent Internet banks operate there in saving and loan products (eg Net.B@nk, E-loan, Everbank and VirtualBank), as well as in online brokerage and other 'private banking' services (eg Charles Schwab and E*Trade). Also, in the Unied States many small and medium-sized banks have established Internet operations.[72]

New competitors of major established banking institutions have emerged in many European countries, but not yet as forcefully as in the United States. In Internet banking, the major new entrants include the UK-based EGG (established by Prudential insurance) and Belgian-based Europeloan, which is marketing loans quite aggressively in the Nordic countries, solely via the Internet. Also at least in France, Germany and Denmark, new Internet-banking operations have been established. However in Europe, these operations have been more frequently established by existing banks as another delivery channel (eq in Sweden and Finland where the activity appears most widespread). Major European institutions have often established direct banks using phone or Internet-based delivery methods, even competing against the traditional bank of the same group. The direct '24 Bank' established by Deutsche Bank is perhaps the most well know, as it has rapidly become a major player in the German retail banking market.[73] In addition, specialized niche banks have emerged outside the traditional banking groups, established by financial or

[72] In the United States, the major incumbent banks have established their own Internet operations or acquired new start-ups.

[73] Other examples of independent direct banks established by major European banks, operating via the Internet, include Banque Directe (of BNP Paribas), Firstdirect (of HSCB), ING Direct (of ING Bank), ebanking.com (of Fortis), ONBanca (of BPCI), Open Bank (of BSCH), Cahoot (of Abbey National) and Evolvebank.com (of Lloyds TSB). Many independent Internet brokerage operations have also been established by European banks (for more information see eg Qualistream.com).

nonfinancial companies, concentrating mainly or solely on remote-access delivery methods.

There have already been cases, where new entrants have significantly undercut the prices of established banks and have already significantly influenced pricing in the banking markets as a whole. The new entrants might have also influenced the delivery decisions of incumbent banks, inducing them to increase their investments in phone and PC banking. The new entrants could undercut the existing rices due to cost advantages. The entrants may also need to offer lower prices, since the existing banks might have competitive advantages due to proximity or greater perceived quality of services or simply to familiarity of the bank and its products. In these cases the market exhibits *vertical differentiation* (European Central Bank 2000), and new entrants must set lower prices to attract any customers, since at equal prices customers would simply prefer the existing banks. These aspects of differentiation will be formally addressed in the next chapter.

Indeed, competition from nonbank institutions can be expected to pose an increasingly important challenge to the established banks. Remote access technologies are expected to represent a very significant impetus for competition by new players in the market, since these lower-cost technologies enable aggressive expansion in the market. This is seen to concern more or less all retail banking activities.

In Europe, there have also emerged many other forms of new competition in banking, eg on part of supermarket chains, insurance companies and car dealers. These entities can also rely on remote access to a significant extent, but this is not always the case. Also money market funds already offer payment services, eg in France, and specialized niche banks that have won market shares, especially in the United Kingdom and Sweden, offer deposit-related payment and account services to often quite narrowly defined customer groups.

To obtain cash, customers still have to rely strongly on cash dispensers, which generates a competitive advantage to banks that possess these networks, though there are some signs that retail firms might start distributing cash. However, the ongoing general decline in the use of cash in European countries (Humphrey et al 1996a) is reducing the importance of this advantage. Most importantly, the widespread establishment of (electronic funds transfer at point of sale) *EFT-POS-terminals* in retail stores and other outlets has significantly increased the use of debit and credit cards in making retail payments and hence reduced the use of cash, as noted in section 2.3.3.

Moreover, there is potential for diffusion of the use of e-cash stored on chip-cards or electronic purses for purchases via the Internet. This innovation could increase the establishment of automated card readers and hence increase the use of payment cards, since the required investment seems to be significantly smaller than that required to install an EFT-POS terminal. The use of e-cash has, however, not taken off very fast (European Central Bank 1999). The main reasons are the slow acceptance by merchants, cost considerations, security concerns and the incompleteness of the regulatory framework.

The introduction of EFT-POS systems has taken place at very dissimilar speeds in the countries studied here (table 2.13). Besides the reduced need to hold cash balances, an accurate record of transactions is a benefit to customers, as well as a time saving compared with the manual handling of cards. Since EFT-POS systems are generally not bank-specific, they have not given individual banks competitive advantages but instead have enhanced the competitive position of the banking industry, which could compensate for the diminishing importance of cash dispensers. This is not so clear-cut, however. EFT-POS terminals are owned by retailers and are typically compatible with a wide range of payment cards, not just those issued by banks, though debit and charge cards issued by banks appear to be the most used payment cards in Europe. In fact, retailers (eg supermarket chains) can themselves become significant suppliers of financial services, as has been the case in the United Kingdom, and to an extent in Sweden.

Remote access also provides new opportunities for credit card companies and other providers of consumer credit, and probably also for specialized mortgage banks. In commercial lending the most likely area for increasing competition outside the traditional banking industry are the low-credit-risk collateralized short-term credits provided by financing companies. Retail corporations have already become significant lenders, eg in auto sales, and have offered deposit services, while their operations have not usually been based on remote-access options.

Table 2.13 **EFT-POS systems**

	EFT-POS terminals per 10000 inhabitants								EFT-POS transactions per capita							
	1989	1991	1992	1993	1994	1995	1996	1997	1989	1991	1992	1993	1994	1995	1996	1997
Belgium	24.8	32.3	40.6	42.3	49.4	55.1	59.7	62.8	7	10	13	16	18	21	24	27
Denmark	24.6	37.4	43.3	42.0	46.2	50.1	79.7	119.2	8	17	21	26	31	46	52	58
Finland	33.3	66.8	77.4	82.9	94.3	95.9	99.5	105.1	11	32	35	34	38	43	46	54
France	28.5	35.6	55.8	74.4	93.4	93.4	93.5	95.6	11	18	23	24	29	32	36	39
Germany	1.8	4.3	6.4	7.1	7.7	8.6	14.0	19.8	0	0.3	0.3	0.9	1.3	1.8	3	3
Italy	1.8	7.9	10.8	13.3	17.9	26.8	37.4	49.0	0	0.1	0.2	0.3	0.4	0.7	3	4
Netherlands	1.4	2.7	7.5	16.1	30.9	47.5	61.8	77.1	1	2	3	4	8	16.6	24	31
Norway	16.8	31.8	42.2	52.8	55.0	66.4			5	8	10	15	20	28		
Portugal	0.8	7.2	15.8	27.9	33.1	38.6	50.0	60.2	0.3	2	5	8	9	13	18	22
Spain	56.0	55.9	67.2	82.9	102.2	122.7	146.6	167.0	2	3	4	6	7	8	8	9
Sweden	4.0	10.3	16.5	30.5	55.2	61.6	69.5	77.8	0.6	4	5	7	9	10	13	16
Switzerland	3.1	7.0	10.2	14.4	23.1	34.4			0.9	2	3	4	6	8		
United Kingdom	13.1	32.9	34.5	46.4	60.0	86.7	93.6	89.9	1.1	6.2	Na	Na	Na	Na	Na	Na
Simple average	*16.1*	*25.6*	*32.9*	*41.8*	*52.5*	*61.9*			*4*	*8*	*10*	*12*	*15*	*19*		

Data sources: BIS's and EMI's Payment System statistics (various issues); Bank of Finland; Finnish Bankers' Association.

In asset management services, close physical contact is likely to remain important for many customers as regards investment advice, and branch-banks should maintain some of their current advantages in this area. Nevertheless, remote supply, eg by foreign banks, niche banks and independent mutual funds and brokerage firms, as well as abundant information on competing offers through the phone and the Internet, put strong discipline on banks that sell these products through their branch network. In fact, the execution of securities transactions is spreading rapidly in many countries through online brokerage services (such as Charles Schwab). This development could in the longer-run lure also a significant part of asset management services away from the traditional branch-based delivery.

There is also increasing competition between banks and insurance companies, as some of their services are clearly overlapping. Moreover, some new solutions, like interactive TV or video banking through the Internet or cable TV, may offer personalized face-to-face service with respect to financial planning and advice. However, these solutions seem still to be in the development stage.

So far, banks have cooperated with technology companies and the latter have themselves not entered the field of financial services. However, many observers expect that the technology companies will someday become banks' most formidable competitors. The reason is that once banking becomes an integral part of electronic commerce (e-commerce) over the Internet, the companies that control the access technologies (portals to the Internet) have a huge competitive advantage, as they can recognize the customer when he connects into the Internet. This recognition can be used to offer tailored financial services based on the identification and analysis of customer preferences. Financial services seem to be regarded as one of the most suitable businesses for e-commerce.

To summarize, it seems clear that the technological transformation described in this section will have an increasingly important effect on the nature and extent of competition in retail banking. Moreover, the discussion has shown that there is increasing potential for 'outside' nonbank competitors to exert competitive pressure on incumbent banks with the help of modern delivery and information processing technologies. The earlier part of this chapter provided evidence of tightened banking competition in Europe after the liberalization of regulations restricting banks' conduct. In this environment, technological transformation is beginning to constitute an increasingly important force that is fundamentally affecting banking competition, basically in all lines of activity.

3 Technological transformation and nonbank competition in a model of retail banking oligopoly

As argued in the earlier parts of this study, retail banking competition is fundamentally changing due to the development of remote-access technologies. By offering a relatively inexpensive alternative delivery channel and mechanism to collect information, it offers a means for banks and nonbanks of various sizes to aggressively strive to extend their customer base. This chapter presents a model that is intended to capture the effects of technological change and the emergence of nonbank service providers on retail banking competition.

As described in section 2.3, remote access possibilities have been established in most European countries and the United States for a wide range of banking products, and they are expected to develop rapidly. At present, the use of remote access is generally less common in lending than in deposit-related investment and payment services. Nevertheless, there has been progress on the lending side as well. Bank borrowers can inform banks of their creditworthiness through electronic channels without visiting a branch and having physical contact with a bank employee. That is, phone and e-mail (Internet) can be used for remote reporting of information to banks for credit risk evaluation and monitoring purposes. This information can then be processed centrally, possibly using automated means like credit scoring to assist in lending decisions. Remote access is currently used for consumer credits and mortgages. Commercial lending might continue to require close credit risk evaluation and monitoring through 'physical contact' to a greater extent, but even this area does not seem to be shielded. The cash distribution function remains outside the scope of remote access as regards 'physical cash', while e-cash can be loaded on chip cards via a PC or used as a payment instrument on the Internet.

As a result of the technological development, customer information on competing offers is expanding considerably, and customers can become significantly more mobile and responsive to price differentials in searching for the best offers. Customers are no longer restricted to their local banking market, consisting of nearby bank branches. As the local market looses its importance, the size of the relevant market for banking competition expands.

Chapter 1 concluded that there are three implications for modelling banking competition: (1) the representative customer approach with anonymity is more appropriate than the spatial approach with fixed customer locations; (2) competition should be allowed (in equilibrium) among all bank and nonbank institutions in the relevant market; (3) the model should allow linking the strategic value of branch and ATM networks to the level of technological development in the banking industry.

To expand on the last point, remote access and information dissemination technologies clearly reduce the strategic value of branches. The same applies to ATMs, as substitute access possibilities reduce their importance. Traditionally, branching has been the most important nonprice feature of retail banking competition for private customers and small and medium sized companies. Basically, a bank has been able to attract customers either by topping rivals' deposit rates, or undercutting loan rates, or by expanding its branch network. Branching has also been the primary source of banks' pricing power, since by providing for less costly access to deposit and payment services it has been the most important means differentiating itself from rivals, while the actual services and products have been quite homogeneous. On the loan side, branches have been the major mechanism for information collection and processing for credit risk evaluation and monitoring purposes, ie for overcoming the informational asymmetry between borrowers and lenders.

In this context, two specific effects of technology should be distinguished. First, as a result of technological development, competitive conditions change within the banking industry across banks with asymmetric branch and ATM network sizes (*network size* and *differentiation effects*). Second, banks' competitive position changes vis-à-vis suppliers of contesting services without these networks (network size or *total network size effects* in the case of network compatibility). As we saw in section 2.3, smaller institutions have already been able to challenge the established branch-based banks, with significant effects on market prices, thanks to remote access technologies.

In this chapter a two-stage, capacity first then pricing, model of retail banking competition is developed according to the principles set out above. The model is then used to address three policy issues that relate to competitive conditions in the loan and deposit markets: (1) the efficiency of the transmission of money market rate changes into loan (and deposit) rates, ie the efficiency of *monetary policy transmission*; (2) *the effects of further deregulation of deposit rates* on banks' lending rates; (3) *the competitive effects of network* *cooperation* (collusion and compatibility) and the related competition policy issues. The main results are summarized at the beginning of each section.

3.1 Outline of the model and basic assumptions

The first stage of the model deals with branch and ATM network (capacity) choices, and the second stage with short-term oligopolistic competition in loan and deposit rates, with given capacity. The underlying idea is that the delivery network choices represent more durable decisions than the interest rate decisions. As usual, the model is solved backwards: the first stage is solved after the second to generate a sub-game perfect outcome based on the expected profits implied by the second stage. There is no explicit spatial structure in the model (ie the exact location of branches and ATMs is irrelevant). The model is a variant of a multi-dimensional product differentiation model developed by Feenstra and Levinsohn (1995) (FL), which is a generalization of the one-dimensional Hotelling-type differentiation model (eg Eaton and Lipsey 1989).

I do not explicitly examine incentives to invest in remote-access technologies. Instead, I take the emergence of alternative access and information dissemination possibilities and new competition outside the traditional banking industry as exogenous shocks or trends and study their implications for banks' interest rate and delivery capacity choices. This approach can be justified by the fact that the development of information technology and infrastructure (eg the Internet) is largely exogenous to banks (European Central Bank 1999). Moreover, branches and ATMs constitute banks' proprietary delivery channels, which makes them fundamentally different from the telephone networks and Internet, which are not owned by banks and are generally open to all firms that wish to enter the market. The number of market participants is given in the model, ie I do not analyse entry decisions explicitly. I also abstract from the pricing of payment services. Finally, I do not allow for customer-tying contracts (as in Chiappori et al 1995) or a branch stealing business from the other branches of the same bank (cannibalization).

In the model, banks are 'universal' in the sense that they operate in both deposit and loan markets. The nonbank competitors specialize in either deposit-related or lending activities. This is in line with the banking structures of many countries. Nonbanks are distinguished from banks as follows: (1) nonbanks do not have branch or ATM networks; (2) nonbanks cannot engage in cooperative arrangements with banks to gain access to branch or ATM networks; (3) nonbanks' services may differ in quality from banks' services. In the deposit market, the nonbank competitor can be thought of eg as a money market mutual fund offering payment management services; in the loan market, eg as a credit card company in respect of household loans or as a financing company (or even the capital market) in respect of corporate loans.

As noted in chapter 1, there are relatively few studies that deal with combined network and price competition in banking. Most studies apply Salop's (1979) spatial model where branching coincides with new entry, and competition between multi-branch banks is not analysed. In these models, competitive conditions change only after entry and exit, not because of delivery network decisions, outside competition or technological change, which are at focus here.

As in Cerasi (1995),[74] the analysis here is more general than in the spatial model applications, since competition among all market participants is allowed, not just between neighbouring firms in the spatial dimension, and there are network size-related competitive benefits that compensate for the 'crowding out effect' captured in the spatial applications. The exact mechanism through which this benefit is realized is, however, different. The model here has the (diminishing) competitive edge vs competitors without branch and ATM networks, while Cerasi (1995) includes the total number of branches in the depositors' utility function. I would argue that the latter would be relevant only in the case of network sharing (compatibility) among banks.

A finally difference as compared to the literature is that ATMs are incorporated as another 'physical' delivery channel. This is justified, since cash dispensing and multipurpose payment ATMs provide many of the most often demanded deposit-related payment and account transfer services and are regularly subject to compatibility arrangements, unlike branches. ATMs cannot be regarded as perfect substitutes for branches, since customers can have a positive valuation for both. Matutes and Padilla (1994) study the impact of ATM compatibility on competition within the banking industry using a three-bank spatial model. They do not analyse the competitive position of the banking industry vis-à-vis outside competitors, which

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[74] Cerasi applies Shaked and Sutton's (1990) model of demand for a single output (deposit services) of multi-product firms (branches represent the different products or variations). Her model does not allow for asymmetries across banks.

here constitutes a kind of externality for parties to the compatibility agreement (*total network size effect*).

3.2 Demand for banking services

This section characterizes the perceived deposit supply and loan demand functions, which are used for equilibrium analyses in the next two sections. The main results are the expressions for own- and cross-price elasticities for the two markets, showing how the elasticities depend on the stance of the alternative delivery technologies. The various channels through which the technological stance has an impact are also identified.

The basic setup of the model is the following. There are N banks that have entered the market to collect deposits, to provide the associated payment services, and to supply loans. At stage one of the game, they establish b_1 branches and b_2 ATMs (vector $b_i = (b_{i1}, b_{i2})$, i = 1,...,N). These decisions are sunk when deposit supply and loan demand are realized. ATMs are relevant for the deposit market only. There is an additional $(N+1)^{th}$ specialized nonbank competitor in both the deposit and loan markets. They each have one office, but no ATMs or access to the ATM network ($b_{N+1} = (1,0)$).

Customers need to bank with either one bank or the nonbank competitor. Depositors have to deposit one unit of funds and borrowers need one unit of financing. Finally, the numbers of depositors and borrowers are fixed.[75]

3.2.1 Supply of deposits

Upon depositing their unit of cash, depositors obtain interest at the rate, as well as payment and account keeping services. They are continuously and uniformly distributed within a certain geographic area (Δ). I allow depositors' preferences for branch and ATM network densities to vary across *representative groups of depositors* that could be defined eg by age, propensity to use remote access, or frequency of banking transactions. These groups are characterized by a difference in importance placed on accessibility to bank branches and ATMs. Each of these groups is characterized by $b^* = (b_1^*, b_2^*) \in \Delta$, which

[75] That is, the deposit and loan market sizes are fixed.

represents their *ideal network density*. The taste distribution is such that b* ranges from (1,0) to the point at which the market space is fully saturated with outlets.

The utility of a *representative depositor*, given a certain b*, depends on the deposit rate and the numbers of branches and ATMs of the institution with which funds are deposited (not their exact location). In line with the FL model, I use a quadratic formulation for the utility function (u). Whether a bank or the nonbank is chosen, the total utility (U) is

$$\begin{aligned}
&U(b_i, b^*, r_i) = u(b_i, b^*) + r_i \equiv \\
&\gamma_0 + \gamma_1' b_i - (b^* - b_i)' T (b^* - b_i) + r_i, \; i = 1,\ldots, N \\
&U(b_i, b^*, r_{N+1}) = u(b_{N+1}, b^*) + r_{N+1} \equiv \\
&\gamma_1' b_{N+1} - (b^* - b_{N+1})' T (b^* - b_{N+1}) + r_{N+1}
\end{aligned} \qquad (3.1)$$

where γ_0 represents the service quality difference between banks and the nonbank that is not related to service accessibility. The quality of the nonbank provider is normalized to zero. $\gamma_0 > 0$ when greater acceptance of bank-provided payment means easier use or a richer assortment of banks' ancillary services generates a quality difference that favours banks. This quality difference generates benefits to all banks vs the nonbank competitor but does not enable banks to distinguish from each other. The underlying notion is that services do not differ that much across banks, while the difference can be much greater when the breadth and quality of banks' services is compared with those of the new players.

The (nonnegative) parameters of the vector $\gamma_1 = (\gamma_{11}, \gamma_{12})$ can be interpreted as marginal utilities of branches and ATMs, when individuals receive services from a bank with a network density b* that is ideal for them (ie marginal utilities are evaluated at ideal network densities). These parameters are constant and depend on depositors' search and transaction costs, when using the alternative access options. When access to alternative delivery channels is constrained or costly, these parameters are significant, but otherwise the marginal benefit would be limited. In any case, the parameters should always be nonnegative.

The *quadratic term* captures the negative effect on utility when branch and ATM network densities are different from the preferred one. The *transport and transaction cost* parameters, τ_1 and τ_2, are constant and positive diagonal elements of the diagonal matrix T, and represent the rates at which utility declines when there is nonpreferred service availability through branches and ATMs. The sizes of these parameters also depend on depositors' costs associated with the alternative access options. There is no utility loss if τ_1 and τ_2 equal zero, which obtains when there is equally (or less) costly and easy access to alternative delivery channels than to branches and ATMs, or if the branch and ATM densities are the preferred ones.

Let Δ_i be the set of depositors with b* who choose bank i. It is defined by the following utility comparison vs other banks and the nonbank competitor

$$
\begin{aligned}
&\Delta_i \equiv \{b^* \in \Delta \mid \gamma_1' b_i - (b^* - b_i)'T(b^* - b_i) + r_i \geq \\
&\gamma_1' b_j - (b^* - b_j)'T(b^* - b_j) + r_j \quad \text{and} \\
&\gamma_0 + \gamma_1' b_i - (b^* - b_i)'T(b^* - b_i) + r_i \geq \\
&\gamma_1' b_{N+1} - (b^* - b_{N+1})'T(b^* - b_{N+1}) + r_{N+1}\}, \quad i, j = 1, \ldots, N, i \neq j
\end{aligned}
\tag{3.2}
$$

The above can be written as

$$
\begin{aligned}
&\Delta_i = \{b^* \in \Delta \mid \gamma_1' b_i + 2b^{*\prime}Tb_i - b_i{}'Tb_i + r_i \geq \\
&\gamma_1' b_j + 2b^{*\prime}Tb_j - b_j'Tb_j + r_j \quad \text{and} \\
&\gamma_0 + \gamma_1' b_i + 2b^{*\prime}Tb_i - b_i'Tb_i + r_i \geq \\
&\gamma_1' b_{N+1} + 2b^{*\prime}Tb_{N+1} - b_{N+1}{}'Tb_{N+1} + r_{N+1}\} \Leftrightarrow \\
&\Delta_i = \{b^* \in \Delta \mid \gamma_1' b_i - \gamma_1' b_j + 2b^{*\prime}T(b_i - b_j) - (b_i'Tb_i - b_j'Tb_j) \geq \\
&r_j - r_i \quad \text{and} \\
&\gamma_0 + \gamma_1' b_i - \gamma_1' b_{N+1} + 2b^{*\prime}T(b_i - b_{N+1}) - (b_i'Tb_i - b_{N+1}{}'Tb_{N+1}) \geq \\
&r_{N+1} - r_i\}, \quad i, j = 1, \ldots, N, \quad i \neq j
\end{aligned}
\tag{3.3}
$$

We see that bank i can increase its deposit base (Δ_i times one unit of cash) and *market share* (Δ_i/Δ) unambiguously by increasing its deposit rate. Under plausible parameter and b* values (not too small), an increase in the size of branch and ATM networks also leads to an increase in market share. We see from the first formulation in (3.3) that an increase in network size unambiguously increases market share as long as $b^* \geq (b_i/2)$, regardless of the values of the parameters γ_1 and T.

The tradeoff between changing the deposit rate or the scope of the distribution network depends on the utility parameters (γ_1, T) (*competition among banks*) or (γ_0, γ_1, T) (*competition with the nonbank supplier*). Note that when all banks increase or reduce their networks proportionally, market shares remain unaffected across banks, but when banks reduce their networks their competitive position vs the nonbank rival weakens. This is the *network size effect,* which is not present in the spatial applications. A change is network size *relative* to rivals affects the scope of the *network differentiation effect* across banks.

The quantities ($r_j – r_i$) and ($r_{N+1} – r_i$) in (3.3) indicate the sizes of the *strategic advantages* of bank i (vs its rivals) due to its branch and ATM networks.[76] Bank i can win depositors with a given b* as long as its deposit rate does not fall below its competitors' rates by more than these amounts.

The set of depositors who choose the nonbank supplier (Δ_{N+1}) is obtained by reversing the direction of the latter inequalities in (3.2) and (3.3). Note that as long as $\gamma_0 > 0$ the nonbank competitor can attract deposits only by raising its interest rate offer.

Derivation of the perceived deposit supply functions, D_i, requires integration over each Δ_i (i = 1, .., N+1), ie

$$D_i = \int_{\Delta_i} \mu db^* \qquad (3.4)$$

where μ is the uniform density of depositors over Δ. (3.4) does not have a closed form solution, but the FL theory proposes a first-order approximation for the quadratic utility function used in (3.1). Their proposition 1 proves the existence of the following semi-elasticities[77] (adapted to deposit rates instead of prices) with respect to own and rivals' deposit rates

---

[76] Alternatively, these quantities measure the *imperfectness of the substitutability* of bank i's services, ie the degree of insulation of bank i from price competition due to its branch and ATM networks.

[77] It is not possible to derive a closed form deposit supply function even in the case of uniform densities μ. Anderson et al (1989) show that a solution exists only when the total number of firms minus one does not exceed the number of differentiation parameters.

$$\text{(a)} \quad \frac{\partial D_i}{\partial r_i D_i} = \sum_{j \neq i}^{N+1} \frac{M\delta_{ij}}{(h_{ij} + \omega_j - \omega_i)}$$

$$\text{(b)} \quad \frac{\partial D_i}{\partial r_j D_i} = \frac{-M\delta_{ij}}{(h_{ij} + \omega_j - \omega_i)} \qquad (3.5)$$

$$\text{(c)} \quad \sum_{j \neq i}^{N+1} \delta_{ij} = 1$$

These semi-elasticities characterize the perceived deposit supply curves, and consequently in section 3.3 the oligopoly pricing equilibrium. The condition of continuous differentiability, necessary for applying the first-order approximation, requires that Δ_i be convex.

In (3.5) h_{ij} is the difference between banks i and j in terms of the *differentiation parameters*, $h_{ij} = (b_i – b_j)'T(b_i – b_j)$, ω_i is the *'utility adjusted price'*, $i – r_i – \gamma_0 – \gamma_1' b_i$, i = market interest rate, expressing price as an interest loss to the depositor, and M is the number of differentiation parameters (here M=2). Finally, the δ_{ij}'s are bank-specific weights, each equal to the share of i's market space that is exposed to competition with j. Because of the assumption that the subsets accounted for by all market participants are fully exposed to competition with rivals, the summation in (3.5c) is strictly equal to one, according to the FL theory. Competition with all market players was one of the basic requirements set out for the model in chapter 1, due to increasing customer mobility because of remote access possibilities. Now, the weights can also be interpreted to correspond to each rival's (endogenously determined) market share, which are normalized so that condition (3.5c) is satisfied. This also has intuitive appeal, since the bigger the market participant in relative terms, the larger its impact on the semi-elasticities. The structure of the weights is thus

$$\sum_{j \neq i}^{N} \delta_{ij} + \delta_{iN+1} \equiv \delta_{-i} + \delta_{N+1} = 1 \qquad (3.6)$$

where δ_{-i} is the joint market share of bank i's rival banks, and δ_{N+1} that of the nonbank competitor (notation simplified).

Result 3.1
The elasticity of bank i's perceived deposit supply (D_i) with respect to the own deposit rates (> 0) can be written as

$$\varepsilon_i^D \equiv \frac{\partial D_i}{\partial r_i}\frac{r_i}{D_i} = \sum_{j\neq i}^{N} \frac{2r_i\delta_{ij}}{(h_{ij} + \gamma_1{'}b_i - \gamma_1{'}b_j + r_i - r_j)} + \frac{2r_i\delta_{N+1}}{(h_{iN+1} + \gamma_0 + \gamma_1{'}b_i - \gamma_1{'}b_{N+1} + r_i - r_{N+1})} \tag{3.7}$$

or

$$\varepsilon_i^D = 2r_i\left[\frac{\delta_{-i}}{h_i^B} + \frac{\delta_{N+1}}{h_i^{NB}}\right] = \frac{2r_i}{H_i}, \quad i, j = 1,\ldots,N, i \neq j$$

PROOF. (3.7) results after applying (3.5) and (3.6). The second expression is obtained by multiplying the first term of the first expression by

$$1 = \frac{\sum_{j\neq i}^{N}\delta_{ij}}{\sum_{j\neq i}^{N}\delta_{ij}} = \frac{\delta_{-i}}{\sum_{j\neq i}^{N}\delta_{ij}}$$

and defining h_i^B, h_i^{NB} and H_i as

$$h_i^B \equiv \left[\sum_{j\neq i}^{N}\frac{\delta_{ij}/\sum_{j\neq i}^{N}\delta_{ij}}{\left(h_{ij} + \gamma_1'b_i - \gamma_1'b_j + r_i - r_j\right)}\right]^{-1}$$

$$h_i^{NB} \equiv \left[\frac{1}{\left(h_{iN+1} + \gamma_0 + \gamma_1'b_i - \gamma_1'b_{N+1} + r_i - r_{N+1}\right)}\right]^{-1} \tag{3.8}$$

$$H_i \equiv \left[\frac{\delta_{-i}}{h_i^B} + \frac{\delta_{N+1}}{h_i^{NB}}\right]^{-1}, \quad i, j = 1,\ldots,N, i \neq j$$

h_i^B is a price-adjusted summary measure of bank i's differentiation vs *rival banks* as regards branch and ATM networks, and h_i^{NB} vs *the nonbank rival*. Finally, the overall differentiation measure, H_i, is a combination (weighed harmonic mean) of the measures h_i^B and h_i^{NB} and is increasing in both. Appendix 3.1 reports the first-order approximations for the perceived deposit supply functions.

Bank i's perceived deposit supply (D_i) is, first, the more inelastic (ie the greater its pricing power), the more it is differentiated from its rivals in terms of branches and ATMs, ie the larger the values of h_i^B and h_i^{NB}. The competitive stance vs any rival is the more important, the larger the rival's market share. Second, the deposit supply elasticities are decreasing in the differences in the utility adjusted deposit rates, ie they are not constant, but decreasing in r_i, given the rivals' deposit rates. Third, the elasticities are increasing in rivals' market shares (δ_{-i} and δ_{N+1}). Hence a bank's market power is the greater, the bigger its market share,which is a usual result.[78]

Banks' pricing power is only due to the competitive advantage vs the nonbank competitor in three cases. First, under symmetric banking industry configurations ($b_i = b$ and $\delta_{ij} = \delta$, i,j = 1, ..., N) each bank's 1/H is the same, and equals (δ_{N+1}/h^{NB}). In this case the deposit supply elasticity faced by all banks depends only on the standing against the nonbank rival (*network size effect*). The aggregate elasticity falls with the size of banks' branch and ATM networks and with the utility parameters T, γ_1, γ_0, and rises with δ_{N+1}.[79] Second, this result holds for the banks that get no benefit from differentiation in terms of the network size. Under plausible parameter and b* values, this holds for the bank with the smallest branch and ATM networks. Third, there is no competitive advantage vs other banks when banks' branch and ATM outlets are compatible, ie banks' clients can use also rival banks' outlets. In this case, however, the *total network size* matters, producing a competitive advantage vs the competitors not having branch or ATM networks. Compatibility can be easily handled in the model by setting the number of outlets for each bank equal to the sum

[78] It can be easily shown that the own-rate elasticity of deposit supply faced by the nonbank supplier falls (pricing power rises) with δ_{N+1}, and rises (pricing power decreases) with T, γ_{11}, γ_0 and the size of banks' delivery networks.

[79] A uniform increase in banks' deposit rates leads to a rise in the deposit supply to the banking sector of [$2\delta_{N+1}/h^{NB}$], which characterizes the elasticity of aggregate banking industry deposit supply in the symmetric cases.

of the outlets of the participating banks. Without compatibility, externalities related to the total number of outlets should not exist, since depositors can use only their own bank's outlets.

Result 3.2

The cross-elasticities of bank i's perceived deposit supply with respect to rivals' rates (< 0) are

$$\varepsilon_{ij}^{D} \equiv \frac{\partial D_i}{\partial r_j}\frac{r_j}{D_i} = -\frac{2r_j\delta_{ij}}{\left(h_{ij} + \gamma_1' b_i - \gamma_1' b_j + r_i - r_j\right)}, \quad i, j = 1,\ldots, N, i \neq j,$$
$$\varepsilon_{iN+1}^{D} = -\frac{2r_{N+1}\delta_{iN+1}}{h_i^{NB}} \qquad (3.9)$$

PROOF. (3.9) is obtained by applying (3.5), (3.6), (3.7) and (3.8).

We see that branch and ATM differentiation makes the deposit supply faced by banks more insulated from rivals' offers. The bigger the market share of the rival, the bigger the impact of its deposit rate on the deposit supply to bank i.

The present model de facto classifies banks in a quality dimension depending on their numbers of branches and ATMs, ie offered service availability through these 'physical' delivery channels. Thus, a type of *vertical differentiation* is present, the differentiation parameter being proximity to customers.

For a *spatial interpretation* of the model, one can consider that the more branches and ATMs a bank has, the denser its (uniform) distribution of outlets, and the closer the bank gets to the representative depositor in geographic terms.[80] In fact, the key predictions of Salop's (1979) model of spatial competition, and its banking applications, are also reproduced here. The 'own rate' elasticity falls with the bank's market share (which in Salop's model is represented by the segment of the 'circle' that the bank occupies), and the elasticity decreases with depositors' transport and transaction costs. However, as noted, the present model is more general. As customers can bank with a number of institutions and become increasingly mobile and less loyal to a single bank, dropping the

[80] The market space might be thought as a square in a two-dimensional Euclidean space.

spatial structure of ‘competition just among geographic neighbours’ is justified.[81]

3.2.2 Demand for loans

The basic assumptions are the same for the loan and deposit markets. Borrowers are uniformly distributed over a market space (P), and each borrower needs to borrow one unit of funds from a bank or nonbank. A representative borrower’s utility can be expressed as

$$
\begin{aligned}
&U\left(b_{1i}, b_1^*, t_i\right) = u\left(b_{1i}, b_1^*\right) - t_i = \eta_0 + \eta_1 b_{1i} - \left(b_1^* - b_{1i}\right)^2 \nu - t_i, \\
&i = 1, \ldots, N \\
&U\left(b_{1N+1}, b_1^*, t_{N+1}\right) = u\left(b_{1N+1}, b_1^*\right) - t_{N+1} \\
&= \eta_1 b_{1N+1} - \left(b_1^* - b_{1N+1}\right)^2 \nu - t_{N+1}
\end{aligned}
\tag{3.10}
$$

where b_1^* is the preferred branch network density, t the loan rate, η_0 the quality difference between banks’ and nonbank’s credit-related services, which is not related to service accessibility, η_1 borrowers’ constant marginal utility of branches, and ν the constant rate at which utility declines when accessibility to branches is not the preferred accessibility.

The interpretation of the ‘utility parameters’ differs from that for the deposit market: η_0 captures the greater utility that borrowers could get from the keener credit risk evaluation and project selection consultation offered by banks than the nonbank lender, which saves borrowers’ costs and increases the expected return on projects for which financing is obtained. The prerequisite for these benefits is that banks have superior information on the borrower and his environment.

In addition to the transport (search) and transaction cost arguments, the positive values of parameters η_1 and ν imply that branching delivers information-related benefits with respect to credit risk evaluation and monitoring. These two parameters approach zero when branching ceases to be a superior device for collecting

[81] The model is especially suited to characterizing competition in a banking system where there are few nationally operating universal banks competing with each other. Scandinavian countries and many other European countries exhibit such banking systems, in contrast to the dispersed US system.

information on borrowers; ie the close 'physical' contact to borrowers fails to deliver special advantages compared with the remote dissemination of information.

Traditionally, lenders with fewer branches, who are more costly to reach and to inform for purposes of credit risk evaluation and monitoring, need to compensate borrowers through lower rates. The costs of informing the lender are important, especially in the case of small firms. According to the literature, the information-related costs are also the main reason why small firms resort to bank lending rather than to capital market finance (eg Mayer 1990 and Petersen and Rajan 1994). Branching enables getting closer to the customer and better evaluating and monitoring credit risk, which produces a pricing advantage, as the credit risk can be more accurately priced. This benefits the borrower as well as the bank. Hence, new information technologies could reduce the benefits of branching, especially at the low-risk end of the spectrum (consumer credits and mortgages, short-term collateralized commercial credits), rather than in risky corporate lending, which requires close scrutinizing of borrowers.

The set of borrowers, P_i, who choose bank i is defined in a similar fashion as the set Δ_i. The tradeoff between changing the loan rate or the scope of the branch network depends on the utility parameters (η_1, ν) (*competition among banks*) or (η_0, η_1, ν) (competition *with the nonblank credit supplier*).

The FL theory is again applied to approximate the semi-elasticities of the perceived loan demand (L_i) for bank i (now, M=1).[82]

[82] The condition of continuous differentiability requires that P_i be convex.

Result 3.3

Analogously to result 3.1, the elasticity of bank i's perceived loan demand (L_i) with respect to own lending rates (< 0) can be written as

$$\varepsilon_i^L \equiv \frac{\partial L_i}{\partial t_i}\frac{t_i}{L_i} = -\sum_{j\neq i}^{N} \frac{t_i \rho_{ij}}{\left(k_{ij} + \eta_1 b_{1i} - \eta_1 b_{1j} + t_j - t_i\right)}$$
$$- \frac{t_i \rho_{iN+1}}{\left(k_{iN+1} + \eta_0 + \eta_1 b_{1i} - \eta_1 b_{1N+1} + t_{N+1} - t_i\right)}$$
$$i, j = 1,..., N, \quad i \neq j \qquad (3.11)$$

or

$$\varepsilon_i^L = -t_i\left[\frac{\rho_{-i}}{k_i^B} + \frac{\rho_{N+1}}{k_i^{NB}}\right] = -\frac{t_i}{K_i} \quad i = 1,..., N$$

where

$k_{ij} \equiv (b_{1i} - b_{1j})^2 \nu$, i, j = 1,...,N+1, $i \neq j$ and

$$k_i^B \equiv \left[\sum_{j\neq i}^{N} \frac{\rho_{ij} / \sum_{j\neq i}^{N} \rho_{ij}}{\left(k_{ij} + \eta_1 b_{1i} - \eta_1 b_{1j} + t_j - t_i\right)}\right]^{-1}$$

$$k_i^{NB} \equiv \left[\frac{1}{k_{iN+1} + \eta_0 + \eta_1 b_{1i} - \eta_1 b_{1N+1} + t_{N+1} - t_i}\right]^{-1} \qquad (3.12)$$

$$K_i \equiv \left[\frac{\rho_{-i}}{k_i^B} + \frac{\rho_{N+1}}{k_i^{NB}}\right]^{-1}, \quad i = 1,..., N, i \neq j$$

and where the normalized weights for the semi-elasticities based on rivals' market shares satisfy

$$\sum_{j\neq i}^{N} \rho_{ij} + \rho_{N+1} \equiv \rho_{-i} + \rho_{N+1} = 1 \qquad (3.13)$$

where ρ_{-i} is the joint market share of bank i's rival banks, and ρ_{N+1} that of the nonbank competitor.

k_i^B represents a price-adjusted summary measure of bank i's differentiation in terms of branches *vs rival banks*, and k_i^{NB} *vs the nonbank rival*. K_i, the overall measure of differentiation, is a combination (weighted harmonic mean) of the two measures, and is increasing in both. Appendix 3.1 contains the first-order approximations for the bank-specific loan demand functions.

First, bank i's perceived loan demand (L_i) is the more inelastic (its pricing power the greater), the larger the values of k_i^B (and k_i^{NB}), which are increasing in b_{1i}, ν, η_1 (and η_0). Second, the elasticity is decreasing in absolute value of differences in utility-adjusted loan rates, ie increasing in t_i. Third, the elasticity is increasing in absolute value in rivals' market shares (ρ_{-i} and ρ_{N+1}).[83] Finally, under symmetric industry configurations, the *within* banking industry effects of branch networks again cancel out, and each bank's 1/K equals ρ_{N+1}/k^{NB}.[84]

As in the deposit market, there should not be significant network externalities related to the total size of the banks' branch network, because information on borrowers' quality is private to the banks and should not benefit the rivals (ie there should be no *total network size effect*).[85]

[83] The perceived loan demand elasticity for the nonbank supplier is decreasing (pricing power increasing) in absolute value in ρ_{N+1} and increasing in ν, η_1, η_0 and the size of banks' branch networks.

[84] The elasticity of the aggregate loan demand for the banking industry is characterized by $-[\rho_{N+1}/k^{NB}]$ in the symmetric cases.

[85] Support for this contention is provided in Kim and Vale (1997), as the authors do not find evidence of any externalities associated with the total number of branches in the Norwegian bank credit market.

Result 3.4
Analogously to result 3.2, the cross-elasticities of bank i's perceived loan demand (> 0) with respect to rivals' loan rates can be written as

$$\varepsilon_{ij}^{L} \equiv \frac{\partial L_i}{\partial t_j}\frac{t_j}{L_i} = \frac{t_j \rho_{ij}}{\left(k_{ij} + \eta_1 b_{1i} - \eta_1 b_{1j} + t_j - t_i\right)}, \quad i, j = 1, ..., N, i \neq j,$$
$$\varepsilon_{iN+1}^{L} = \frac{t_{N+1}\rho_{iN+1}}{k_i^{NB}} \tag{3.14}$$

Differentiation in terms of branches insulates the loan demand for bank i from rivals' rates, as does a positive quality advantage vs the nonbank competitor.

The predictions are again in line with the core results from spatial models of banking competition, while the treatment here is more general. There are signs of increasing mobility and decreasing customer loyalty of borrowers as well, which reduces the significance of the spatial aspect and supports the adopted broader view of competition among all market participants.

3.3 Short-term oligopolistic competition in loan and deposit rates

This section presents the second-stage equilibrium conditions for noncooperative and cooperative cases and examines the determinants of banks' markups. These conditions are needed for the applications of the model presented at the end of this chapter and the empirical analysis reported in chapter 4. The next section studies the first stage to determine the subgame perfect equilibrium.

The main results of this section relate to a detailed examination of the sources of pricing power and how they are inversely affected by alternative delivery technologies. In addition, the variability of banks' interest rates is shown to decline with the technological progress, given the size of banks' branch and ATM networks.

In the price competition phase (stage two) banks choose the loan and deposit rates to maximize profits, given the delivery capacity from stage one (and the number of banks from stage zero)

$$\begin{aligned}
&\max_{(t_i, r_i)} \pi_i(i, t_i, t_j, r_i, r_j, b_i, b_j, K_i, H_i, N) \\
&= t_i L_i(t_i, t_j, b_{1i}, b_{1j}, K_i, N) + iS_i(L_i, D_i) \\
&- r_i D_i(r_i, r_j, b_i, b_j, H_i, N) - C_i(L_i, D_i, b_i) \\
&\text{s.t.} \quad S_i \equiv D_i - L_i, \quad i, j = 1, \ldots, N, \quad i \neq j
\end{aligned} \tag{3.15}$$

The balance restriction, S_i, equals the amount of excess deposits invested in securities that earn a market rate of interest ($D_i > L_i$) or the amount of market funding for excess loans ($D_i < L_i$).

Following the widely-applied Klein-Monti model (eg Santomero 1984, Freixas and Rochet, 1997), it is assumed that banks can exercise market power when setting loan and deposit rates but are too small to influence the money market rate (i). In order to keep the model tractable in the later stages, it is assumed that the short-term operating (noninterest) costs ($C_i(L_i, D_i, b_i)$) are separable by activity (ie $\partial^2 C/\partial L \partial D = 0$) and that the second partial derivatives of the cost function are zero with respect to the arguments. The first assumption implies that economies or diseconomies of scope do not exist and the second that (short-run) marginal operating costs are constant with respect to lending and deposit volumes. Finally, the cost functions may be bank-specific.[86]

Since revenues are concave under the adopted deposit supply and loan demand specifications, there exists a point of maximum profits for the above cost specifications. In the following, the assumption of noncooperative Bertrand conduct in the setting of loan and deposit rates is first applied, but this restriction is relaxed later on.

[86] The marginal operating cost of granting loans (c^L) includes an average expected credit risk per unit of incremental loans granted. The marginal operating cost of security investments is assumed to be zero and the reserve requirement is excluded for simplicity.

Result 3.5

If banks act as Bertrand competitors treating the loan and deposit rates of other banks as fixed, the Nash equilibrium loan $\left(t_i^*\right)$ *and deposit rates* $\left(r_i^*\right)$ *are*

$$
\begin{aligned}
t_i^*\left(i, c_i^L, b_{1i}, N\right) &= i + c_i^L + \left[\frac{\rho_{-i}}{k_i^B} + \frac{\rho_{N+1}}{k_i^{NB}}\right]^{-1} = i + c_i^L + K_i \\
r_i^*\left(i, c_i^D, b_i, N\right) &= i - c_i^D - \frac{1}{2}\left[\frac{\delta_{-i}}{h_i^B} + \frac{\delta_{N+1}}{h_i^{NB}}\right]^{-1} = i - c_i^D - \frac{H_i}{2}
\end{aligned}
\qquad (3.16)
$$

where

$$
c_i^L \equiv \frac{\partial C_i}{\partial L_i} = c_i^L(b_{1i}), \quad \text{and} \quad c_i^D \equiv \frac{\partial C_i}{\partial D_i} = c_i^D(b_i), \quad i, j = 1, \ldots, N
$$

PROOF. Appendix 3.2. The second-order conditions are analysed in section 3.5.

We see that banks' *markups* in the loan and deposit markets are the wider, the higher the values of the differentiation measures against other banks and the nonbank rival.[87] Result 3.5 is in line with vertical differentiation models, in which firms with higher quality can set higher prices.

The *relative markup* or *Lerner index* of bank i's price competition intensity (defined as the ratio of price minus marginal cost to price), equals the inverse of the absolute value of the perceived loan demand or deposit supply elasticity, ie K_i/t_i or $H_i/2r_i$. Therefore, the analysis of markups coincides with the analysis of the perceived elasticities, and the factors that give pricing power vs other banks can be separated from those that give pricing power for the banking industry as a whole. When the respective elasticities are infinite, markups vanish and banks act as price takers in the loan and deposit markets. The

[87] When $L_i > D_i$ i equals banks' marginal cost of funds. When $L_i < D_i$, banks' marginal cost of funds $\left(r_i + c_i^D\right)$ can be lower than i, but then i represents the opportunity return on investment and $\left(r_i + c_i^L\right)$ is the minimum that should be earned from incremental lending.

markups go to zero when both k_i^B and k_i^{NB} or both h_i^B and h_i^{NB} are zero or when there are neither network differentiation nor network size (nor total network size) effects.

Table 3.1 summarizes the key comparative static properties of the equilibrium loan and deposit markups in absolute terms. Banks' loan (deposit) markups go to zero when η_1, η_0 and ν (γ_{11}, γ_{12}, γ_0, and τ_1, τ_2) go to zero *simultaneously*. Thus positive marginal utilities derived from 'physical' banking outlets (ie the transport, search or transaction cost savings associated with these outlets), or a positive service quality gap vs nonbanks, can alone maintain some pricing power for banks. However, the diffusion of the remote access technologies, and the decreasing cost of using them, reduces all these parameters, which generates a *permanent* and *structural* increase in competition. Expansion in the nonbank's activities has the same effect, as the markups are decreasing in ρ_{N+1} and δ_{N+1} respectively.

Table 3.1. **Signs of comparative static effects on equilibrium markups**

	$\left(t_i^* - i - c_i^L\right) = K_i$	$\left(i - r_i^* - c_i^D\right) = H_i / 2$
K_i, k_i^B, k_i^{NB}	+, +, +	0, 0, 0
H_i, h_i^B, h_i^{NB}	0, 0, 0	+, +, +
η_1, η_0	+, +	0, 0
γ_{11}, γ_{12}, γ_0	0, 0, 0	+, +, +
ν	+	0
τ_1, τ_2	0, 0	+, +
ρ_{-i}, ρ_{N+1}	–, –	0, 0
δ_{-i}, δ_{N+1}	0, 0	–, –
N^*	–	–

* If $\partial\rho_{-i}/\partial N > 0$ or $\partial\delta_{-i}/\partial N > 0$.

Result 3.6

In the cooperative case, the Nash equilibrium loan $\left(t_i^*\right)$ *and deposit rates* $\left(r_i^*\right)$ *are*

$$t_i^*\left(i, c_i^L, b_{1i}, N\right) = i + c_i^L + \left[(1-\theta_L)\left(\frac{1}{K_i}\right) + \theta_L\left(\frac{1}{L_i}\right)\sum_{j\neq i}^{N}\left(\frac{\partial \rho_{ij}}{\partial t_j}\right)\right]^{-1}$$

$$\approx i + c_i^L + \left[(1-\theta_L)\frac{1}{K_i}\right]^{-1} \qquad (3.17)$$

$$r_i^*\left(i, c_i^D, b_i, N\right) = i - c_i^D - \left[(1-\theta_D)\left(\frac{2}{H_i}\right) - \theta_D\left(\frac{1}{D_i}\right)\sum_{j\neq i}^{N}\left(\frac{\partial \delta_{ij}}{\partial r_j}\right)\right]^{-1}$$

$$\approx i - c_i^D - \left[(1-\theta_D)\frac{2}{H_i}\right]^{-1}$$

where[88]

$$\theta_L \equiv \frac{\partial t_j}{\partial t_i}, \theta_D \equiv \frac{\partial r_j}{\partial r_i}, i, j = 1,\ldots,N, i \neq j, 0 \leq \theta_L \leq 1, \ 0 \leq \theta_D \leq 1, \text{and}$$

$$\frac{\partial t_{N+1}}{\partial t_i}, \frac{\partial r_{N+1}}{\partial r_i} = 0, \frac{\partial \rho_{ij}}{\partial t_j} < 0, \text{and } \frac{\partial \delta_{ij}}{\partial r_j} > 0$$

ie there is no price coordination between banks and the nonbank.

PROOF. Appendix 3.2.

Equation (3.17) is not in reduced form as loans and deposits and market shares appear on the right hand side of the equations.

[88] Oligopolistic price conjectures (strategic coordination terms) are defined equal across all banks following Waterson (1984). The conjectural variation formulation has been criticised by many theorists (see eg Tirole 1988, ch. 6.2.2), since it gives little insight into the determination of the conjectural variation terms. However, Cabral (1995) finds theoretical justification for the common perception or use of the conjectural variations solution as a reduced form of an equilibrium of an unmodeled dynamic game. In addition, the conjectural variation formulation has turned out to be a very useful way to model cooperative conduct for empirical analysis, as in chapter 4, since the conjectural variation terms can be empirically identified (see eg Bresnahan 1989).

Parameters θ_L and θ_D identify the full range of different cooperative oligopolistic conduct. θ_L and θ_D equal to zero is consistent with noncooperative Bertrand-Nash competition in prices, in which case (3.17) reduces to the 'elasticity relationship' (3.15). In this case, any pricing power is only due to differentiation, captured through the indices K and H. Collusive conduct is consistent with $\theta_L, \theta_D > 0$, and joint profit maximization, ie monopoly or perfect cartel pricing is associated with θ_L and θ_D equal to one. In the latter case banks' markups are the widest.[89] Notice that the oligopolistic price conjectures serve to reduce the elasticity of the perceived loan demand and deposit supply curves and to further widen banks' markups. In symmetric banking industry configurations, collusion can widen banks' markups from those generated solely by the network size effects, ie from those defined by ρ_{N+1}/k^{NB} or δ_{N+1}/h^{NB}.[90]

Since the numbers of branches and ATMs are exogenous in this second stage of the game, I can state the following proposition, given the network decisions from the stage one:

Proposition 3.1.a

The more asymmetric banks are as regards their branch (branch and ATM) networks, market shares and marginal operating costs, the greater the variance of loan (deposit) rates across banks.

Proposition 3.1.b

The greater the utility parameters η and v (γ_{11}, γ_{12} and τ_1, τ_2), the greater the variance of loan (deposit) rates across banks under asymmetric industry configurations.

PROOF. (3.1.a) in the extreme cases of symmetric banking industry configurations ($b_i = b$, $\rho_{ji} = \rho$ and $\delta_{ji} = \delta$, $i = 1,...,N$), all banks have equal markups and the variances of the loan and deposit rates reflect only the variance of the marginal operating costs (which in the model can be due to eg differences in credit risk on the lending side). If marginal costs are also the same, the variance of the rates is zero under symmetric configurations. (3.1.b) holds because the utility

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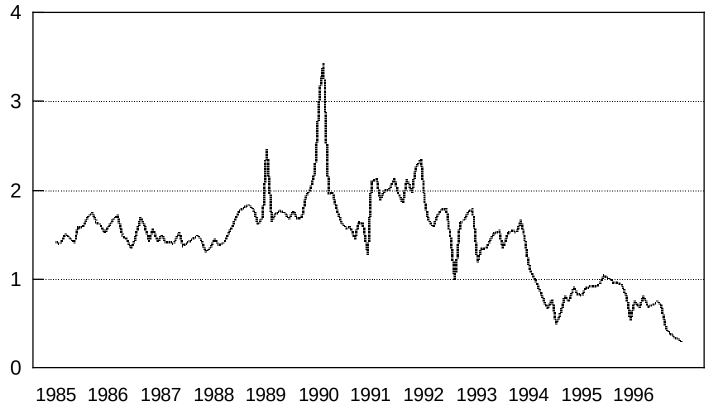
[89] The degree of collusion is given here for the given period of time, and its sustainability to withstand entry, or price changes, is not analysed. The mere existence of a credible nonbank rival may prevent banks from engaging in collusion.

[90] Oligopoly theory concludes that collusion is the likelier the more symmetric the firms (eg Shapiro 1989).

parameters produce differences in banks' markups that are increasing in the values of the parameters.

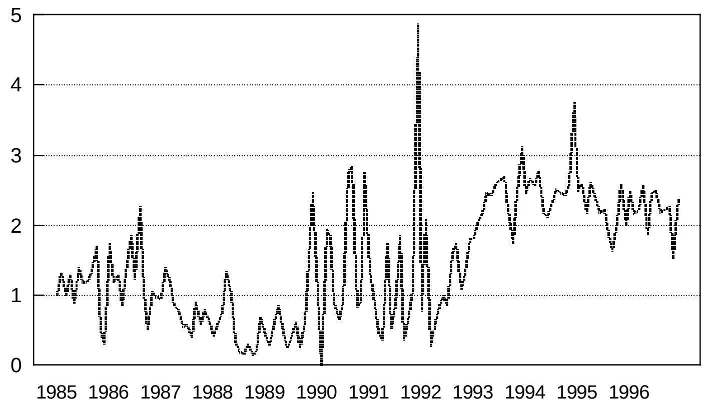
The above propositions indicate that the technological progress can reduce the variability of banks' rates, given their branch and ATM networks. This also refers to the argument that the 'localization' of markets looses its significance. In Finland the average loan and deposit rates have indeed been significantly negatively correlated with branch network size. During the periods of deregulation of banks' deposit rates (1989–1991) and loan rates (1986–1990), the variability of average deposit rates (figure 3.1) and lending rates (figure 3.2) naturally increased. Subsequently, the variability of average loan rates has fallen much less visibly (and the variability is higher) than on the deposit side. This suggests that the significance of banks' 'physical' delivery outlets has remained higher on the lending side. Further discussion on the Finnish evidence is left for more careful empirical work in chapter 4.

Figure 3.1 **Gap between highest and lowest average deposit rates of major Finnish banks, percentage points**



Data source: Bank of Finland.

Figure 3.2 **Gap between highest and lowest average new lending rates of major Finnish banks, percentage points**



Data source: Bank of Finland.

3.4 Branch and ATM network choices and cooperation

This section solves the equilibrium conditions for the first stage competition in branch and ATM networks. The impacts of alternative delivery technologies on branch and ATM capacities are examined, as well as the role of delivery capacity coordination and compatibility arrangements. Capacity collusion reduces the number of branches and ATMs and, under plausible parameter values, lowers banks' markups in price competition (second stage). The impact of compatibility arrangements (sharing delivery outlets) is similar to that of collusion, but the effect of reducing the number of outlets is smaller, if one examines the cases of collusion (no compatibility) and compatibility (no collusion) separately.

In stage one, banks choose their branch and ATM network size (b_1 and b_2) expecting to receive the profits implied by the price sub-game. These capacity choices represent more lasting decisions than the pricing decisions and affect the loan demand and deposit supply faced by banks, as well as the intensity of price competition among market participants.

Bank i chooses b_{1i} and b_{2i} to maximize its reduced form profit function

$$\max_{(b_{1i},b_{2i})} \pi_i^R (t_i^*(b_{1i}, b_{1j}, N), r_i^*(b_i, b_j, N), b_i, b_j, K_i, H_i, N)$$
$$\equiv \pi_i^R (b_i, b_j, N) = t_i^*(b_{1i}, b_{1j}, N)L_i + iS_i - r_i^*(b_i, b_j, N)D_i - \quad (3.18)$$
$$C_i(L_i, D_i, b_i) - f_i\text{'}b_i, i, j = 1,..., N, i \neq j$$

where

$L_i = L_i(t_i, t_j, b_{1i}, b_{1j}, K_i, N)$
$D_i = D_i(r_i, r_j, b_i, b_j, H_i, N)$
$S_i \equiv D_i - L_i$

The vector $f_i = (f_{1i}, f_{2i})$ represents bank-specific sunk costs associated with branch and ATM establishment. Long-run operating costs are thus equal to $C_i + f_i\text{'}b_i$.

Result 3.7
The conditions for sub-game perfect equilibrium numbers of branches (b_{1i}^*) *and ATMs* (b_{2i}^*) *reduce to*

$$\frac{\partial \pi_i^R}{\partial b_{1i}} = (1-\theta_{B1})\left(t_i^* - i - c_i^L\right)\frac{\partial L_i}{\partial b_{1i}}\bigg|_{k_i^B} + \left(t_i^* - i - c_i^L\right)\frac{\partial L_i}{\partial b_{1i}}\bigg|_{k_i^{NB}}$$
$$+ (1-\theta_{B1})\left(i - r_i^* - c_i^D\right)\frac{\partial D_i}{\partial b_{1i}}\bigg|_{h_i^B} + \left(i - r_i^* - c_i^D\right)\frac{\partial D_i}{\partial b_{1i}}\bigg|_{h_i^{NB}}$$
$$- \frac{\partial C_i}{\partial b_{1i}} - f_{1i} = 0 \quad (3.19)$$
$$\frac{\partial \pi_i^R}{\partial b_{2i}} = (1-\theta_{B2})\left(i - r_i^* - c_i^D\right)\frac{\partial D_i}{\partial b_{2i}}\bigg|_{h_i^B} + \left(i - r_i^* - c_i^D\right)\frac{\partial D_i}{\partial b_{2i}}\bigg|_{h_i^{NB}}$$
$$- \frac{\partial C_i}{\partial b_{2i}} - f_{2i} = 0.$$

That is, outlets are established up to the point where the above conditions are satisfied. In (3.19)

$$\theta_{B1} \equiv \frac{\partial b_{1j}}{\partial b_{1i}}, \theta_{B2} \equiv \frac{\partial b_{2j}}{\partial b_{2i}}, \forall i, j = 1,..., N, i \neq j, 0 \leq \theta_{B1} \leq 1, 0 \leq \theta_{B2} \leq 1, \text{and}$$
$$\frac{\partial b_{1N+1}}{\partial b_{1i}}, \frac{\partial b_{2N+1}}{\partial b_{2i}} = 0$$

ie there is no capacity coordination between banks and the nonbank. Note that the partial derivatives are conditioned on the effects on loan demand and deposit supply through k_i^B *and* h_i^B *and* k_i^{NB} *and* h_i^{NB}.

PROOF. Appendix 3.3.[91]

The possibility of coordination in capacity setting is parameterized in a similar fashion as for price coordination. θ_{B1} or θ_{B2} equal to zero signifies perfectly competitive capacity setting, and θ_{B1} or θ_{B2} equal to one perfect coordination.

Since here all customers have equal utility parameters, asymmetric configurations can arise only due to differences in the operating cost functions and sunk branch and ATM establishment costs across banks. The lower the marginal effect of outlets on the operating costs or the smaller the associated sunk costs, the more branches or ATMs a bank establishes.[92] As a result of this notion, a counterpart for proposition 3.1a can be established:

Proposition 3.2
The more asymmetric banks are with respect to the marginal cost effects of branch ($\partial C_i/\partial b_{1i}$) or ATM establishment ($\partial C_i/\partial b_{2i}$) or sunk costs of branches (f_{1i}) or ATMs (f_{2i}), the greater the variance of loan and deposit markups in the second stage of the game.

PROOF. Follows from results 3.5 (or 3.6) and 3.7, since asymmetries across banks with respect to numbers of branches and ATMs would generate differences in markups in the loan and deposit markets.

The differences in the cost effects can be due to differences in input prices (imperfect input markets) or in internal management efficiency.

We see from (3.19) that the wider the envisaged markups in the second stage of the game, the more branches or ATMs are established. This is true as long as $\partial L_i/\partial b_{1i}$, $\partial D_i/\partial b_{1i}$, and $\partial D_i/\partial b_{2i}$ are nonnegative. These conditions hold under plausible values of the respective utility

[91] Although branches and ATMs do not steal business from the same bank's other outlets, there is a sort of cannibalism, however, since setting up ATMs can reduce depositors' valuation of branches (γ_{11}, τ_1). The cost benefits of ATMs would then need to exceed this loss.
[92] This is the same result as obtained from the simple spatial model developed in chapter 1.

parameters, and they hold irrespective of these values when the preferred network sizes are sufficiently large, as has been already established for the size of the market segment captured by bank i

$$\frac{\partial L_i}{\partial b_{1i}} \geq 0 \Leftrightarrow \frac{\partial P_i}{\partial b_{1i}} \geq 0, \text{ i.e. when } b_1^* \geq \frac{b_{1i}}{2}$$
$$\frac{\partial D_i}{\partial b_i} \geq 0 \Leftrightarrow \frac{\partial \Delta_i}{\partial b_i} \geq 0, \text{ i.e. when } b^* \geq \frac{b_i}{2}, \; i = 1,\ldots,N \tag{3.20}$$

Under the conditions of nonnegativity (3.20), the above partial derivatives are increasing in the underlying utility parameters (η_1, γ_{11}, ν, τ_1) and (γ_{12}, τ_2) respectively. Alternatively, a less general formulation could be applied by making the plausible assumption that customers' utility loss is zero whenever the branch or ATM network size exceeds the preferred one (ie a truncated utility function). Under this assumption, the above partial derivatives would always be nonnegative, as there would always be a positive impact of additional branches or ATMs on market share. Hence, an increase in markups would always lead to the establishment of a larger number of branches or ATMs.

Applying result 3.7, we see that under plausible assumptions (as stated above) effective loan or deposit rate regulation (eg a deposit rate ceiling below the free equilibrium rates) widens banks' markups and encourages the setting up of more branches and ATMs, as the marginal benefit of capturing new clients is higher than under effective price competition. In fact, a history of extensive regulation of deposit rates has been regarded as the main reason for extensive branch networks in many European countries (Neven 1993, Chiappori et al 1995).

In sum, increasing price competition lowers the optimal numbers of branches and ATMs. This trend is already now observable in many countries, as noted in section 2.3.

The comparative static effects of the underlying utility parameters on the sub-game perfect equilibrium numbers of branches and ATMs are very complex in the general oligopoly case with N+1 firms, asymmetric costs and two capacity variables. Here, the case of a monopoly bank (or perfect capacity collusion) is studied, for which the comparative static effects of the model parameters are tractable, since only the stance of the monopoly bank vs the nonbank rivals matters. These effects are collected in table 3.2, given the cost assumptions reported in section 3.3. As shown in appendix 3.3, the expressions can be signed with the help of the second-order conditions for profit maximum, and there is no need to make any assumptions about competitive conditions in the pricing stage.

Table 3.2 **Signs of comparative static effects on sub-game perfect equilibrium b_1^* and b_2^* of a monopoly bank (or perfect capacity collusion)**

	b_1^*		b_2^*	
	$\partial^2\pi^R/\partial b_1\partial b_2 < 0$	$\partial^2\pi^R/\partial b_1\partial b_2 > 0$	$\partial^2\pi^R/\partial b_1\partial b_2 < 0$	$\partial^2\pi^R/\partial b_1\partial b_2 > 0$
η_1, ν	+, +	+, +	–, –	+, +
γ_{11}, γ_{12}	?, ?	+, +	?, ?	+, +
τ_1, τ_2	?, ?	+, +	?, ?	+, +
η_0	+	+	–	+
γ_0	?	+	?	+

Whether ATMs increase or reduce the marginal profitability of branches or vice versa determines the cross-effects of the utility parameters. For example, if ATMs reduce the marginal profitability of branches ($\partial^2\pi/\partial b_1\partial b_2 < 0$) (which might be a more plausible case) an increase in borrowers' valuations of branches via higher values of η_1 or ν would reduce the optimal number of ATMs. As a result of two capacity variables on the deposit side, the comparative static impacts of depositors' utility parameters are generally ambiguous under negative cross-effects on marginal profitability, but the impacts will be similar to those on the loan side as long as the direct effects on marginal profitability $\left(\partial^2\pi/\partial b_k^2\right) < 0$, (k = 1, 2), exceed the cross effects on marginal profitability (appendix 3.3). When this holds, the comparative static effect of τ_1 on b_1^* is always positive, for example. Hence, a structural decline in the utility parameters related to branches (η_1, γ_{11}, ν, τ_1) and ATMs (γ_{12}, τ_2) would reduce the optimal numbers of branches and ATMs via increasing price competition. While the monopoly case is illustrative, a note of caution is in place when generalizing these results, since in the general oligopoly case we might encounter ambiguities that do not show up in the comparative static analysis for the monopoly.

Let us next turn to the analysis of the various cooperative arrangements. The following propositions (3.3–3.5) are made under the assumption that conditions (3.20) hold.

Proposition 3.3a

Noncooperative capacity decisions (θ_{B1} or θ_{B2} = 0) lead to the highest numbers of branches or ATMs, and capacity collusion (θ_{B1} or θ_{B2} > 0) always reduces the scope of banks' branch or ATM networks, ceteris paribus.

3.3b

Of the various collusive arrangements, semi-collusion in interest rates only (θ_L or θ_D > 0 and θ_{B1} or θ_{B2} = 0) generates the largest branch and ATM networks; double-collusion in both rates and delivery capacities (θ_L or θ_D > 0 and θ_{B1} or θ_{B2} > 0) produces an intermediate result; and semi-collusion in capacities only (θ_L or θ_D = 0, and θ_{B1} or θ_{B2} > 0) generates the smallest branch and ATM networks.[93]

PROOF. Follows from results 3.6 and 3.7.

Establishment of branches and ATMs by one bank reduces the profits of the others, given their prices. In a cooperative capacity setting, this effect is internalized or banks expect their rivals to match their establishment decisions, and a bank cannot gain market power. The branch and ATM networks of each bank are therefore smaller than under effective capacity competition.[94] Proposition 3.3b reflects the general result that effective price competition reduces the optimal numbers of branches and ATMs, and collusion in prices intensifies competition in nonprice terms.

In Finland, banks set up a joint firm to manage a fully compatible cash dispenser network in 1994. This led to a reduction in the overall number of ATMs by 15 per cent in the first year and by an additional 5 per cent in the second year after the agreement, which is in line with proposition 3.3a. Section 4.3 discusses in more detail the development of ATM networks in Finland.

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[93] Semi-collusion means here collusion in prices or capacity but not both, while double collusion denotes both price and capacity collusion. These issues have been studied in general terms by Fershtman and Gandal (1994), and propositions 3.a and 3.b reflect their general results. Also Matsui (1989) shows how cartel pricing may lead to larger capital investments.

[94] One could also consider that capacity reductions are realized the more rapidly, the more widespread and common across the banking industry a reduction in underlying profitability and ensuing overcapacity problem. This corresponds to the situation in Finland in the mid-1990s. When some banks expand and some face rationalization pressure, collusion is less likely and capacity reductions are more sluggish.

Proposition 3.4
Capacity collusion leads to a decrease in banks' markups in lending and deposit taking over the money market rate and the respective marginal operating costs in the price setting sub-game, ceteris paribus.

PROOF. If there is perfect capacity collusion (θ_{B1} or θ_{B2} = 1), branches or ATMs are extended by result 3.7 up to the point where the marginal benefit due to increasing competitive advantage *vs nonbank rivals*, $\left(\partial k_i^{NB} / \partial b_{1i}\right)$ or $\left(\partial h_i^{NB} / \partial b_i\right)$, equals the respective net increase in costs, $\partial C_i/\partial b_i + f_i$. If capacity collusion is imperfect ($0 \leq \theta_{B1} < 1$ or $0 \leq \theta_{B2} < 1$), more branches and ATMs will be established than stipulated by the above conditions, since banks would strive to realize differentiation benefits *vs other banks* through $\left(\partial k_i^{B} / \partial b_{1i}\right)$ or $\left(\partial h_i^{B} / \partial b_i\right)$ and loan and deposit markups would widen by results 3.5 or 3.6.

Note that $\partial C_i/\partial b_i$ includes the direct marginal cost effect of branches and ATMs and the possible reductions in the marginal operating costs of loans $\left(\partial c_i^{L} / \partial b_{1i}\right)$ or deposit services $\left(\partial c_i^{D} / \partial b_i\right)$ through branch and ATM establishment. Branches could lower the cost of granting loans due to more careful credit risk evaluation and monitoring possibilities, while ATMs could reduce the cost of deposit services due to the savings in labour costs and greater potential for scale economies in electronic processing of payments. These cost effects add to the benefits of the additional outlets on the revenue side.

Compatibility of ATM networks lowers banks h^B's, as they cannot appropriate the benefits of their own proprietary ATM networks *vs other banks* (Matutes and Padilla 1994). In the case of full compatibility, the part of h_i^B generated by b_{2i} vanishes.[95] However, there is an increase in competitive advantage *vs the nonbank competitor* (which is increasing in τ_2 and γ_{12}), which could be substantial (especially for small banks). These benefits, plus the associated cost savings from overlapping functions and realization of the scale economies of automated transactions (lower average costs), must be large enough to compensate for the loss in pricing advantage

[95] In the case of full ATM compatibility, all banks' ATMs are interconnected. Partial compatibility could also be parameterized in the model. Possible free riding effects on ATM establishment under compatibility arrangements are not analysed.

against other banks, in order for banks to enter into a compatibility agreement. After a competitive start, ATM compatibility arrangements have become quite typical in Europe (section 2.3.4), which suggests that the benefits have outweighed the competitive losses.

Proposition 3.5
Full compatibility of all banks' ATMs reduces ATM establishment as perfect capacity collusion in ATMs ($\theta_{B2} = 1$), since competition among banks in ATM establishment disappears. The resulting number of ATMs is, however, higher under compatibility.

PROOF. Full compatibility means that $\partial D_i / \partial b_{2i} \big| h_i^B = 0, i = 1,..., N$ (network differentiation effects vanish), which has the same effect on the equilibrium conditions (3.19) as $\theta_{B2} = 1$. The latter part of 3.5 holds, because $\partial D_i / \partial b_{2i} \big| h_i^{NB}$ increases under compatibility agreements.

Under full compatibility, ATMs are established up to the point that the marginal benefit due to the enhanced competitive standing vs the nonbank rival is offset by the marginal (net) effect on the operating cost of deposit services plus the sunk ATM establishment cost. Section 3.6 discusses the impact of ATM compatibility on banks' pricing and the related competition policy issues.[96] Small banks can, under compatibility arrangements, compete on a more equal footing with larger ones that are themselves able to provide a wide network and realize the related competitive and cost benefits.[97] Hence the benefits from ATM compatibility are asymmetric across banks of different sizes, and large banks are less apt to enter into compatibility arrangements. Of course, the appropriation of the benefits and costs of a common network is an 'internal' pricing issue for the banks included in the agreement, but satisfactory solutions for large banks might be hard to obtain when size differences are large across the banks

[96] In Finland, the compatibility agreements made in the late 1980s had a visible effect of slowing the growth in the total number of cash dispensers (see section 4.3), as the model predicts.
[97] In terms of this model, the decision to enter a compatibility agreement would also depend on the cost asymmetry. The banks with the lowest costs would themselves establish wider networks and be less prone to accept compatibility.

participating in the agreement. In Finland, the largest bank recently disconnected its payment transfer ATMs from the common network.

3.5 Policy issues (I): monetary policy transmission and deregulation of deposit rates

The two policy issues of this section are approached by analysing the short run equilibrium conditions of the model, as set out in section 3.3).

3.5.1 Transmission of money market rates into loan and deposit rates

This section presents a comparative static analysis of the influences of the various aspects covered by the model on the efficiency of monetary policy transmission, defined as the pass-through of money market rate changes into banks' loan (and deposit) rates. The major conclusion is that the declining competitive advantages that banks enjoy in the loan market due to their extensive branch networks and expanding nonbank competition (or declining quality advantage of banks vs nonbanks) unambiguously enhance the transmission of monetary policy. Another important result is that the asymmetries of banks in terms of delivery networks (to the extent that they matter for customers) weaken the transmission process. This result, together with the first one, provides a basis for the conclusion that competitive, technological and structural differences across banking systems can produce differences in the transmission mechanism at the national level, which has been observed in empirical studies. For example, many observers believe that the national segmentation of the European banking industry and their underlying differences in competitive conditions and structure produce significantly country-specific pass-through from policy-controlled interest rates to banks' loan and deposit rates.[98]

[98] See eg Cottarelli and Kourelis (1994), Dornbusch et al (1998), Kieler and Saarenheimo (1998) and Guiso et al (1999).

This chapter contributes by underpinning these effects with a well-founded model. Moreover, the analysis here implies that technological progress in banking would produce convergence in the transmission process by increasing competition and reducing the impact of structural differences. Finally, by providing a detailed micro-level account of the transmission of money market rates into equilibrium loan (and deposit) rates, this analysis provides hypotheses that might be used for related empirical analyses of the stickiness of banks' rates, which are quite scant.

Rotemberg and Saloner (1987) provided a framework for analysing the issue at hand. Namely, they offered an explanation for the often-observed phenomenon of greater price rigidity with a monopoly than with an oligopoly with respect to a change in marginal production cost. Their explanation is partly based on the proposition that firms' incentives to alter prices in response to changes in marginal cost increase with the price elasticity of their perceived demand curves.

This is analogous to the issue of banks changing their rates on loans and deposits in response to a change in the money market rate, as the stance of monetary policy is reflected in the money market rate. Hannan and Berger (1989 and 1991) apply Rotemberg and Saloner's methodology in an empirical study of the pass-through of changes in the money market rate into banks' deposit rates. Their analysis is based on linear deposit supply functions and does not include the loan market; neither do they explicitly examine oligopoly equilibria, which are driven by the *strategic substitutability* or *complementarity* of oligopolists' products, as shown by Bulow et al (1985).

The reaction functions of bank i's rivals, as in Dixit (1986), are summarized as a single aggregate reaction function which defines the optimal reaction of the rivals to a change in bank i's loan and deposit rates.[99] Otherwise, a full solution to the following problems would require solving a system of (N+1)(N+1) equations, which is not manageable with product heterogeneity. As detailed in Bulow et al (1985), the slopes of the aggregate reaction functions are determined by $g^L_{-i} \equiv \partial^2\pi_{-i}/\partial t_{-i}\partial t_i$ and $g^D_{-i} \equiv \partial^2\pi_{-i}/\partial r_{-i}\partial r_i$ for the loan and deposit rates respectively. The slopes of bank i's reaction functions are in turn determined by $g^L_i \equiv \partial^2\pi_i/\partial t_i\partial t_{-i}$ and $g^D_i \equiv \partial^2\pi_i/\partial r_i\partial r_{-i}$. When these quantities are positive, there is strategic complementarity, and the

[99] Dixit (1986) uses this procedure to obtain comparative static results for a general oligopoly model that is capable of handling all the usual equilibrium concepts.

reaction curves are upward sloping. The usual presumption for price competition is that oligopolists regard their products as *strategic complements*: when an oligopolist lowers or raises its price, its competitors adjust their own prices accordingly. Strategic complementarity *always* obtains under the demand and cost specifications here, since Bulow et al (1985) show that, with constant marginal cost (with respect to the strategic variable in question), this holds if an increase in rivals' prices lowers the elasticity of firms' perceived demand curves. We see from result 3.3 that the absolute value of the perceived loan demand elasticity of bank i falls with an increase in rivals' loan rates. In addition, we see from result 3.1 that the value of the perceived deposit supply elasticity decreases with a reduction in rivals' deposit rates.

Changing loan or deposit rates always involves some costs. These include the costs associated with producing customer information (menu costs) and with the possible violation of the implicit or explicit contracts between banks and their customers. Moreover, the sustainability of the new level of the money market rate may be uncertain, which would cause banks to be hesitant in changing their loan rates in order to avoid negative customer reactions ('hysteresis phenomenon'). Hence, following Rotemberg and Saloner (1987) and Berger and Hannan (1989, 1991), bank i's incentive to change loan and deposit rates in response to a change in the money market rate depends on the gross profit gain that results from these decisions.[100] Given the costs of changing customers' rates, the actual changing of the loan or deposit rates is the more likely, the greater the amount by which the overall gross profit would deviate from a new optimum, as defined by the new money market rate, if the rates remained unchanged.

The loss in profits for bank i, if it does not change its loan and deposit rates after an unexpected change in the money market rate, can be approximated by a Taylor series approximation at the old optimum (t_i^* and r_i^*)

[100] When Rotemberg and Saloner (1987) compare a monopoly with a duopoly, they essentially find that price changes are more attractive to a duopolist because some of the benefits thereof are derived at the expense of the competitor, which enhances the positive profit effect.

$$\pi_i(t_i) - \pi_i\left(t_i^*\right) \approx \left(\frac{d\pi\left(t_i^*\right)}{dt_i}\right)(\Delta t_i) + \frac{1}{2}\left(\frac{d^2\pi_i\left(t_i^*\right)}{dt_i^2}\right)(\Delta t_i)^2,$$

$$\Delta t_i = t_i^* - t_i \tag{3.21}$$

$$\pi_i(r_i) - \pi_i\left(r_i^*\right) \approx \left(\frac{d\pi\left(r_i^*\right)}{dr_i}\right)(\Delta r_i) + \frac{1}{2}\left(\frac{d^2\pi_i\left(r_i^*\right)}{dr_i^2}\right)(\Delta r_i)^2,$$

$$\Delta r_i = r_i^* - r_i$$

The first terms in the series are zero due to profit maximization (envelope theorem). The *gross gains* (G) from changing the loan and deposit rates are equal to the negatives of the forgone profits, which are positive by the second order conditions for profit maximization

$$G_i^t \approx -\frac{1}{2}\left(\frac{d^2\pi_i\left(t_i^*\right)}{dt_i^2}\right)(\Delta t_i)^2 > 0, \quad G_i^r \approx -\frac{1}{2}\left(\frac{d^2\pi_i\left(r_i^*\right)}{dr_i^2}\right)(\Delta r_i)^2 > 0 \tag{3.22}$$

Expressing the gross gains in terms of the money market rate change produces the following expressions

$$G_i^t \approx -\frac{1}{2}\left(\frac{dt_i}{di}\right)^2\left(\frac{d^2\pi_i\left(t_i^*\right)}{dt_i^2}\right)(\Delta i)^2,$$

$$G_i^r \approx -\frac{1}{2}\left(\frac{dr_i}{di}\right)^2\left(\frac{d^2\pi_i\left(r_i^*\right)}{dr_i^2}\right)(\Delta i)^2, \quad i = 1,\ldots,N+1 \tag{3.23}$$

The above quantities, giving the *likelihood* of the rate change, can be solved from the second-stage oligopoly equilibrium conditions. The *sizes* of the reactions, (dt_i/di) and (dr_i/di), can be solved as well. This analysis is carried out in appendix 3.4. It turns out that a fully closed form solution for the gross profit gains and the differentials exists only for symmetric banking industry configurations, where the within-banking industry effects cancel out. Although closed form solutions are not obtainable, it is shown in appendix 3.4 that relevant comparative static properties also hold for the general case of asymmetric banking industry configurations.

Table 3.3 and propositions 3.6a and b give the comparative static effects of the model variables and parameters on gross profit gains under strategic complementarity, given the assumptions on the operating cost function (section 3.3). It is shown in appendix 3.4. (results A.3.4.1 and 2) that all factors that increase the profit reduction of not changing the loan and deposit rates also increase the size of the pass-through of a money market rate change to banks' loan and deposit rates. Thus, the effects given in table 3.3 hold also for (dt_i/di) and (dr_i/di).

Table 3.3 **Signs of comparative static effects on incentive to change loan and deposit rates and size of change**

	G_i^t or (dt_i/di)	G_i^r or (dr_i/di)
K_i, k_i^B, k_i^{NB}	–, –, –	0, 0, 0
H_i, h_i^B, h_i^{NB}	0, 0, 0	–, –, –
η_1, η_0	–, –	0, 0
γ_{11}, γ_{12}, γ_0	0, 0, 0	–, –, –
ν, τ_1, τ_2	–, 0, 0	0, –, –
ρ_{N+1}, δ_{N+1}	+, 0	0, +
θ_L, θ_D	–, 0	0, –

Drawing on the analysis presented in appendix 3.4, I state the following propositions.

Proposition 3.6a
(Efficiency of monetary policy transmission)
The response of lending rates to a change in the money market rate is always the more likely and the larger,

– *the less banks are differentiated from rival banks* (k_i^B) *and the nonbank supplier of credit* (k_i^{NB}) *in terms of branch network*
– *the smaller the borrowers' marginal utility of branches* (η_1) *and utility loss of imperfect accessibility to branches* (ν)
– *the smaller the quality difference of banks' credit-related services vs those of nonbank suppliers of credit* (η_0)
– *the less banks' coordinate the pricing of loans (the smaller the* θ_L)
– *the greater the market share of nonbank suppliers of credit* (ρ_{N+1}).

3.6b

The response of deposit rates to a change in the money market rate is always the more likely and the larger,

- *the less banks are differentiated in terms of branch and ATM networks from rival banks* $\left(h_i^B\right)$ *and the nonbank supplier of deposit-related services* $\left(h_i^{NB}\right)$
- *the smaller the depositors' marginal utilities of branches* (γ_{11}) *and ATMs* (γ_{12}) *and respective utility losses due to imperfect accessibility to branches and ATMs* (τ_1 *and* τ_2)
- *the smaller the quality difference of banks' deposit-related services vs those of nonbank suppliers of deposit services* (γ_0)
- *the less banks' coordinate the pricing of deposits (the smaller the* θ_D)
- *the greater the market share of nonbank suppliers of deposit-related services* (δ_{N+1}).

PROOF. Appendix 3.4.

Hence Rotemberg and Saloner's (1987) observation that the perceived demand elasticities determine the size of the price reaction is essentially established here also. All factors that increase the elasticities of perceived loan demand and deposit supply schedules also increase the sensitivities of the loan and deposit rates with respect to money market rate changes.[101] Collusion in price setting increases the rigidity of loan and deposit rates, because it acts as if reducing the perceived elasticity of loan demand or deposit supply. Technological change in banking is apt to structurally increase the pass-through and hence enhance the efficiency of monetary policy transmission, as it reduces the marginal utility of physical banking outlets and the utility losses related to imperfect accessibility.[102]

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[101] Hannan and Berger (1991) find that banks in more concentrated local markets exhibit greater deposit rate rigidity. Cottarelli and Kourelis (1994) find evidence that in international comparison weak transmission of monetary policy can be explained by imperfect competition, which they measure by banking concentration and lack of capital market development.

[102] To the extent that lending rates follow long-term market rates, incomplete pass-through of short-term market rates to long-term rates can also result in incomplete transmission into banks' lending rates. Moreover, fixed rate loans, or discrete adjustment of variable rate loans causes additional stickiness in the average rates on banks' loan stocks, independent of banks' pricing policies. In Finland, the use of short-term market rates and banks own prime rates as reference rates in lending has grown continually. This

Differences across banking systems in the euro area as to how large the pass-through of money market rate changes into banks' lending rates would lead to differences transmission of the single monetary policy. There is evidence that the pass-throughs do differ significantly across European countries;[103] the model here provides a rationale for this relating to the structure of the banking system. Differences in the pass-through produce differing effects of the single monetary policy in terms of the 'interest channel'. According to the above results, technological development in banking would enhance the pass-through of monetary policy changes to lending rates and could produce convergence across countries. This would be the result of less 'localized' and more competitive pricing of credits. Enhanced integration of European credit markets, due to the EMU, would also have the same effect, to the extent that competition increases in the euro area.

Similarly, increased use of the capital market in firms' funding (analogous to more nonbank competition) would make the monetary policy transmission more effective. The disadvantage is that changing conditions in the credit markets produce new uncertainties for monetary policy making. Thus ongoing monitoring of the credit markets would be necessary. Finally, the common monetary policy regime of the euro area should enhance the convergence in the future, since the full range of maturities of money market rates is now uniform for these countries. To the extent that these market rates are used as benchmarks in banks' pricing, and as they reflect expectations of future short-term rates, EMU should to some extent at least, harmonize the pass-through from money market rates to banks' loan and deposit rates.

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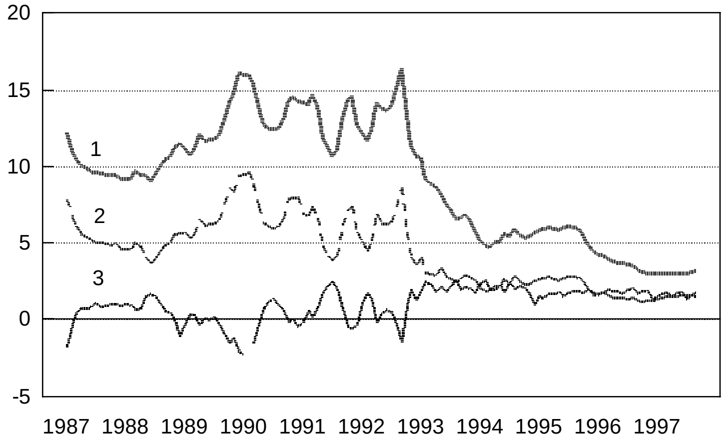
should in principle increase the pass-through of the market rates, but prime rates can still be adjusted imperfectly and banks can absorb changes in money market rates in their margin over the market reference rate, according to the model predictions. Also, banks' choices of the reference rates can be thought of resulting from the competitive conditions as described here.

[103] Borio and Fritz (1995), Cottarelli and Kourelis 1994, Dornbusch et al 1998 and Mojon 2000. There are also a number of country-specific studies reported eg in central bank bulletins.

Figure 3.3 **Finnish banks' average margins in new lending (3) and deposit taking (2) over the money market rate (3-month Helibor) (1) (monthly observations 1987–1998), percentage points**



Data source: Bank of Finland.

The stickiness of loan and deposit rates means that loan margins should narrow and deposit margins widen when the money market rate rises. Figure 3.3 depicts the development of Finnish banks' average margins over the money market rate in lending and deposit taking and demonstrates quite clearly the stickiness of their loan and deposit rates.

Allowing for economies or diseconomies of scope would cause intractability in the case when price coordination is allowed. Nevertheless, it can be shown that a monopoly bank is less likely to react to a change in a money market rate by changing its loan and deposit rates under significant economies of scope. Increasing eg the loan rate would lower the marginal profitability of deposit taking, and this would result in a smaller change in the loan rate. This result is likely to carry over to the oligopoly situation, given the analysis of Bulow et al (1985).[104]

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[104] Lending and deposit taking are likely to exhibit scope economies. For example, the information from deposit customers can be reused when granting loans, which results in lower credit risk to the extent depositors are also lenders. Moreover, the same branches and employees can service loan and deposit customers. Empirical evidence also points to the existence of the economies of scope between loans and deposits (eg Humphrey and Pulley 1993). However, the recent emergence of specialized banks and nonbanks, new delivery technologies and unbundling of many financial services could indicate that economies of scope have lost some of their significance.

Because the perceived loan demand (deposit supply) curve is downward sloping (upward sloping) ie L'< 0 (D' > 0), loan (deposit) rates should be stickier upward (downward) than downward (upward), ceteris paribus. However, the asymmetric reaction may be due to other factors that can work in the other direction, and thus the question of asymmetric reactions becomes primarily an empirical issue. For instance, the breakdown of collusive arrangements is more likely in the case of price decreases, which reduces the incentive to lower loan rates or raise deposit rates, while customer reactions would be more negative in the case of price increases, which increase the costs of raising loan rates or lowering deposit rates.

3.5.2 Implications of asymmetric technological development

The analysis of appendix 3.4 can be used to analyse the impact of asymmetric technological progress on the deposit and loan side. Namely, given strategic complementarity, the following propositions obtain

Proposition 3.7a

If technological transformation proceeds faster in the deposit than loan market, ie H_i falls faster than K_i, due to reductions in the respective utility parameters, loan rates become relatively stickier than deposit rates in responding to money market rate changes.

3.7b

And, banks' loan rates become more unresponsive to deposit rate changes, ie dt_i/dr_i declines.

3.7c

Faster nonbank expansion in the deposit than loan market has the same effects as the faster technological progress.

PROOF. 3.7a obtains directly from propositions 3.6a and b. 3.7b obtains as all factors that increase dt_i/di increase dt_i/dr_i, while all factors that increase dr_i/di reduce dt_i/dr_i (appendix 3.4). Also, 3.7c follows directly from propositions 3.6a and b.

These propositions imply that if the trend of faster progress on the deposit side strengthens or persists, banks' overall interest margins become more and more variable and money market rate increases result in an increasingly adverse direct impact on banks' overall profitability (excluding the indirect effects via macroeconomic performance). This is the case because loan rates would become relatively more insensitive to money market rate changes than would deposit rates, and any deposit rate increase would have a smaller impact on optimal loan rates.

Finally, an increase in price competition in the loan market due to a reduction in banks' differentiation as regards their branch networks or technological progress, or an increase in nonbank competition, would increase the reaction of loan rates to changes in the deposit rate. These kinds of developments in the deposit market would have the opposite effects.

3.5.3 Implications of further deregulation of deposit rates

The traditional justification given for deposit rate regulation was to lower the cost of funds for banks' borrowers. If deposit rates were by regulation below what would obtain under free competition, deregulation would reduce banks' deposit margins and thus have an effect analogous to a decrease in the H_i's. Thus, according to the analysis of the previous section, deregulation would *by itself* make loan rates more insulated from changes in deposit rates.

Even though banking deregulation has proceeded far, some controls, particularly on demand deposit rates, remain in place in many countries. In Finland, up until June 2000 interest earnings on all accounts paying less than a certain rate were taxfree (see chapter 4). This limit reduced banks' interest cost at least by the amount of the customers' tax benefit. Abolition of these exemptions should raise banks' deposit rates, because depositors will require compensation for the additional tax.

An increase in deposit market competition, due to the rapid expansion of remote access possibilities and substitutes for traditional bank accounts, would reduce the future impact of the removal of tax exemptions on bank lending rates. Also in the case of continuously more extensive technological advances on the deposit side than the lending side, further deregulation of banks' deposit rate setting would have a smaller and smaller impact on loan rates, and the repercussions for banks' borrowers would become more and more favourable, in contrast to the traditional views.

As shown by Chiappori et al (1995), loan rates may be cross-subsidized from the deposit margin when deposit rates are regulated, and abolition of this practice after deregulation would result in an increase in loan rates. However, when controls on deposit rates are effected through tax exemptions, as in Finland, banks' cross-subsidization possibilities are significantly less than under definite deposit rate ceilings, since rivals are able to attract depositors with higher, but taxable, deposit rate offerings.[105]

3.6 Policy issues (II): implications for competition policy

From the competition policy viewpoint, a structural increase in competition and contestability of the banking markets strongly alleviates any concerns about adequacy of competition even though there is ongoing consolidation within banking systems, resulting in higher concentration in all EU countries. As regards more specific issues, the analysis of section 3.4 can be used to evaluate the desirability of network compatibility agreements among banks, more specifically, ATM compatibility, which is a wide-spread form of compatibility. All in all, ATM compatibility agreements could be viewed quite favourably from the competition policy viewpoint, as the undesirable effects on consumers seem quite unlikely; in fact, consumers are significantly likelier to benefit than suffer from these arrangements.

The following argumentation underlies the above conclusion. Full ATM compatibility across the banking industry would improve all banks' competitive position vs nonbank suppliers of deposit-related services, while it would cancel out the effects of differences in ATM networks on the degree of differentiation of banks vs other banks. The net effect on banks' markups in the deposit market depends, by results 3.5 and 3.6, on the balance of these two effects. If banks are symmetric in terms of their ATM networks, a compatibility agreement induces an increase in banks' markups, since the former effect dominates the latter. However, the complete effect on deposit rates also includes a possible effect of compatibility on the marginal operating cost of deposit services. ATM interoperability may well lower the per-transaction cost of ATM transactions (and encourage

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[105] In Chiappori et al (1995), cross-subsidization emerges in equilibrium when the model allos for borrowers being required to hold deposit with the lending bank. Such a tying can emerge only when deposit rates are regulated, because otherwise customers can be attracted with more favorable competing interest rate offerings.

customers to use ATMs instead of branches), which could indeed lower the marginal operating cost of deposit services. Hence the more asymmetric banks are in terms of ATM networks and the bigger the marginal cost reducing effect of ATM interoperability, the more favourable (from the customers' viewpoint) the impact of ATM compatibility agreements on deposit rates.

Furthermore, ATM compatibility probably increases the number of outlets that are available to all banks' customers, which would produce a positive utility effect. This excludes the possibility that the network reducing effect of ATMs (proposition 3.5) is so strong that the total number of ATMs falls below the size of some banks' previous network.

European competition law allows banks to engage in cooperation in payment networks (giro circuits and ATM networks) provided the cooperation has no adverse impact on price competition.[106] Based on proposition 3.4, this principle seems sound: capacity collusion in fact supports price competition. This is also supported by the principle of free access to shared payment systems, which helps to reduce the pricing power of large banks. However, the effect of capacity collusion on customer utility is ambiguous, since fewer branches and ATMs reduce the utility and lower markups increase it. In general, these effects would loose their significance with the diffusion of alternative electronic delivery technologies for banking services.

Finally, the definition of *relevant markets* for banking services has been central to this chapter. The general implication is that this issue should be constantly reviewed (eg for merger control purposes). The relevant market has two components, a *geographic market* and a *product market* (eg Smith and Ryan 1997). Remote banking technologies allow customers to obtain financial services easily from suppliers that do not have close physical presence. Hence the focus of competition policy should be increasingly on the national, rather than

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[106] The basic elements of the competition policy guidelines are, firstly, a clear distinction between interbank and bank-client relations; cooperation in the former is tolerated provided there is no adverse impact on competition in bank-customer relations. This distinction was made in the Commission's 'Eurocheque' decision of 1984. Secondly, the Commission has clearly stated that attempts to block entry to shared payment systems, and hence protect participants from outside competition, would be regarded as violations of the antitrust rules of the EU. Finally, EU competition provisions would be breached if the system were open in principle but entry conditions were discriminatory, ie if the levied entry charge and unit compensation for the services provided the 'host network' exceeded the true economic cost of operating the network (including interest on initial investment, depreciation and goodwill). (Commission of the EC 1992, CEPS 1994).

local community, level. Possibilities for cross-border acquisition of services or increasing cross-border merger and acquisition activities can reduce the importance of even the national market. Technological advances, EMU and the European single market are likely to create an increasingly homogeneous market for financial services. In particular, the euro area could become the relevant geographic market, although some remaining barriers, especially due to persisting customer preferences for domestic service providers, could sustain the relevance of national markets. As regards the product markets, a broader interpretation seems to be required as well, and the products and services offered by nonbank providers should be included in the definitions of relevant product markets for banking services.

3.7 Conclusion of chapter 3

Let us conclude by considering the major implications of the analysis in terms of competitive conditions in the banking industry. The model developed in this chapter regards branching and ATM network choices of banks as a means of enhancing demand for loans and supply of deposits and gaining pricing power via differentiation vis-à-vis other banks and nonbank competitors. The extent of these gains depends fundamentally on customers' valuation of branches and ATMs. Technological transformation in retail banking reduces these gains and reduces the competitive advantages of banks' with large networks vs small banks and nonbank rivals. If banks are symmetric in terms of their branch and ATM networks and market shares, banks' pricing power depends only on their competitive standing vs nonbank competitors, if banks' do not act collusively. This in turn hinges on the benefits due to branching and ATM networks (which may be enhanced by compatibility arrangements) and on the quality difference between banks' and nonbanks' services. This quality difference is also affected by technological advances, since eg an increasingly wide assortment of payment and account maintenance services can be offered by nonbank competitors.

Unless banks are able to retrieve market power through differentiating in some novel service quality aspects or through collusion, competition would increase considerably due to the emergence of new electronic delivery technologies and expansion of nonbank supply, even without new entry. As shown in table 3.1, a structural decline in banks' markups in loan (deposit) markets would follow a decline in borrowers' (depositors') marginal utility of branches (branches and ATMs) and in the utility loss via imperfect accessibility to branches (branches and ATMs) associated with the technological transformation. The expansion in nonbank competitors' activities has the same adverse effect on banks' markups.

The possibilities for regaining pricing power seem to be limited, and therefore the resulting customer benefits could be considerable. Technological change certainly provides new possibilities for *product innovation* (eg combining many different financial and nonfinancial products drawing on a centralized pool of customer information) and for obtaining a solid customer base. However, the possibilities for regaining market power seem quite limited, since retail banks are apparently developing their services in the same directions, and the competitive threat from outside the traditional banking industry is increasing in importance (see section 2.3.6). Barriers to entry generated by regulation have also been significantly reduced due to widespread deregulation and the opening-up of international competition following the onset of the European single market and EMU. Moreover, technological development is likely to further reduce barriers to entry through reducing the sunk costs of market entry (which can, in terms of the model, be interpreted as the sunk costs associated with branch and ATM establishment). As a result, the possibilities for collusive conduct have diminished. The outlook is for banks to increasingly attract customers through price competition and thus allow customers to participate in cost savings due to technological advancements in banking.

The fact that banks' profits have usually derived mainly from retail banking suggests that they have indeed been able to capture rents in these activities. X-inefficiency is usually found to vary considerably across banks in many countries, which is another sign of imperfect competition.[107] The pro-competitive effects of technological transformation and nonbank competition are probably strongest in the area of private retail deposit customers, in which banks' have traditionally enjoyed the widest margins. The resulting customer benefits are thus likely to be significant, while banks will have to face a structural decline in their revenues.

Declining markups lower banks' revenues, and as shown in section 3.5.2 more rapid technological transformation and diffusion of nonbank competition on the deposit side, as seems to be taking place, would put particular pressure on banks' net interest revenue. Banks'

[107] Berger and Humphrey (1995) present an extensive survey of the literature.

net interest revenue, and hence profitability, would become more volatile and vulnerable with respect to increases in the money market interest rate.

The numbers of branches and possibly also ATMs are likely to fall in the future, since the equilibrium outcomes depend on the revenue-increasing effects of these outlets, which decline with structural increases in price competition, due to technological transformation and nonbank competition. This trend is already observable in many countries, though there are many additional country-specific reasons.

The major conclusion for monetary policy is that reducing banks' competitive advantages in the loan market (that are due to extensive branch networks) and extending external competition would unambiguously enhance the transmission of money market rate changes into loan rates. That is, the efficiency of monetary policy transmission would increase.

Finally, the channels through which technological change affects the outcomes of price and capacity competition in banking have been identified, which could prove helpful for empirical work on this issue. This is the purpose of chapter 4.

Appendix 3.1

First-order approximations for deposit supply and loan demand

The following first-order approximation can be obtained for banks' deposit supply curves based on results 3.1 and 3.2, as in Feenstra and Levinsohn (1995).

$$\ln D_i = \alpha_0 + 2\frac{\left(r_i + \gamma_0 + \gamma_1' b_i\right)}{H_i} - 2\sum_{j\neq i}^{N} \frac{\delta_{ij}(r_j + \gamma_0 + \gamma_1' b_j)}{(h_{ij} + \gamma_1' b_i - \gamma_1' b_j + r_i - r_j)} - \frac{\delta_{iN+1}(r_{N+1} + \gamma_1)}{(h_{iN+1} + \gamma_0 + \gamma_1' b_i - \gamma_1' b_{N+1} + r_i - r_{N+1})}, \quad i, j = 1, \ldots, N, i \neq j \tag{A.3.1.1}$$

A first-order approximation for banks' loan demand function, based on results 3.3 and 3.4, is

$$\ln L_i = \beta_0 - \frac{\left(t_i - \eta_1 b_{1i} - \eta_0\right)}{K_i} + \sum_{j\neq i}^{N} \frac{\rho_{ij}(t_j - \eta_1 b_{1j} - \eta_0)}{(k_{ij} + \eta_1 b_{1i} - \eta_1 b_{1j} + t_j - t_i)} + \frac{\rho_{iN+1}(t_{N+1} - \eta_1)}{(k_{iN+1} + \eta_0 + \eta_1 b_{1i} - \eta_1 b_{1N+1} + t_{N+1} - t_i)}, \quad i, j = 1, \ldots, N, i \neq j \tag{A.3.1.2}$$

The intercept terms capture the effects on total market size, which increase equally all banks' deposit supply and loan demand.

Appendix 3.2

Derivation of results 3.5 and 3.6

The necessary first-order conditions for profit maximization are

$$\begin{aligned}\frac{d\pi_i}{dt_i} &= L_i + \left(t_i - i - c_i^L\right)\frac{\partial L_i}{\partial t_i} + \left(t_i - i - c_i^L\right)\sum_{j\neq i}^{N}\frac{\partial L_i}{\partial t_j}\frac{\partial t_j}{\partial t_i} = 0 \\ \frac{d\pi_i}{dr_i} &= -D_i + \left(i - r_i - c_i^D\right)\frac{\partial D_i}{\partial r_i} + \left(i - r_i - c_i^D\right)\sum_{j\neq i}^{N}\frac{\partial D_i}{\partial r_j}\frac{\partial r_j}{\partial r_i} = 0\end{aligned} \qquad \text{(A.3.2.1)}$$

The final terms of (A3.2.1) exist only in the cooperative case, which allows for price conjectures.

Since

$$\frac{\partial L_i}{\partial t_j} = \frac{L_i \rho_{ij}}{(k_{ij} + \eta_1 b_{1i} - \eta_1 b_{1j} + t_j - t_i)} + \frac{\partial L_i}{\partial \rho_{ij}}\frac{\partial \rho_{ij}}{\partial t_j}, \quad \text{and}$$

$$\frac{\partial D_i}{\partial r_j} = \frac{D_i \delta_{ij}}{(h_{ij} + \gamma_1' b_i - \gamma_1' b_j + r_i - r_j)} + \frac{\partial D_i}{\partial \delta_{ij}}\frac{\partial \delta_{ij}}{\partial r_j}$$

the first-order conditions can be written as

$$\begin{aligned}&1 - \left(t_i - i - c_i^L\right)\left(\frac{1}{K_i}\right) \\ &\quad + \theta_L\left(t_i - i - c_i^L\right)\left(\sum_{j\neq i}^{N}\frac{\partial L_i}{\partial t_j L_i} - \frac{1}{L_i}\sum_{j\neq i}^{N}\frac{\partial \rho_{ij}}{\partial t_j}\right) = 0 \\ &-1 + \left(i - r_i - c_i^D\right)\left(\frac{2}{H_i}\right) \\ &\quad + \theta_D\left(i - r_i - c_i^D\right)\left(\sum_{j\neq i}^{N}\frac{\partial D_i}{\partial r_j D_i} - \frac{1}{D_i}\sum_{j\neq i}^{N}\frac{\partial \delta_{ij}}{\partial r_j}\right) = 0\end{aligned} \qquad \text{(A.3.2.2)}$$

Results 3.5 and 3.6 are obtained from (A3.2.2) by applying the formulas for own and cross-rate elasticities of section 3.2.1, calculating the respective derivatives of the loan and deposit market shares, and factoring out the equilibrium loan and deposit rates. Note that, according to the model,

$$\sum_{j\neq i}^{N}\frac{\partial L_i}{\partial t_j}=-\frac{\partial L_i}{\partial t_i},\quad \sum_{j\neq i}^{N}\frac{\partial D_i}{\partial r_j}=-\frac{\partial D_i}{\partial r_i}\quad \text{and}\quad \frac{\partial L_i}{\partial \rho_{ij}}=\frac{\partial D_i}{\partial \delta_{ij}}=-1$$

Appendix 3.3

Derivation of result 3.7 and comparative statics for monopoly

To solve the programme (3.18), one need not calculate the derivatives with respect to t* and r* due to the envelope theorem, ie $\partial \pi_i^R / \partial t_i = 0$ and $\partial \pi_i^R / \partial r_i = 0$ and hence $\partial t_j^* / \partial b_{1i}$, $\partial r_j^* / \partial b_{1i}$ and $\partial r_j^* / \partial b_{2i}$ do not appear in the equilibrium conditions. To establish the equilibrium conditions, look instead at the *direct demand effects* of b_1 and b_2 on L_i and D_i and the *strategic effects via rivals' capacity decisions*. The condition for b_{2i} is unaffected by the loan rates or lending volumes.

The *direct demand effects* (conditioned on the competitive effects vis-à-vis other banks and against the nonbank rivals) are as follows

$$\left.\frac{\partial \pi_i^R}{\partial b_{1i}}\right|_{\text{direct demand effect}} = \left(t_i^* - i - c_i^L\right)\left.\frac{\partial L_i}{\partial b_{1i}}\right|_{k_i^B} + \left(t_i^* - i - c_i^L\right)\left.\frac{\partial L_i}{\partial b_{1i}}\right|_{k_i^{NB}} + \left(i - r_i^* - c_i^D\right)\left.\frac{\partial D_i}{\partial b_{1i}}\right|_{h_i^B} + \left(i - r_i^* - c_i^D\right)\left.\frac{\partial D_i}{\partial b_{1i}}\right|_{h_i^{NB}} \qquad \text{(A.3.3.1)}$$

$$\left.\frac{\partial \pi_i^R}{\partial b_{2i}}\right|_{\text{direct demand effect}} = \left(i - r_i^* - c_i^D\right)\left.\frac{\partial D_i}{\partial b_{2i}}\right|_{h_i^B} + \left(i - r_i^* - c_i^D\right)\left.\frac{\partial D_i}{\partial b_{2i}}\right|_{h_i^{NB}}, \quad i = 1,\ldots,N$$

The *strategic effects via rivals' capacity* choices are

$$\left.\frac{\partial \pi_i^R}{\partial b_{1i}}\right|_{\text{strategic capacity effect}} = \left(t_i^* - i - c_i^L\right)\left(\sum_{j\neq i}^{N} \frac{\partial L_i}{\partial b_{1j}} \frac{\partial b_{1j}}{\partial b_{1i}}\right)$$

$$+ \left(i - r_i^* - c_i^D\right)\left(\sum_{j\neq i}^{N} \frac{\partial D_i}{\partial b_{1j}} \frac{\partial b_{1j}}{\partial b_{1i}}\right) \qquad \text{(A.3.3.2)}$$

$$\left.\frac{\partial \pi_i^R}{\partial b_{2i}}\right|_{\text{strategic capacity effect}} = \left(i - r_i^* - c_i^D\right)\left(\sum_{j\neq i}^{N} \frac{\partial D_i}{\partial b_{2j}} \frac{\partial b_{2j}}{\partial b_{2i}}\right),$$

$$i = 1, \ldots, N, i \neq j$$

Result 3.7 holds after combining (A3.3.1) and (A3.3.2) and noting that

$$\left.\frac{\partial L_i}{\partial b_{1i}}\right|_{k_i^B} = \left.\frac{\partial L_i}{\partial t_i}\frac{\partial t_i}{\partial b_{1i}}\right|_{k_i^B} = -\left.\sum_{j\neq i}^{N}\frac{\partial L_i}{\partial t_j}\frac{\partial t_j}{\partial b_{1j}}\right|_{k_i^B}$$

$$\left.\frac{\partial D_i}{\partial b_{1i}}\right|_{h_i^B} = \left.\frac{\partial D_i}{\partial r_i}\frac{\partial r_i}{\partial b_{1i}}\right|_{h_i^B} = -\left.\sum_{j\neq i}^{N}\frac{\partial D_i}{\partial r_j}\frac{\partial r_j}{\partial b_{1j}}\right|_{h_i^B}$$

$$\left.\frac{\partial D_i}{\partial b_{2i}}\right|_{h_i^B} = \left.\frac{\partial D_i}{\partial r_i}\frac{\partial r_i}{\partial b_{2i}}\right|_{h_i^B} = -\left.\sum_{j\neq i}^{N}\frac{\partial D_i}{\partial r_j}\frac{\partial r_j}{\partial b_{2j}}\right|_{h_i^B}, \quad i, j = 1, \ldots, N, i \neq j$$

The comparative static results presented in table 3.2 for a monopoly bank are derived by totally differentiating the equilibrium conditions under result 3.7 with respect to b_1, b_2 and the parameter in question, after adjusting conditions (3.19) for the monopoly case and replacing the loan and deposit markups by K and H/2 respectively (subscript i can be dropped). Finally, the problem does not need to be solved simultaneously for the monopoly bank and the nonbank competitors, since nonbank competitors' capacity is predetermined.

To give an example,

$$\frac{db_1}{d\eta_1} = \frac{-\frac{\partial K}{\partial \eta_1}\frac{\partial L}{\partial b_1}\left(\frac{d^2\pi^R}{db_2^2}\right)}{|\Pi|} > 0, \frac{db_2}{d\eta_1} = \frac{\frac{\partial K}{\partial \eta_1}\frac{\partial L}{\partial b_1}\left(\frac{d^2\pi^R}{db_1 b_2}\right)}{|\Pi|}$$

$$\frac{db_1}{d\tau_1} = \frac{-\frac{1}{2}\frac{\partial H}{\partial \tau_1}\frac{\partial D}{\partial b_1}\left(\frac{d^2\pi^R}{db_2^2}\right) + \frac{1}{2}\frac{\partial H}{\partial \tau_1}\frac{\partial D}{\partial b_1}\left(\frac{d^2\pi^R}{db_1 db_2}\right)}{|\Pi|} \qquad (A.3.3.3)$$

$$\frac{db_2}{d\tau_1} = \frac{-\frac{1}{2}\frac{\partial H}{\partial \tau_1}\frac{\partial D}{\partial b_2}\left(\frac{d^2\pi^R}{db_1^2}\right) + \frac{1}{2}\frac{\partial H}{\partial \tau_1}\frac{\partial D}{\partial b_1}\left(\frac{d^2\pi^R}{db_2 db_1}\right)}{|\Pi|}, \quad \text{where}$$

$$|\Pi| > 0$$

Only the competitive standing vs the nonbank rivals matters for the monopoly bank. This standing is in turn determined by the degree of differentiation of the monopolist vis-à-vis the nonbank rivals, ie K and H depend only on k^{NB} and h^{NB}.

The Cramer determinant ($|\Pi|$) is positive by the second-order condition for the stability of the equilibrium. For example, the first comparative static derivative gets a positive sign, since the second-order derivative of profits with respect to b_2 is negative, due to the second order condition for profit maximization, and K is increasing in η_1. The other comparative static derivatives that appear in table 3.2 are obtained similarly.

Appendix 3.4

Derivation of propositions 3.6a and b

Given the cost assumptions (section 3.3) and the application of Dixit's (1986) methodology (section 3.5.1), the following first-order conditions determine the oligopoly equilibrium

$$\frac{d\pi_i}{dt_i} = L_i + \left(t_i^* - i - c_i^L\right)\frac{dL_i}{dt_i} = 0$$
$$\frac{d\pi_i}{dr_i} = -D_i + \left(i - r_i^* - c_i^L\right)\frac{dD_i}{dr_i} = 0$$
$$\frac{d\pi_{-i}}{dt_{-i}} = L_{-i} + \left(t_{-i}^* - i - c_{-i}^L\right)\frac{dL_{-i}}{dt_{-i}} = 0 \qquad \text{(A.3.4.1)}$$
$$\frac{d\pi_{-i}}{dr_{-i}} = -D_{-i} + \left(i - r_{-i}^* - c_{-i}^D\right)\frac{dD_{-i}}{dr_{-i}} = 0, \quad \text{where}$$
$$L_{-i} \equiv \sum_{j\neq i}^{N+1} L_j \quad \text{and} \quad D_{-i} \equiv \sum_{j\neq i}^{N+1} D_j$$

The differentials dt_i/di and dr_i/di can be obtained by totally differentiating the above system of first-order equilibrium conditions with respect to t_i, r_i, t_{-i}, r_{-i} (latter two representing the average rates of rivals) and i and applying the Cramer's rule. The system of equations takes the following form, given the cost assumptions

$$\begin{pmatrix} \frac{d^2\pi_i}{dt_i^2} & 0 & \frac{d^2\pi_i}{dt_i dt_{-i}} & 0 \\ 0 & \frac{d^2\pi_i}{dr_i^2} & 0 & \frac{d^2\pi_i}{dr_i dr_{-i}} \\ \frac{d^2\pi_{-i}}{dt_{-i}dt_i} & 0 & \frac{d^2\pi_{-i}}{dt_{-i}^2} & 0 \\ 0 & \frac{d^2\pi_i}{dr_{-i}dr_i} & 0 & \frac{d^2\pi_i}{dr_{-i}^2} \end{pmatrix} \begin{pmatrix} dt_i \\ dr_i \\ dt_{-i} \\ dr_{-i} \end{pmatrix} = \begin{pmatrix} -\frac{d^2\pi_i}{dt_i di} \\ -\frac{d^2\pi_i}{dr_i di} \\ -\frac{d^2\pi_{-i}}{dt_{-i}di} \\ -\frac{d^2\pi_i}{dr_{-i}di} \end{pmatrix} di \qquad \text{(A.3.4.2)}$$

Result A.3.4.1

The following holds for the sizes of responses of equilibrium loan (dt_i/di) and deposit rates (dr_i/di) to a change in the money market rate

$$\frac{dt_i}{di} = \frac{\frac{d^2\pi_i}{dt_i di}\left[-\Omega_1 + \frac{g_i^L \Omega_2}{\frac{d^2\pi_i}{dt_i di}}\right]}{\frac{d^2\pi_i}{dt_i^2}\left[\Omega_1 + \frac{g_i^L \Omega_3}{\frac{d^2\pi_i}{dt_i^2}}\right]}, \quad \frac{dr_i}{di} = \frac{\frac{d^2\pi_i}{dr_i di}\left[-\Omega_4 + \frac{g_i^D \Omega_5}{\frac{d^2\pi_i}{dr_i di}}\right]}{\frac{d^2\pi_i}{dr_i^2}\left[\Omega_4 + \frac{g_i^D \Omega_6}{\frac{d^2\pi_i}{dr_i^2}}\right]}, \qquad \text{(A.3.4.3)}$$

$i = 1, \ldots, N+1, \; i \neq j$

In results A.3.4.1 and 2, the quantities $\Omega_1, \ldots, \Omega_6$ are negative under strategic complementarity because of the second order conditions for profit maximization and stability conditions for the loan and deposit market equilibria (see below).

Result A.3.4.2

The following approximate expressions result for the gross gains of changing loan rates $\left(G_i^t\right)$ *and deposit rates* $\left(G_i^r\right)$

$$G_i^t \approx \frac{1}{2}\frac{\left(\dfrac{d^2\pi_i}{dt_i di}\right)^2\left[-\Omega_1+\dfrac{g_i^L\Omega_2}{\dfrac{d^2\pi_i}{dt_i di}}\right]^2}{-\left(\dfrac{d^2\pi_i}{dt_i^2}\right)\left[\Omega_1+\dfrac{g_i^L\Omega_3}{\dfrac{d^2\pi_i}{dt_i^2}}\right]^2}\left(\Delta i\right)^2>0$$

$$G_i^r \approx \frac{1}{2}\frac{\left(\dfrac{d^2\pi_i}{dr_i di}\right)^2\left[-\Omega_4+\dfrac{g_i^D\Omega_5}{\dfrac{d^2\pi_i}{dr_i di}}\right]^2}{-\left(\dfrac{d^2\pi_i}{dr_i^2}\right)\left[\Omega_4+\dfrac{g_i^D\Omega_6}{\dfrac{d^2\pi_i}{dr_i^2}}\right]^2}\left(\Delta i\right)^2>0 \qquad \text{(A.3.4.4)}$$

where $\Omega_1, \Omega_2, \Omega_3, \Omega_4, \Omega_5$ and $\Omega_6 < 0$.

The Ω quantities are as follows

$$\Omega_1 \equiv \left(\frac{d^2\pi_{-i}}{dt_{-i}^2}\right)(SC^D) < 0$$

$$\Omega_2 \equiv \left(-\frac{d^2\pi_{-i}}{dt_{-i}di}\right)\left(g_i^D g_{-i}^D - g_{-i}^L\left(\frac{d^2\pi_{-i}}{dr_{-i}^2}\right)\right) < 0, \text{since} -\left(\frac{d^2\pi_{-i}}{dt_{-i}di}\right) < 0$$

$$\Omega_3 \equiv -g_{-i}^L(SC^D) < 0$$

$$\Omega_4 \equiv \left(\frac{d^2\pi_{-i}}{dr_{-i}^2}\right) < 0$$

$$\Omega_5 \equiv -g_{-i}^D\left(-\frac{d^2\pi_{-i}}{dr_{-i}di}\right) < 0, \text{since}\left(-\frac{d^2\pi_{-i}}{dr_{-i}di}\right) > 0$$

$$\Omega_6 \equiv -g_i^D g_{-i}^D < 0$$

$$\text{where } SC^D \equiv \left(\frac{d^2\pi_i}{dr_i^2}\frac{d^2\pi_{-i}}{dr_{-i}^2} - g_i^D g_{-i}^D\right) > 0$$

$$g_i^L = \frac{\partial^2\pi_i}{\partial t_i \partial t_{-i}} > 0, g_i^D = \frac{\partial^2\pi_i}{\partial r_i \partial r_{-i}} > 0, g_{-i}^L = \frac{\partial^2\pi_{-i}}{\partial t_{-i}\partial t_i} > 0, g_{-i}^D = \frac{\partial^2\pi_{-i}}{\partial r_{-i}\partial r_i} > 0 \tag{A.3.4.5}$$

$SC^D > 0$ is the condition for stability of the deposit market equilibrium. Otherwise, the negative signs follow from strategic complementarity, second-order conditions for profit maximum, and the above given signs of the cross profit derivatives with respect to i (which can be verified from A3.4.1).

Result A.3.4.3

Given the assumptions for the operating cost function, the following holds for the quantities that determine the sizes of responses of loan and deposit rates, and the respective gross profit gains, to an increase in the money market rate

$$\frac{d^2\pi_i}{dt_i di} = -\frac{dL_i}{dt_i} = -(1-\theta_L)\frac{\partial L_i}{\partial t_i}$$

$$\frac{d^2\pi_i}{dr_i di} = \frac{dD_i}{dr_i} = (1-\theta_D)\frac{\partial D_i}{\partial r_i}$$

$$\frac{d^2\pi_i}{dt_i^2} = 2\frac{dL_i}{dt_i} + \left(t_i^* - i - c_i^L\right)\frac{d^2L_i}{dt_i^2} = 2(1-\theta_L)\frac{\partial L_i}{\partial t_i}$$

$$+(1-\theta_L)^2\left(t_i^* - i - c_i^L\right)\frac{\partial^2 L_i}{\partial t_i^2}$$

$$\frac{d^2\pi_i}{dr_i^2} = -2\frac{dD_i}{dr_i} + \left(i - r_i^* - c_i^D\right)\frac{d^2D_i}{dr_i^2} = -2(1-\theta_D)\frac{\partial D_i}{\partial r_i}$$

$$+(1-\theta_D)^2\left(i - r_i^* - c_i^D\right)\frac{\partial^2 D_i}{\partial r_i^2} \qquad \text{(A.3.4.6)}$$

PROOF. To derive the result, note first that

$$\frac{dL_i}{dt_i} = \frac{\partial L_i}{\partial t_i} + \frac{\partial L_i}{\partial t_{-i}}\frac{\partial t_{-i}}{\partial t_i} \equiv (1-\theta_L)\frac{\partial L_i}{\partial t_i}, \text{ since } \frac{\partial L_i}{\partial t_i} = -\frac{\partial L_i}{\partial t_{-i}}$$

Secondly,

$$\frac{d^2L_i}{dt_i^2} = \frac{d}{dt_i}\left[(1-\theta_L)\frac{\partial L_i}{\partial t_i}\right] = (1-\theta_L)\left[\frac{\partial^2 L_i}{\partial t_i^2} + \frac{\partial^2 L_i}{\partial t_i \partial t_{-i}}\frac{\partial t_{-i}}{\partial t_i}\right]$$

$$= (1-\theta_L)^2\frac{\partial^2 L_i}{\partial t_i^2}$$

The results for the deposit market can be obtained by similar calculations.

A fully closed form solution for the differentials in (A.3.4.3), and hence also for the gross profit gains (A.3.4.4), exists only for *symmetric banking industry configurations*, where the within banking industry effects cancel out.

Result A.3.4.4

The following holds for symmetric banking industry configurations ($b_i = b$, $\rho_{ij} = \rho$ and $\delta_{ij} = \delta$, i,j = 1, ..., N)

$$\left(G_i^t\right)^{1/2} \approx$$

$$\left(\Omega_0^L\right)^{1/2}\left(\frac{L_i}{k_i^{NB}}\right)^{1/2} \frac{\left[-\Omega_1 + \dfrac{g_i^L \Omega_2}{(1-\theta_L)\dfrac{L_i}{k_i^{NB}}\rho_{iN+1}}\right]}{\left[\Omega_1 - \dfrac{g_i^L \Omega_3}{(1-\theta_L)^2 \dfrac{L_i}{k_i^{NB}}\rho_{iN+1}\left(\dfrac{2}{1-\theta_L} + \dfrac{1}{\rho_{iN+1}} - 1\right)}\right]}(\Delta i)$$

$$\left(G_i^r\right)^{1/2} \approx$$

$$\left(\Omega_0^D\right)^{1/2}\left(\frac{2D_i}{h_i^{NB}}\right)^{1/2} \frac{\left[-\Omega_4 + \dfrac{g_i^D \Omega_5}{(1-\theta_D)\dfrac{2D_i}{h_i^{NB}}\delta_{iN+1}}\right]}{\left[\Omega_4 - \dfrac{g_i^D \Omega_6}{(1-\theta_D)^2 \dfrac{2D_i}{h_i^{NB}}\delta_{iN+1}\left(\dfrac{2}{1-\theta_D} + \dfrac{1}{2\delta_{iN+1}} - 1\right)}\right]}(\Delta i)$$

(A.3.4.7)

where Ω_1, Ω_2, Ω_3, Ω_4, Ω_5 and $\Omega_6 < 0$, i = 1,...,N

The multipliers take the following form

$$\Omega_0^L \equiv \frac{1}{2}\left(\frac{\rho_{iN+1}}{\frac{2}{1-\theta_L}+\frac{1}{\rho_{iN+1}}-1}\right) \quad \text{and} \quad \Omega_0^D \equiv \frac{1}{2}\left(\frac{\delta_{iN+1}}{\frac{2}{1-\theta_D}+\frac{1}{2\delta_{iN+1}}-1}\right)$$

PROOF. This follows from results A.3.4.2. and 3, after calculating the partial derivatives given in result A.3.4.3. The noncooperative Bertrand case can be obtained by setting θ_L and θ_D equal to zero.[108]

Given strategic complementarity, result A.3.4.4. allows one to conclude definitely that banks' incentives to change loan and deposit rates are always the greater, the smaller their pricing power. The gross gains reach their maximum when the differentiation indices (with respect to the nonbank competitor) approach zero.

Although closed form solutions are not available for the general case of *asymmetric banking industry configurations*, the crucial second derivatives (under result A.3.4.3) behave similarly as regards K_i and H_i, as established with respect to k_i^{NB} and h_i^{NB}. This is true since

$$\frac{\partial^2 L_i}{\partial t_i^2} = \frac{\frac{L_i}{K_i}+\frac{\partial}{\partial t_i}(K_i)}{K_i^2} \quad \text{and} \quad \frac{\partial^2 D_i}{\partial r_i^2} = \frac{2\frac{D_i}{H_i}-\frac{\partial}{\partial r_i}(H_i)}{H_i^2} \qquad \text{(A.3.4.8)}$$

which are decreasing in K_i and H_i. The first derivatives are clear by results 3.1 and 3.3. Hence, the key comparative static properties hold also in the general case. This completes the derivation of the results that are needed for propositions 3.6.a and b.

Finally, the following result directly holds from result A.3.4.1.

[108] Note that the cases of perfect collusion in the loan and deposit markets are not nicely behaved in the above formulations and so must be studied separately.

Result A.3.4.5

For the size of the reaction of the equilibrium loan rates to changes in the deposit rates, it holds that

$$\frac{dt_i}{dr_i} = \frac{\frac{dt_i}{di}}{\frac{dr_i}{di}} = \frac{\frac{d^2\pi_i}{dt_i di}\left[-\Omega_1 + \frac{g_i^L \Omega_2}{\frac{d^2\pi_i}{dt_i di}}\right]\frac{d^2\pi_i}{dr_i^2}\left[\Omega_4 + \frac{g_i^D \Omega_6}{\frac{d^2\pi_i}{dr_i^2}}\right]}{\frac{d^2\pi_i}{dt_i^2}\left[\Omega_1 + \frac{g_i^L \Omega_3}{\frac{d^2\pi_i}{dt_i^2}}\right]\frac{d^2\pi_i}{dr_i di}\left[-\Omega_4 + \frac{g_i^D \Omega_5}{\frac{d^2\pi_i}{dr_i di}}\right]} \tag{A.3.4.9}$$

where Ω_1, Ω_2, Ω_3, Ω_4, Ω_5 and $\Omega_6 < 0$, $i = 1,...,N+1$, $i \neq j$

4 Delivery networks and banks' pricing behaviour: evidence from Finland

The previous chapter developed a model of retail banking competition that establishes a link between banks' pricing power and the extent to which they are (vertically) differentiated in terms of branch and ATM networks and quality advantage vis-à-vis nonbank competitors. Furthermore, the transformation of delivery technologies in banking was shown to reduce the pricing power and market share benefits banks can realize from their branch and ATM networks, either against banks with smaller networks or against specialized banks or nonbanks without these networks (*network differentiation* and *size effects*). Technological transformation reduces and equalizes banks' markups in loan and deposit markets to the extent that it reduces the rates at which customers' utility declines as their accessibility to branches and ATMs worsens. As a result, competition in banking increases. New access options for banking services, new methods to disseminate information for credit risk evaluation and monitoring purposes and more extensive information on competing products and services make customers more mobile, and banks and nonbanks with small branch or ATM networks can compete on a more equal footing with banks with extensive networks.

In this chapter, loan and deposit pricing equations are estimated using panel data on Finnish banks. Corporate and household credit markets are analysed separately. The pricing equations are derived from the second stage game of the theoretical model (section 3.3), ie short run (SR) price competition with fixed delivery capacity. The aim of the estimations is to assess the effects of banks' prevailing differentiation in terms of branch and ATM networks on their markups in loan and deposit markets and whether changes can be observed over time due to technological change.

Finland provides a good opportunity for empirically investigating changes in the importance of branch and ATM networks as sources of pricing advantage, since the transformation of the delivery methods has already advanced quite far, particularly in the area of deposit-related activities. This chapter presents a relatively simple empirical method of investigating these issues by applying the theoretical model.

There is an identification problem if banks' pricing behaviour is other than noncooperative Bertrand-Nash behaviour, since then pricing power can be due to either collusion or differentiation, or both. The aim here is to distinguish between the two by controlling for the possibility of cooperative behaviour or changes in it over time.[109] This issue is also of more general interest, since eg conclusions about the potential effects of the European Single Market on banking competition and contestability are dependent on whether the primary source of banks' pricing power is network differentiation or collusion.[110]

In the *new empirical industrial organization* (NEIO)[111] literature there are basically two approaches to the problem of measurement of cooperative conduct in product-differentiated industries (Bresnahan 1989). Either the elasticities of demand (including cross-elasticities) are carefully investigated to measure the degree of insulation of firms' demand from rivals' prices or an empirical model of competitive interaction is estimated. I adopt the latter approach because I wish to measure the contribution of cooperative conduct to banks' markups. This approach has been applied quite extensively in recent times to various industries. It involves a simultaneous estimation of demand and pricing (supply) relations in order to identify the parameters characterizing oligopolistic conduct. However, based on Bresnahan's (1989) and Slade's (1995) surveys of the literature, the majority of the applications seem to treat products as homogeneous across firms.

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[109] Econometric studies originating from Lee and Porter (1984) and Porter (1985) have confirmed that changes in firm conduct can take place over time, as predicted by theoretical oligopoly models. Namely, the Green and Porter (1984), Rotemberg and Saloner (1986) and related regime-switch models predict periodic switches of oligopolistic conduct as a part of the cartel enforcement mechanism.

[110] According to the analysis of Cairns (1996), reliable measurement of pricing power should focus on the implications of product differentiation.

[111] NEIO literature, which started to emerge in the early 1980s, is fundamentally different from the previously predominant empirical method in the field, ie the structure-conduct-performance paradigm (SCPP), which tests whether firms have more market power in concentrated markets. In contrast, NEIO literature attempts to measure competitive behaviour directly and precisely by estimating empirical counterparts of theoretical oligopoly models. Bresnahan's (1989) survey summarizes the main criticism of the SCPP approach. Most importantly, the SCPP approach cannot actually discriminate whether good performance is due to bad (pricing power) or good (efficiency) conduct. There is much literature on the validity of the SCPP in banking – especially from the US (Berger and Hannan 1989, Bourke 1989, Molyneux 1993, and Goldberg and Rai 1996; Berger 1995 contains a summary). These studies usually find a positive relation between concentration or market share and profitability. However, these studies are plagued by the above methodological problem, as well as by identification and measurement problems, as discussed eg in Vesala (1995b, ch. 1).

Banking applications using the NEIO approach to measure competitive conduct include Spiller and Favaro (1984), Gelfand and Spiller (1987), Shaffer (1989), Hannan and Liang (1993), Neven and Röller (1994), Shaffer and DiSalvo (1994), Suominen (1994), Vesala (1995b, ch. 4) and Berg and Kim (1998). None of these studies discriminates between differentiation and oligopolistic coordination as sources of pricing power.[112]

Empirical work that investigates nonprice competition in banking is relatively scant. Mester (1987a and b) and Calem and Nakamura (1995) examine the competitive effects of branching vs unit banking strategies in the United States and find that branching tends to lead to more competitive outcomes because banks then become less geographically differentiated form each other. Schmid (1994) finds empirical support for the hypothesis that unconstrained nonprice competition in branch networks has in Europe resulted in overbranching from the social standpoint. This result is in line with theoretical results indicating that a lack of price competition due to regulation or collusion supports competition in nonprice terms (refer to result 3.7). Cerasi et al (1997) study the impact of deregulation of banks' rate setting on branching in eight European countries and find that the increased price competition has lowered banks' branch network sizes, though branches still seem to give a competitive advantage over banks with smaller networks. These results are in line with the prediction that price competition reduces the size of the optimal branch network. Finally, Kim and Vale (1997) investigate the role of branches for competition in the Norwegian credit market and find that the branch network has clearly been used as a strategic nonprice variable in competition.[113]

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[112] A related empirical literature uses the Panzar-Rosse (1987) methodology based on estimating the factor price elasticities of firms' revenue functions to make inferences about the appropriate model of competition for a particular industry. Banking applications of this methodology include Nathan and Neave (1989), Molyneux et. al. (1992), Shaffer and DiSalvo (1994), and Bikker and Groeneveld (1998) (also Vesala 1995b). This methodology is indirect, since it actually traces out the demand relation rather than the supply relation, which is actually affected by oligopolistic conduct (Bresnahan 1989).

[113] There is also some empirical work on the effect of branching on service availability (eg Evanoff 1988) and on the determinants of banks' branching decisions (eg Buono and Eakin 1990, Barros 1995). ATM network decisions have not been empiricaly assessed, as far as I know. There are also a number of papers on the social desirability of branching regulations (Jayaratne and Strahan 1997 contains a summary) and on the cost efficiency effects of branching (Berger and Humphrey 1995 summarize the large international literature on the cost efficiency of banking firms).

This chapter proceeds as follows. The empirical pricing equations are first derived, and the adopted system models for identifying the coordination parameters are then formulated. The chapter then describes the data and variables used in the estimations and then turns to the empirical implementation of the models and discussion of the findings. The findings have implications for future developments in banking income, conduct and competitiveness, and for the monetary policy efficiency issue, as studied in chapter 3.

4.1 Derivation of empirical pricing equations

For profit maximizing banks that invest excess funds from deposits in securities, earning the market rate of interest, or that issue securities to finance excess loans, the SR pricing equations for the loan and deposit markets are the first-order conditions for the oligopoly equilibria in the two markets. They represent optimal rate setting decisions given the level of 'physical' delivery capacity. The corporate (m=1) and household (m=2) credit markets will be analysed separately, since these two market segments are quite different in terms of products and lending procedures. The main intent is to examine whether the estimates of the 'utility parameters' that characterize the value of banks' 'physical' delivery outlets for clients differ markedly across these two segments. This should be the case since the means and nature of informing the lender and the possibilities to 'shop around' for the best offers in the market should differ significantly. These two market segments also constitute a proxy for the retail credit market, which is the target of the theory.

Under noncooperative Bertrand-Nash competition, the pricing equations take at time t the following form (result 3.5)

$$\begin{aligned} T_t^m(i_t, B_{1t}, C_t^{Lm}, N_t) &= i_t + C_t^{Lm} + K_t^m, \quad m = 1,2 \\ R_t(i_t, B_{1t}, B_{2t}, C_t^D, N_t) &= i_t - C_t^D - \frac{H_t}{2} \end{aligned} \tag{4.1}$$

where T^m and R are the column vectors of loan and deposit rates, $\left(t_1^m,...,t_N^m\right)$' and $(r_1,...,r_N)$', B_1 and B_2 the column vectors of numbers of branches and ATMs, $(b_{11},...,b_{1N})$' and $(b_{21},...,b_{2N})$', and C^{Lm} and C^D the column vectors of bank-specific SR marginal operating costs of corporate and household loan provision and deposit-taking activities, $\left(c_1^{Lm},...,c_N^{Lm}\right)$' and $\left(c_1^D,...,c_N^D\right)$', as will be specified below. i denotes the money market interest rate and N the number of banks in the market. In the empirical analysis, the same banks operate in both the loan and deposit markets, which accords with Finnish banking structure. However, the panel data is unbalanced, so that N can vary over time.

K^m and H represent the column vectors $\left(K_1^m,...,K_N^m\right)'$ and $(H_1,...,H_N)'$ of *the summary indices of banks' differentiation* with respect to branch and ATM networks as will be further specified in section 4.2 (referring to results 3.1 and 3.3). These measures determine the semi-elasticities of the loan demand and deposit supply perceived by the banks with respect to their loan and deposit rates, so that the elasticities are the lower (ie pricing power the greater), the larger the values of these measures. The elements of the K and H/2 vectors are also equal to the *absolute markups* that banks enjoy in loan and deposit markets over the money market rate and SR marginal operating costs. The *relative markups* (ie the *Lerner indices* of price competition intensity) equal K_i^m / t_i^m and $H_i/2r_i$.

It is postulated that the bank-level SR operating cost functions with fixed delivery capacities are different for lending and deposit-taking, the difference being that ATMs are not part of the operating cost function for lending activities. The cost functions are however defined to account for the multiproduct nature of banking by allowing for possible economies of scope between lending and deposit-taking. In turn, the marginal SR operating costs are postulated as linear in their arguments: fixed capacities, ie numbers of branches and ATMs (deposit costs only); activity levels, ie lending (L^m) or deposit-taking (D) volumes, to control for increasing or decreasing returns to scale; 'cross-activity' levels to account for economies of scope; and k input prices (w_k),[114] which may be bank-specific

[114] Estimates of marginal costs are needed in any NEIO assessment of oligopoly markups. Roberts and Samuelson (1988) develop a methodology to derive marginal cost estimates from an empirical cost function that is estimated together with factor-share equations to ensure parameter consistency. The estimates of the cost function parameters are then used to generate firm-specific estimates of marginal costs, which are used as input in the estimation of the pricing equations. I adopt a different methodology, and estimate simultaneously the parameters of the cost function and the pricing relations, as in a banking application by Shaffer and DiSalvo (1994), since the simultaneous method is statistically preferred to the two-stage approach.

$$
\begin{aligned}
c_{it}^{Lm} &\equiv \frac{\partial C_{SRit}^{Lm}(L_{it}, D_{it} \mid b_{1it}, w_{ikt})}{\partial L_{it}^{m}} \\
&= \beta_0^m + \lambda_i^{Lm} + \beta_1^m b_{1it} + \beta_2^m L_{it}^m + \beta_3^m D_{it} + \sum{}^k \beta_{4k}^m w_{ikt} + \varepsilon_t^{Lm} \\
c_{it}^{D} &\equiv \frac{\partial C_{SRit}^{D}(L_{it}, D_{it} \mid b_{1it}, b_{2it}, w_{ikt})}{\partial D_{it}} \\
&= \mu_0 + \lambda_i^{D} + \mu_{11} b_{1it} + \mu_{12} b_{2it} + \mu_2 D_{it} + \mu_3 L_{it} + \sum{}^k \mu_{4k} w_{ikt} + \varepsilon_t^{D}, \\
L_{it} &= \sum{}^m L_{it}^m, \quad i = 1,\dots, N_t, \quad m = 1,2
\end{aligned}
\tag{4.2}
$$

where the λ's represent bank-specific components in the SR marginal operating costs that are not correlated with the other arguments, ie they represent the *fixed effects* in the panel estimation context. The fixed effects reflect cost efficiency differences across banks. Hence a high λ may be due to overcapacity, waste or even extensive credit risk taking, which increase costs relative to other banks. The random effects (the ε's) reflect the production cost of service quality, which is not related to the size of banks' branch or ATM networks. These include the quality of all services associated with lending and deposit-taking, eg credit consultation, credit risk evaluation, and quality of payment transfers that have some value to banks' clients.

A quadratic functional form for the underlying SR cost functions is consistent with the above marginal cost functions.[115] It is a fairly flexible form, as it contains the arguments squared and cross-terms in addition to the linear terms, and is quite often applied in empirical research. For example, a linear marginal cost function was adopted by Bresnahan (1982) in his original test of competitive conduct.

It is important to allow for increasing or decreasing returns to scale by including activity levels as explanatory variables in the SR marginal operating cost functions. A fairly common practice in the literature is to use average variable costs or other constant proxies to specify marginal costs (see eg the airline application by Brander and Zhang 1993). This can obviously induce errors, since the slope of the marginal cost curve is ignored. Specifically, one could mismeasure the true price-marginal cost markup, and end up attributing what is really the slope of the SR marginal cost curve to pricing power. Here, for example, if there are local decreasing returns to scale, assuming

---

[115] The quadratic SR operating cost function for lending activities takes the following form:

$$
\begin{aligned}
C^L_{SRit} = {} & \left(\beta^m_0 + \lambda^{Lm}_i + \beta^m_1 b_{1it} + \beta^m_3 D_{it} + \Sigma^k \beta^m_{4k} w_{ikt} + \varepsilon^{Lm}_t\right) L^m_{it} \\
& + \left(\beta^n_0 + \lambda^{Ln}_i + \beta^n_1 b_{1it} + \beta^n_3 D_{it} + \Sigma^k \beta^n_{4k} w_{ikt} + \varepsilon^{Ln}_t\right) L^n_{it} \\
& + \left(\mu_0 + \lambda^D_i + \mu_{11} b_{1it} + \mu_{12} b_{2it} + \mu_3 L_{it} + \Sigma^k \mu_{4k} w_{ikt} + \varepsilon^D_t\right) D_{it} \\
& + \tfrac{1}{2}\beta^m_2 L^{m2}_{it} + \tfrac{1}{2}\beta^n_2 L^{n2}_{it} + \tfrac{1}{2}\mu_2 D^2_{it} + \phi_1 b_{1it} + \Sigma^k \phi_{2k} w_{ikt} \\
& + \phi_3 b^2_{1it} + \Sigma^k \phi_{4k} w^2_{ikt} + \Sigma^k \phi_{5k} w_{ikt} b_{1it}, \quad m,n = 1,2, \quad m \neq n
\end{aligned}
$$

The SR operating cost function for deposit-taking can be constructed in a similar fashion. To meet the requirements imposed by the theory, the cost function must be (i) concave, (ii) nondecreasing and (iii) homogeneous of degree one in input prices (eg Varian 1992). Meeting the last requirement is problematic, since the required parameter restrictions would be very complex. An alternative would be to adopt eg the often-applied translog form for the cost function, for which the theoretical parameter restrictions are much simpler. However, in this case the marginal cost functions must be specified in linear form in order to solve the simultaneity problem and to obtain estimating equations that are in line with the underlying theory. In the literature, the theoretical cost function restrictions are often neglected altogether. The long-run (LR) operating cost function for lending activities is defined by, $C^L_{LRit} = C^L_{SRit} + f_{1it} b_{1it}$, where f_{1i} is bank i's fixed cost of branch establishment. If there are constant returns to scale, the SR marginal operating cost curve is identical to the LR curve, where capacities are also allowed to change.

constant returns to scale could account for the rejection of zero markups. Loan and deposit margins vs the money market rate could exceed average operating costs and yet still be close to the marginal costs.[116]

The pricing equations take the following form, once the SR marginal operating costs (4.2) are inserted in (4.1)

$$\begin{aligned} T_t^m &= i_t + \beta_0^m + \Lambda\lambda^{Lm} + B_{1t}\beta_1^m + MT_t^m\left(K_t^m\left(B_{1t}, \nu^m, Z_t^m\right)\right) \\ &\quad + L_t^m\beta_2^m + D_t\beta_3^m + W_t\beta_4^m + \varepsilon_t^{Lm}, \quad m = 1,2 \\ R_t &= i_t - \mu_0 - \Lambda\lambda^D - B_{1t}\mu_{11} - B_{2t}\mu_{12} \\ &\quad - MR_t\left(H_t\left(B_{1t}, B_{2t}, \tau_1, \tau_2, \Xi_t\right)\right) - D_t\mu_2 - L_t\mu_3 - W_t\mu_4 - \varepsilon_t^D \end{aligned} \tag{4.3}$$

where Λ is a matrix of firm dummies that generate the fixed effects in the SR marginal operating cost functions. The oligopoly markups, MT^m and MR, depend on the 'physical' delivery capacities; the parameters describing the rate at which customer utility decreases when access to 'physical' delivery outlets worsens (ν^m, and τ_1, τ_2); and the loan and deposit rates adjusted for marginal utilities with respect to 'physical' delivery outlets and quality differences vs nonbank competitors. These *marginal utility-adjusted rates* are the elements of the column vectors $Z^m = \left(\zeta_1^m = t_1 - \eta_0^m - \eta_1^m b_{11}, ..., \zeta_N^m\right)'$ and $\Xi = \left(\xi_1 = r_1 + \gamma_0 + \gamma_{11}b_{11} + \gamma_{12}b_{21}, ..., \xi_N\right)'$. Lastly, W is the column vector of factor prices, $(w_1,...,w_k)'$, and β_4^m and μ_4 the respective parameter row vectors.

The above pricing equations entail *a simultaneity problem*, since the marginal utility-adjusted rates appear on the RHS of the equations. In what follows, the simultaneity problem is resolved following Feenstra and Levinsohn (1995).

Recall from section 3.2.1 that the constant marginal utility parameters are to be interpreted as the marginal utilities evaluated at the ideal density of the branch and ATM networks, b*. Hence, they depend on the specification of the ideal densities and are, accordingly, sensitive to additive transformations of the ideal densities. Additive transformations produce utility functions where the marginal utility

[116] As regards banking applications of the NEIO, possible deviations between marginal and average oprating costs are explicitly addressed in Shaffer and DiSalvo (1994). Spiller and Favaro (1984) and Gelfand and Spiller (1987) ignore marginal operating costs altogether and simply use the market interest rate as a proxy for banks' marginal costs.

parameters differ only by a scalar from the original ones, as defined under b*.[117] There will always be additive transformations, and hence scalars (eg a) that equalize the marginal utility and cost parameters, so that $\left(\eta_1^m = \beta_1^m, \quad \gamma_{11} = \mu_{11}, \quad \gamma_{12} = \mu_{12}\right)$ can be imposed without loss of generality.[118] When this is the case, for example, the new error term ($\in$) in the first equation of (4.3) will differ from the old one only by another scalar (eg $\in_t^{Lm} = \varepsilon_t^{Lm} + aB_{1t}$), which is the difference between the marginal utility and marginal cost. The new error term still captures the production cost of the service quality, which is not related to the size of branch and ATM networks.[119] The marginal cost of producing the quality, which is not related to the delivery networks, should be highly correlated with the respective marginal utility,[120] so that there is a scalar difference also between the two parameters, and $\left(\eta_0^m = \beta_0^m, \quad \gamma_0 = \mu_0\right)$ can be imposed. That is, the attributes related to the unobserved quality increase both marginal utility and marginal production cost.

[117] For example, redefining the ideal density as b** = b* + y transforms the parameter vector γ_1 to a new vector, which differs from the old one by a scalar. The utility function obtains another element (2y'Tb** – y'Ty), which, however, does not affect consumer choice. Hence, the only relevant difference is the transformation of the marginal utility parameters (see Feenstra and Levinsohn, 1995, p. 22). This illustrates a general point made in Caplin and Nalebuff (1991) that the utility function and the distribution of ideal products are jointly determined.

[118] To demonstrate that generality is not lost, consider a borrower's choice of preferred network density. Given the quadratic utility function (section 3.2), this is based on the solution to $\max_{b_1>0} U(b_1,b^*,t) = \eta_0 + \eta_1 b_1 - (b_1 - b_1^*)^2\nu - t(i,b_1)$, s.t. $t(i,b_1) = \beta_0 + \beta_1 b_1$. In this formulation, marginal costs are simply taken to be a function of delivery capacity, and it is assumed that a continuous choice is available for borrowers under marginal cost pricing. Then the first-order condition is $\eta_1 - 2\nu(b_1 - b_1^*) = \beta_1$. Hence the optimal solution ($b_1 = b_1^*$) implies that the respective marginal cost and utility parameters must be the same (see Feenstra and Levinsohn 1995).

[119] We can see this by inserting $(\beta_1^m = \gamma_1^m + a)$ into the first equation of (4.3). A similar procedure can be used with the second equation as well.

[120] Feenstra and Levinsohn (1995) consider the case where they are perfectly correlated. Another solution would be to consider a utility function where there are no explict (η_0^m, γ_0) marginal utility terms, but only an error term related to the non-measured characteristics. This should be highly correlated with the error term of the marginal cost function, and so the simultaneity problem can be solved.

The new error terms are denoted by $\in$, taking into account the adjustment of the original error terms. Consequently, the marginal utility-adjusted loan and deposit rates can be expressed as

$$\begin{aligned}
Z_t &= T_t - \beta_0^m - B_{1t}\beta_1^m \\
&= i_t + \Lambda\lambda^{Lm} + MT_t^m\left(K_m^t\left(B_{1t}, \nu^m, Z_t^m\right)\right) + L_t^m\beta_2^m \\
&\quad + D_t\beta_3^m + W_t\beta_4^m + \in_t^{LM} \\
\Xi_t &= R_t + \mu_0 + B_{1t}\mu_{11} + B_{2t}\mu_{12} \\
&= i_t - \Lambda\lambda^D - MR_t\left(H_t\left(B_{1t}, B_{2t}, \tau_1, \tau_2, \Xi\right)\right) - D_t\mu_2 \\
&\quad - L_t\mu_3 - W_t\mu_4 - \in_t^D
\end{aligned} \tag{4.4}$$

which implicitly determines the marginal utility-adjusted rates as a function of the model parameters (Ψ^m, Φ) and arguments $\left(Z_t^m \equiv F^m\left(\Psi^m, B_{1t}, L_t^m, D_t, W_t\right)\right.$ and $\Xi_t \equiv G(\Phi, B_{1t}, B_{2t}, L_t, D_t, W_t)$. That is, the marginal utility-adjusted rates are fully determined by bank-specific cost effects and oligopoly markups ($MT_t^{*m} \equiv K_t^{*m}(B_{1t}, \nu^m)$ and $MR_t^* \equiv H_t^*\left(B_{1t}, B_{2t}, \tau_1, \tau_2\right)/2\big)$, which depend only on differences in the sizes of branch and ATM networks and the associated utility parameters. Since they do not depend on loan and deposit rates, the simultaneity problem is solved.[121] After substituting the redefined markups into (4.4), the loan and deposit rates appear on the LHS only.

Period dummies, PD, are included in the estimating equations in order to control for the effects on banks' markups of changes in deposit regulation regimes that occur within the sample period, and in order to separate the effects of liberalization from the effects of technological change. Loan rates were already practically free of regulation during this period.

Furthermore, the time trend (t) is attached to the utility parameters in order to investigate changes over time. Finally, the money market rate (i) is included in the model also independently, since in imperfectly competitive markets the pass-through of money market rate changes into banks' loan and deposit rates can be highly imperfect, and money market rate changes are reflected in banks'

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[121] This approach also stipulates that the semi-elasticities of perceived loan demand and deposit supply, which determine the respective markups, do not depend on the level of loan or deposit rates, whereas the elasticities do. Empirically, this formulation means imposing a more restrictive functional form.

margins vs the money market rate (eg Hannan and Berger 1991). As shown in section 3.5 (propositions 3.6a and b), technological change should increase the pass-through of money market rate changes and reduce the impact of the interest rate level on margins. This implication will be tested in the estimations.

After rearranging (4.4), substituting the oligopoly markups MT^{*m} and MR* into (4.4) to solve the simultaneity problem, and making all of the above mentioned additions, the following pricing equations are obtained, and will be estimated

$$\begin{aligned} T_t^m - i_t &= \beta_0^m + PD_t\beta_0^{PDm} + \Lambda\lambda^{Lm} + K_t^{*m}(B_{1t}, \nu^m(t)) \\ &\quad + B_{1t}\beta_1^m(t) + L_t^m\beta_2^m + D_t\beta_3^m + W_t\beta_4^m + \beta_5^m(t)i_t + \in_t^{Lm}, \qquad (4.5.1) \end{aligned}$$

$m = 1,2$

$$\begin{aligned} i_t - R_t &= \mu_0 + PD_t\mu_0^{PD} + \Lambda\lambda^D + H_t^*(B_{1t}, B_{2t}, \tau_1(t), \tau_2(t))/2 \\ &\quad + B_{1t}\mu_{11}(t) + B_{2t}\mu_{12}(t) + D_t\mu_2 + L_t\mu_3 + W_t\mu_4 \qquad (4.5.2) \\ &\quad + \mu_5(t)i_t + \in_t^D, \end{aligned}$$

4.2 Specification and properties of network differentiation indices

In (4.5.1) and (4.5.2) the *network differentiation indices* take the following form, as stipulated by the theoretical model (results 3.1 and 3.3), and redefined to control for the simultaneity problem

$$K_{it}^{*m} \equiv \left(\sum_{j\neq i} k_{ijt}^{*m}\right)^{-1} \equiv \left(\sum_{j\neq i} \frac{\dfrac{\rho_{jt}^{m}}{\sum_{j\neq i} \rho_{jt}^{m}}}{(b_{1it} - b_{1jt})^2 \nu^m} \right)^{-1} \equiv \nu^m \left(\sum_{j\neq i} k_{ijt}^{**m}\right)^{-1}$$

$$\equiv \nu^m K_{it}^{**}, b_1^* \geq b_{1i} / 2, \forall i = 1,..., N, j = 1,..., N+1, i \neq j \qquad (4.6)$$

$$H_{it}^{*} \equiv \left(\sum_{j\neq i} h_{ij}^{*m}\right)^{-1} \equiv \left(\sum_{j\neq i} \frac{\dfrac{\delta_{jt}}{\sum_{j\neq i} \delta_{jt}}}{(b_{1it} - b_{1jt})^2 \tau_1 + (b_{2it} - b_{2jt})^2 \tau_2} \right)^{-1}$$

$$b^* \geq b_i / 2, \forall i = 1,..., N, j = 1,..., N+1, i \neq j$$

If $b_{1it} \leq b_{1jt}$, then $k_{ij}^{*m} = \zeta$; if $b_{1it} \leq b_{1jt} \wedge b_{2it} \leq b_{2jt}$, then $h_{ij}^{*} = \zeta$.

In (4.6) ρ^m and δ represent market shares in the loan and deposit markets and are used as the weights in the calculation of differentiation indices. The larger the market shares of rivals to bank i, the smaller the value of bank i's differentiation index. Hence, there is the typical positive relationship between a bank's market share and its pricing power, as in the standard, homogeneous product Cournot oligopoly model for symmetric firms, where the market price falls with the number of firms, ie with each firms' market share (eg Tirole 1988, ch. 5).

It is assumed that the preferred network densities are larger than the treshold values (see section 3.2.1), so that an increase in branch or ATM networks unambigously increases market share in the respective markets, given the prices charged by the players in the markets. This is an intuitive and simplifying assumption, and hence should not be empirically too restrictive. This assumption also allows a straightforward interpretation of the differentiation indices in terms of sizes of branch and ATM networks. The higher the number of branches and ATMs, the more pricing power is obtained from the networks, which is a plausible idea. When this assumption holds, the indices are defined as a very small number ζ (to avoid division by zero), when the bank has fewer branches or ATMs than its competitor.

The addition of the (N+1)th term in the calculation of the K*'s and the H*'s captures the effect of the size of bank i's networks independent of any comparison to other banks with 'physical' delivery networks. This corresponds to the competitive advantage vs nonbank competitors that do not have these networks.

The two-dimensional form of H* produces technical problems, since the τ-parameters cannot be factored out from the summation in the same way as the ν^m parameters to produce the indices K**, as demonstrated in (4.6). As a result, the estimating equation would need to contain all 'cross-differences' in delivery networks among all N(N–1)/2 pairs of banks. To establish a more efficient estimating equation with respect to the use of degrees of freedom, branches and ATMs are treated as separate differentiation parameters to construct one-dimensional indices

$$H_{it}^{*}/2 = \left(\sum_{j\neq i} \frac{\frac{\delta_{jt}}{\sum_{j\neq i}\delta_{jt}}}{(b_{1it}-b_{1jt})^2 \tau_1^{*}} \right)^{-1} + \left(\sum_{j\neq i} \frac{\frac{\delta_{jt}}{\sum_{j\neq i}\delta_{jt}}}{(b_{2it}-b_{2jt})^2 \tau_2^{*}} \right)^{-1} \qquad (4.7)$$

$$\equiv \tau_1^{*}\left(\sum_{j\neq i} h_{ijt}^{b1**}\right)^{-1} + \tau_2^{*}\left(\sum_{j\neq i} h_{ijt}^{b2**}\right)^{-1} \equiv \tau_1^{*}H_{1it}^{**} + \tau_2^{*}H_{2it}^{**}$$

which greatly simplifies the estimation. Once the τ* parameters are estimated, the effect of this simplification on the value of the index can be assessed.

The properties of the network differentiation indices are illustrated in the following by considering first symmetric and then asymmetric banking structures. That is, considering first only network size effects and then also allowing for network differentiation effects.

Let there be N banks, of which M have equal-sized branch networks, and identical market shares.[122] Let b_T symbolize the total number of branches in the banking industry, and ρ_F the market share of the 'fringe', which is made up of the (N–M) unit banks and the nonbank competitor. The (N–M) other banks operate as unit banks, each with just a single (branch) office. Now, after some manipulation, the expression for the one-dimensional differentiation index, which I denote *symmetry-equivalent differentiation index* KS**, can be written as (subscripts t, m and 1 omitted)

[122] Hence the joint market share of the rival institutions to bank i (ρ_{-i}) are the same for all M branch-banks.

$$KS^{**}_{i\in M} = \left(\frac{1}{\rho_{-i}} \left((M-1)\rho_{-i}\zeta + \frac{\rho_F}{\left(\frac{b_T - (N-M)}{M} - 1 \right)^2} \right) \right)^{-1} \qquad (4.8.1)$$

$$\rho_{-i} \equiv \sum_{j\neq i} \rho_j, \rho_F \equiv \sum_{k\notin M} \rho_k, \; i = 1,...,N, \; j,k = 1,...,N+1$$

We see that, for given b_T and N, the maximum value of the index obtains when the branch network is controlled by just one bank (M=1) and other institutions make up the 'fringe'. The *expression for the maximum value* is $(b_T - N)^2$, as in this case $\rho_{-i} = \rho_F$. Further, for given b_T, KS** is at its *maximum value* of $(b_T - 1)^2$ when the only branch-bank is also the only bank (N=M=1). However, with large b_T and small N, the maximum value is largely determined by b_T.[123]

The index KS** is highly *convex*, as illustrated in figure 4.1. The value falls substantially, but at a decreasing rate, when there is more than one bank controlling the branch network (M>1). Hence the index allots a high reward to a monopoly position in the 'physical' delivery network. Symmetric branch-banks do not have a competitive advantage over other branch-banks, and their relative pricing power vs the 'fringe' falls with the number of branch-banks or with a decrease in the total number of branches.[124]

The convexity property of the KS** index is maintained in the general cases of asymmetric branch-banks. In the asymmetric cases, banks can have pricing power also vs other banks with branch networks. The value of the index is the larger, the greater the extent to which the bank in question controls the branch network as compared to its rivals. The effect of asymmetry on the index value is demonstrated in figure 4.1, where line (3) is drawn under the assumption that M* (≥ 2) branch-banks possess 75% of the network

[123] Note that the value of the index is not defined when $\rho_F = 0$.

[124] The KS** index (or its sum over all banks) should actually be interpreted as a measure of concentration, which takes into account both branches and market shares, since in the symmetric case branch-banks are not differentiated from each other as regards the scope of the branch network. The properties of KS** resemble those of the conventional Herfindahl-index of market concentration (sum of the squared market shares) or individual firms' contribution to the index, as the latter are also strongly convex measures.

(x=0.75).[125] In the case where there is only one branch-bank (M*=1), there is of course no difference between the symmetric and asymmetric banking structures and hence the maximum value of the index is always the same, $(b_T - N)^2$, regardless of any asymmetries in the banking sector.

It is possible to assess how much the calculated bank-specific differentiation indices, K_{it}^{**m}, deviate from the index value for the case where all banks are symmetric, ie where the index KS** is calculated using the total number of branches and banks in the banking system in question (refer to equation (4.8.1)). The difference between the two indices $\left(K_{it}^{**m} - KS_t^{**m} \equiv KD_{it}^{**m}\right)$ constitutes a measure of the differentiation of bank i vs other banks with branch networks (ie the *network differentiation effect*). In addition, the ratio $\left(KD_{it}^{**m} / K_{it}^{**m}\right)$ gives the percentage of bank i's pricing advantage that is due to this effect, ie its branch-network exceeding its rivals' networks. The rest is due to the *network size effect*. These calculations are done for the Finnish banking industry in section 4.4.2. The estimates of bank-specific markups and their decompositions can be obtained by multiplying the K_{it}^{**} indices by the corresponding estimates of the ν-parameters.

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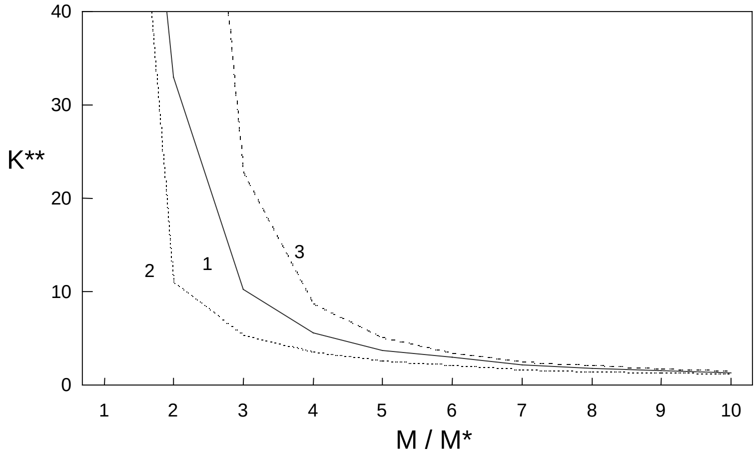
[125] The value of the differentiation index takes the following form in the particular example of an asymmetric banking structure where x% of the branch network is controlled by M* banks

$$KA_{i\in M}^{**} = \left(\frac{1}{\rho_{-i}} \left((M^*-1)\rho_{-i}\zeta + (M - M^*)\frac{\rho_M}{\left(\left(\frac{x(b_T - (N-M))}{M^*} - \frac{(1-x)(b_T - (N-M))}{(M-M^*)}\right)^2\right)} + \frac{\rho_F}{\left(\frac{b_T - (N-M)}{M^*} - 1\right)^2} \right)\right)^{-1}$$

$\rho_{-i} \equiv \Sigma_{j\neq i}\rho_j, \rho_M \equiv \Sigma_{l\in M,\in M^*}\rho_l$, $\rho_F \equiv \Sigma_{k\notin M}\rho_k$, $i,l = 1,...,N$, $j,k = 1,...,N+1$

Figure 4.1 **Illustration of symmetry-equivalent differentiation index, KS**,** (1. market share of the 'fringe' 0.1, and 2. market share of the 'fringe' 0.9), **and an asymmetric example** (3. x = 0.75). Figures drawn on the assumptions $b_T = 1000$, N = 20, $\zeta = 0.1$



As a final point, note that the value of the differentiation index K** is always positive for a bank that has more than one branch, while for unit banks the index value is at *minimum* value of zero. To see this, the index for the bank k, which has the smallest branch network among the branch-banks, can be expressed as

$$K_k^{**} = \rho_{-k}\left(\frac{(b_k - 1)^2}{(M-1)\rho_{-k}\zeta(b_k - 1)^2 + \rho_F}\right) \tag{4.8.2}$$

where M stands for the number of branch-banks. We now see that the value of K_k^{**} is zero when $b_k = 1$ (unit banks).

4.3 Identifying cooperative conduct

The empirical pricing equations (4.5.1) and (4.5.2) are based on the assumption of Bertrand-Nash behaviour on the part of banks. The aim of this section is to derive empirical system models consisting of demand and pricing relations that can be used to test the validity of the

Bertrand-Nash restriction against alternative forms of conduct, and to estimate the portions of banks' markups over marginal costs and the money market rate that are due to differentiation in delivery networks and to collusive conduct (ie anticompetitive price coordination among banks in setting loan or deposit rates). Collusive behaviour may well be 'tacit', ie not based on an explicit cartel agreement.

The following first-order approximations of the loan demand and deposit supply relations can be obtained using the respective expressions for the own- and cross-rate semi-elasticities (results 3.1, 3.2, 3.3 and 3.4, and appendix 3.1)

$$\begin{aligned}
\ln L_t^m &= \alpha_0^{LDm} - \alpha_1^{LDm} \frac{\left(T_t^m - \eta_0^m - B_{1t}\eta_1^m\right)}{K_t^m} \\
&\quad + \alpha_2^{LDm} \sum_{j \neq i} \frac{\rho_{jt}^m \left(t_{jt}^m - \eta_0^m - \eta_1^m b_{1jt}\right)}{k_{ijt}^m}, \quad m = 1,2 \\
\ln D_{it} &= \alpha_0^{DD} + \alpha_1^{DD} \frac{\left(R_t + \gamma_0 + B_{1t}\gamma_{11} + B_{2t}\gamma_{12}\right)}{H_t/2} \\
&\quad - \alpha_2^{DD} \sum_{j \neq i} \frac{\delta_{jt}\left(r_{jt} + \gamma_0 + \gamma_{11}b_{1jt} + \gamma_{12}b_{2jt}\right)}{h_{ijt}/2}
\end{aligned} \tag{4.9}$$

where the intercepts $\left(\alpha_0^{LDm}, \alpha_0^{DD}\right)$ capture the range of factors that affect the total size of the loan and deposit markets. The theory implies that the weighting parameters $\left(\alpha_1^{LDm} = \alpha_2^{LDm} > 0,\right.$ $\left.\alpha_1^{DD} = \alpha_2^{DD} > 0\right)$ should be positive, and the same in absolute terms for own- and cross-effects in the loan demand and deposit supply relations. Namely, if the prices of all institutions rise in proportion, the individual demands should remain unaffected. This homogeneity implication of the theory will however be tested rather than imposed at the outset.

Based on (4.9), the following empirical demand equations can be constructed

$$\begin{aligned}\ln L_t^m &= \alpha_0^{LDm} + YR\alpha_0^{YLDm} + \Lambda\lambda^{LDm} \\ &- \alpha_1^{LDm}\frac{\left(T_t^m - \beta_0^m - B_{1t}\beta^m(t)\right)}{K_t^{*m}(B_{1t},\nu^m(t))} \\ &+ \alpha_2^{LDm}\frac{\left(T_t^{m-i} - \beta_0^m - B_{1t}^{-i}\beta_1^m(t)\right)}{K_t^{*m-i}\left(B_{1t}^{-i},\nu^m(t)\right)} \\ &+ X_t\alpha_3^{LDm} + (X_t \times T_t)\alpha_4^{LDm} + \in_t^{LDm},\ m = 1,2\end{aligned} \tag{4.10.1}$$

$$\begin{aligned}\ln D_t &= \alpha_0^{DD} + YR\alpha_0^{YDD} + \Lambda\lambda^{DD} \\ &+ \alpha_1^{DD}\frac{(R_t + \mu_0 + B_{1t}\mu_{11}(t) + B_{2t}\mu_{12}(t))}{H_t^*(B_{1t},B_{2t},\tau_1(t),\tau_2(t))/2} \\ &- \alpha_2^{DD}\frac{\left(R_t^{-i} + \mu_0 + B_{1t}^{-i}\mu_{11}(t) + B_{2t}^{-i}\mu_{12}(t)\right)}{H_t^{*-i}\left(B_{1t}^{-i},B_{2t}^{-i},\tau_1(t),\tau_2(t)\right)/2} \\ &+ Y_t\alpha_3^{DD} + (Y_t \times R_t)\alpha_4^{DD} + \in_t^{DD}\end{aligned} \tag{4.10.2}$$

In (4.10.1) and (4.10.2), the effects of rivals' rates on bank i's loan demand and deposit supply are approximated by the averages (B_{1t}^{-i}, B_{2t}^{-i}, T^{m-i}, R^{-i}, K^{*m-i}, H^{*-i}) for bank i's rival institutions, instead of including all (N–1) ratios in the model.[126] Note that the loan demand and deposit supply relations have as arguments own and average rival 'marginal utility adjusted rates'. Cyclical variables that affect the total loan demand and deposit supply in period t (X_t, Y_t) are inserted in place of the original intercepts $\left(\alpha_0^{Lm},\alpha_0^D\right)$. Year dummies (YR) are included to reflect unmodelled components of the error terms that are correlated with time, and firm dummies, Λ (fixed effects), reflect those that are correlated with the characteristics of the institutions in the sample. Multiplicative terms ($X_t \times T_t$, $Y_t \times R_t$) are incorporated in the model, because the slopes of the loan demand and deposit supply functions must depend on an exogenous variable in order to identify the oligopolistic coordination parameters, as will be discussed below. Finally, the equations incorporate the substitutions between the marginal utility and cost parameters and the time trends, as before.

Now the semi-elasticities take the form

[126] This corresponds to summarizing rivals' reaction curves with a single reaction curve for purposes of conducting comparative static analyses (Dixit 1986) (see also section 3.5.1). Note that this procedure renders the market share weights unnecessary for the cross-effects in the loan demand and deposit supply relations.

$$\frac{\partial L_t^m}{\partial T_t^m L_t^m} = -\frac{\alpha_1^{LDm}}{K_t^{*m}(B_{1t}, \nu^m(t))} + X_t \alpha_4^{LDm}, \; m = 1,2$$
$$\frac{\partial D_t}{\partial R_t D_t} = \frac{\alpha_1^{DD}}{H_t^*(B_{1t}, B_{2t}, \tau_1(t), \tau_2(t))/2} + Y_t \alpha_4^{DD} \qquad (4.11)$$

The general first-order conditions for loan and deposit pricing equations are

$$L_t^m + \left(1 - \theta_L^m\right)\left(T_t^m - i_t - C_t^{Lm}\right)\frac{\partial L_t^m}{\partial T_t^m} = 0, \; m = 1,2$$
$$-D_t + (1 - \theta_D)\left(i_t - R_t - C_t^D\right)\frac{\partial D_t}{\partial R_t} = 0 \qquad (4.12)$$
$$\theta_L = \frac{\partial t_{jt}}{\partial t_{it}}, \quad \theta_D = \frac{\partial r_{jt}}{\partial r_{it}} \; \forall i, j$$

since $\frac{\partial L_{it}^m}{\partial t_{it}^m} = -\sum \frac{\partial L_{it}^m}{\partial t_{jt}^m}$ and $\frac{\partial D_{it}}{\partial r_{it}} = -\sum \frac{\partial D_{it}}{\partial r_{jt}}$ according to the theoretical model. Parameters $\left(\theta_L^m, \theta_D\right)$ correspond to the coordination parameters used in the NEIO analyses to identify the full range of different oligopolistic conduct. If parameters $\left(\theta_L^m, \theta_D\right)$ can be identified, they can be interpreted as the degree of coordination among firms in the price-setting game. These parameters index all possible outcomes between noncooperative Bertrand-Nash behaviour and perfect collusion (joint profit maximization as in a monopoly firm). $\left(\theta_L^m, \theta_D\right)$ equal to zero is consistent with Bertrand-Nash conduct and $\left(\theta_L^m, \theta_D\right)$ equal to one with perfect collusion. The case of perfect collusion is however not nicely behaved (division by zero), and $\left(0 \le \theta_L^m, \theta_D < 1\right)$ must be set.[127]

The first-order conditions that constitute the loan and deposit pricing equations (ie supply relations) are then, after dividing (4.12) by L and D and applying (4.11),

[127] The problem of identifying perfect collusion arises here because of the functional forms adopted, and is not usually encountered in the literature.

$$T_t^m - i_t = PD_t \beta_0^{PDm} + C_t^{Lm}(t) + \frac{1}{1-\theta_L^m(t)} \frac{1}{\dfrac{\alpha_1^{LDm}}{K_t^{*m}(B_{1t}, \nu^m(t))} - X_t \alpha_4^{LDm}} + \in_t^{LPm}, m = 1,2 \qquad (4.13.1)$$

$$i_t - R_t = PD_t \mu_0^{PD} + C_t^D(t) + \frac{1}{1-\theta_D(t)} \frac{1}{\dfrac{\alpha_1^{DD}}{H_t^*(B_{1t}, B_{2t}, \tau_1(t), \tau_2(t))/2} + Y_t \alpha_4^{DD}} + \in_t^{DP} \qquad (4.13.2)$$

where $C_t^{Lm}(t)$ and $C_t^D(t)$ are the SR marginal operating costs as defined in (4.2) (including the time trends) and the PDs are the period dummies to control for the deposit regulation regimes.

Identification of the coordination parameters involves simultaneous estimation of the respective demand and supply relations, (4.10.1) and (4.10.2), and (4.13.1) and (4.13.2). The extent of 'cross-market' cooperative conduct is not assessed (as in Vesala 1995b, ch. 4), which allows proceeding by estimating the respective two-equation systems separately, thus saving degrees of freedom. Bank-specific variation in the coordination parameters is not allowed either. An extra benefit of the system estimations is that the simultaneous estimation forces the estimates of the 'utility parameters' to be consistent also with the loan demand and deposit supply relations derived from the theory.

The methodology for this kind of identification of the coordination parameter was originally developed in Bresnahan (1982). The idea is to let exogeneous shifts in the demand relation move firms' marginal revenue schedules, which in turn trace out the supply relation, and the equilibrium (here (L_t^*, T_t^*), (D_t^*, R_t^*)) changes in a way that depends on the extent of oligopolistic coordination. Lau (1982) has shown that the necessary and sufficient condition for identification is that the demand relation be separable in at least one exogenous variable that is not an argument of the marginal cost function.[128] This method to identify the conduct parameters is called the *structural model-*

[128] Shaffer (1989) represents an early application of this methodology to the assessment of competition in US banking, and Suominen (1994) to the Finnish banking industry.

approach to measuring pricing power and has won wide acceptance (eg Boyer 1996). In the spirit of NEIO, it has been able to eliminate the apparent indeterminacy of oligopoly pricing and has provided a means of empirically measuring oligopolistic conduct.

Röller and Sickles (1998) argue that a simultaneous estimation of capacity setting and pricing equations would improve the efficiency of the estimates of the coordination parameters and eliminate any bias in them due to the *sequential strategic effect* of capacity on rivals' prices. The bias is upwards if there is overinvestment in capacity, due to this effect in the first stage of the game. Whenever the sequential strategic effect is zero, there is no need to specify the two-stage setup in order to measure pricing power.[129] Capacity setting has not typically been endogenized in related NEIO studies on competitive conduct in which coordination parameters are estimated.

In the formulation adopted here, however, there is an effect of capacity on prices only in the case that the capacity of bank i exceeds that of competitor bank j. For any such pair, bank i's decisions would have no effect on bank j's prices, and the sequential strategic effect in question would not arise. Only *the direct effect of capacity on revenues* (through the differentiation indices) and *SR marginal cost* (included in [4.2]) need to be considered.[130]

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[129] Röller and Sickles (1998) find in their study of conduct in the European airline industry that, when capacity setting is endogenized in the empirical model, the conclusions for product market competition are significantly different from those for the traditional approach, in which only prices or quantities are strategic variables. Kim and Vale (1997) conclude that the traditional approach in banking studies, ie of treating branches as an exogenous variable, would result in misspecified empirical models of competitive conduct, which is in line with Röller's and Sickles' results.

[130] Here, the first-order conditions for the first stage of the game are independent of the coordination parameters, as only the size of the envisioned markup in the price setting subgame (stage two) matters, regardless of the composition of the markup. Naturally, this would not hold for many other empirical models of banks' rate setting, for which the bias indentified by Röller and Sickles (1998) could emerge. Additional restrictions on other parameters could also be derived here from the first-order conditions for capacity setting. This would however require estimating a complex model of six simultaneous equations, since the condition for branches includes both loan and deposit markups and the effects of loans and deposits on SR marginal operating costs.

4.4 Data and empirical specifications

4.4.1 Data and variable operationalizations

The panel data set used in the estimations is unbalanced and contains information on nine different Finnish banks over an eleven-year period, 1986–1996, so that at minimum seven banks form each of the yearly cross-sections. Some data, eg corporate and household loan rates, are completely available only from 1990 onwards.

The data set covers almost entirely the Finnish banking sector. I treat cooperative and savings banks as single multibranch organizations, since this is the way they have actually operated, with centralized control and marketing (eg common prime rates). Also a lot of official data used in this study are collected only for savings and cooperative banks as groups. Changes in the number of banks across cross-sections are due firstly to a merger of the two largest commercial banks in Finland (KOP and Unionbank) to form Merita-Bank in 1995 and, secondly, to the entry of a small commercial bank, Interbank, in 1989. Branches of foreign banks are excluded from the sample, since they engage in very little retail banking activity in Finland.[131]

The panel data set is constructed on a quarterly basis. Yearly data would provide significantly less degrees of freedom, which would be a problem for the system estimations in particular. As data on branches and ATMs are available only on a yearly basis, they have been transformed into quarterly data by assuming that changes in banks' branch and ATM networks take place smoothly over each year. According to banks, this is a fairly good approximation to actual changes in networks over a year, as plans to reduce or increase the number of outlets are carried out gradually. This is due inter alia to the need to smooth the use of internal resources over the course of a year. Moreover, this data transformation should not significantly affect differences across banks in the cross-sectional dimension, which are of particular interest in this study.

[131] One of the foreign banks has however been expanding its retail operations.

Table 4.1 **Variables used in estimations**

Variable	Operationalization
Rates and volumes:	
T	Average new lending rate
TB	Average new corporate lending rate (excl. financial institutions)
TH	Average new household lending rate
R	Average deposit rate
L	Volume of new lending
LB	Volume of new corporate lending (excl. financial institutions)
LH	Volume of new household lending
D	Volume of savings and demand deposits
	All the above items refer to items in domestic currency
'Physical' delivery capacity:	
B_{11}	Number of branches, excl. post offices
B_{12}	Number of branches, incl. post offices
B_2	Number of ATMs in the network offered to clients
B_{2C}	Number of cash dispensers in the network offered to clients
B_{2P}	Number of payment ATMs in the network offered to clients
K**	Loan market differentation index, excl. post offices
KB**	Corporate loan market branch network differentation index, excl. post offices
KH**	Household loan market branch network differentation index, excl. post offices
H_1^{**}	Deposit market branch network differentation index, incl. post offices
H_2^{**}	Deposit market cash dispenser network differentiation index
H_3^{**}	Deposit market payment ATM network differentiation index
H_4^{**}	Deposit market total ATM network differentation index (both cash dispensing and payment ATMs)
Bank-specific input prices:	
w_1	Price of labour: total staff expenses per number of full time employees (deflated by CPI)
w_2	Price of variable inputs: total nonstaff expenses per balance sheet total (deflated by CPI)
w_3	Price of variable EDP inputs: total variable EDP expenses per balance sheet total (deflated by CPI)
Industry-specific input prices:	
w_4	Real banking industry wage index
w_5	Total industry nonstaff expenses per aggregate balance sheet total (deflated by CPI)
w_6	Total industry variable EDP expenses per aggregate balance sheet total (deflated by CPI)
	All input prices expressed as index 1990=100
Macroeconomic variables:	
i	3-month money market rate (Helibor)
X, Y	Gross domestic product
Period dummies:	
PD_1 (=1 in 1989–1990)	End of 'cartel' agreement for deposit rates (since January 1989)
PD_2 (=1 in 1991–1996)	Withholding tax on deposit income (since January 1991)

R following a symbol signifies deflation by CPI.

Table 4.1 contains the variables that will be used in the estimations. The variables for the analysis of the entire credit market (T and L) include, in addition to the separately examined corporate and household lending, loans to financial institutions and public entities, which should be relatively independent of delivery networks. Household and corporate lending have however constituted the bulk of bank lending. Only domestic currency-denominated items are included in the lending volumes and average rates. Foreign currency-denominated lending was quite significant in the early period until the end of the 1990s, but has since declined considerably, primarily due to heavy depreciation of the markka in the early 1990s. The deposit volume measure (D) contains all markka savings and demand deposits by the domestic public.

As to the branch capacity, post offices are available to Postipankki (later Leonia Bank), which is a government-owned commercial bank. However, Postipankki customers generally use post offices only for deposit matters. Hence, in the baseline cases, post offices are excluded from the loan market analysis but included in the deposit market analysis. There is no distinction between branches by size, product range or other such factors; they are treated as homogeneous.

The numbers of ATMs, and the respective differentiation indices, include all ATMs available to each banks' clients, so that ATM compatibility agreements between banks are accounted for. This is the case since customer utility is the same regardless of whether one uses his own or other banks' ATMs, since banks have not charged any fees for using ATMs.

As regards cash dispensers, which are used for cash withdrawals and account enquiries, there have been basically three development stages within the sample period: (1) a period of two competing networks, ie that of commercial banks and that of the cooperative and savings banks (from 1986 to 1988 or 1989, when savings banks and then cooperative banks joined the commercial banks' network); (2) a fully compatible network (from 1989 to 1993); and (3) centralized ownership and management of compatible cash dispensers through a jointly-owned company, Automatia Ltd (from 1994 onwards). The first payment ATMs appeared in the late 1980s. They are significantly more advanced than the cash dispensers, since they can be used for a variety of payments and account transfers (but not for cash withdrawals). There was a phase of competing bank-specific payment ATM networks until 1993. In 1994 and 1995 there was universal compatibility, and in 1996 the largest bank, Merita, exited from the compatibility agreement.

In the absence of direct observations, it has become standard in banking cost studies to impute input prices from ratios of expenses for each input to the quantity of the corresponding input. Also here, only the banking wage index represents a direct input price measure at the industry level. The quantity of labour input can be easily measured as the number of employees, while this is not the case with other (nonstaff) variable inputs.[132] Banks are purchasing more and more services needed in the production of banking services, notably EDP (electronic data processing) services from dedicated firms (ie outsourcing), and therefore balance sheet figures on materials and equipment do not correspond to actual input usage. Rents and leases entail the same problem. For this reason, I specify the prices for the other variable inputs as ratios of the corresponding expenses to balance sheet total, in order to circumvent the input quantity measurement problems and in order to control for the effect of the scale of operations.

Input price proxies based on total nonstaff expenses or EDP expenses are used as alternative specifications, as the latter are included in the former. Focusing on EDP expenses would cover an important part of variable nonstaff expenses, and avoid certain 'noise' items that are not related to the use of variable inputs, but some input usage would be excluded, which would matter particularly if banks' input mixes differ.

The industry-specific input prices represent alternative specifications to the bank-specific prices. Their use assumes that banks act as price takers in homogeneous input markets and use the same kinds of inputs. Under the industry-level specification, the fixed effects in the SR marginal operating cost function also include bank-level differences in input prices, if they exist.

Finally, the period dummies control for the effects of changes in deposit rate regulation on banks' markups. Until the end of 1988 demand and savings deposit rates were subject to a cartel-like agreement, as the interest income was tax exempt if at least two bank groups offered these deposits on similar conditions. Between January 1989 and 1991 tax exemption was determined by comparison to the Bank of Finland base rate. Since January 1991 a withholding tax has been levied on taxable deposits, which represents a significant

[132] There are some measurement problems concerning bank-specific input prices during 1994–1996 due to the restructuring of the sector with considerable reductions in the numbers of bank employees and branches. The data have been carefully adjusted for these changes.

deregulation of deposit rate setting. The maximum level of tax-exempt interest income has decreased over time with market interest rates, and was until summer 2000 2% annualized interest. Certain time deposits also were stipulated as tax-exempt during the sample period, since the last existing deposits of this type lost their tax exempt status at the end of 1997. In sum, indirect regulation of deposit rates through tax rulings existed (although to decreasing extent) during the sample period. The existence of tax exemption rules can restrict price competition and generate biases in customer behaviour to the extent that depositors have preferences for tax-exempt deposit accounts. These exemptions ceased to exist in June 2000.

4.4.2 Description of key variables

Table 4.2a gives the averages and standard deviations of the loan and deposit rates, which are the dependent variables in the empirical pricing equations. Table 4.2b gives the same information for numbers of branches and ATMs and respective differentiation indices, which are the key explanatory variables. The branch network differentiation indices are quite similar for corporate and household lending markets as well as for the deposit market, since banks' market shares in all three activities are significantly correlated. Data on bank branches and ATMs were obtained from the Finnish Bankers' Association, and the rest of the data from the Bank of Finland and Statistics Finland.

The theory proposes that technological transformation should reduce variability of loan and deposit rates across banks, holding differences in banks' 'physical' delivery networks constant (proposition 3.1). The average number of branches has decreased over the sample period, reflecting restructuring in the banking industry, which has greatly reduced the total number of branches (table 4.3). However, toward the end of the sample period, asymmetries in banks' networks (and market shares) increased due to the restructuring and shrinking of the savings bank sector[133] and the Merita merger. The result of these tendencies is a decline in the average value of the branch network differentiation indices until 1993 and a significant rise

[133] The savings bank sector was most severely affected by the dire banking problems in Finland in the early 1990s. In October 1993 around 80% of savings banks' assets (and outlets) were sold to rival banks (merged into Savings Bank Finland in 1992), or transferred to an asset management company, Arsenal Ltd, to take care of the 'bad asset' problem.

thereafter.[134] Also the standard deviations of the indices across banks increased toward the end of the sample period, which would work in the direction of increasing the variability of the rates, holding the technology levels (utility parameters) constant.

Table 4.2a **Averages and standard deviations of loan and deposit rates and margins vs money market rate across banks**

	Market rate (i)	Avg new lending rate (T)			Avg deposit rate (R)		
		Avg	Std.dev	Avg margin (T–i)	Avg	Std.dev	Avg margin (i–R)
1986	12.60	10.47	0.50	–2.13	4.43	0.59	8.17
1987	10.03	10.22	0.30	0.19	4.15	0.62	5.88
1988	9.97	10.70	1.17	0.73	4.74	0.86	5.23
1989	12.56	11.56	0.95	–1.00	5.29	0.84	7.27
1990	14.00	13.33	1.24	–0.66	6.37	0.73	7.62
1991	13.08	13.45	0.71	0.37	7.59	1.79	5.49
1992	13.25	13.58	0.90	0.33	7.98	1.51	5.27
1993	7.78	9.62	0.86	1.85	5.02	0.84	2.76
1994	5.35	7.32	0.87	1.98	3.12	0.47	2.23
1995	5.75	7.52	1.02	1.77	3.17	0.71	2.58
1996	3.63	5.59		1.97	2.22	0.41	1.40
Avg	*9.81*	*10.45*		*0.64*	*4.98*		*4.83*

	Avg new household lending rate			Avg new corporate lending rate		
	Avg	Std.dev	Avg margin (TH–i)	Avg	Std.dev	Avg margin (TB–i)
1989	11.28	1.17	–1.03	12.02	0.70	–0.35
1990	13.21	1.11	–0.53	13.66	1.22	–0.51
1991	13.68	0.56	0.55	12.80	2.66	–0.25
1992	13.74	0.80	0.72	13.13	1.23	–0.06
1993	10.20	0.97	2.68	9.36	0.50	1.64
1994	8.21	0.71	2.95	6.87	0.60	1.54
1995	8.17	0.62	2.48	7.32	0.63	1.59
1996	6.37	0.65	2.94	5.36	0.77	1.81
Avg	*10.71*		*0.90*	*10.21*		*0.40*

Data source: Bank of Finland.

[134] The network differentiation indices used in the estimations and reported in table 4.2b are slightly adjusted from the theoretical formula. Firstly, an upper limit is imposed, since the bank with the largest network would otherwise obtain a very high value, which distorts the estimations, particularly when the post offices are included. The upper limit is arbitrarily set at 20, which is around four times larger than the value for the second largest bank in terms of the delivery networks. Naturally, this procedure only affects the index value of the bank with the largest networks. Note that the particular choice of the upper limit affects the estimation results to some extent in quantitative terms. Secondly, in calculating the index, each banks' comparison to the nonbank benchmark is unweighed by market share, since reliable data on nonbanks' market shares are very difficult to obtain.

Table 4.2b **Averages and standard deviations of branches and ATMs and the respective differentiation indices across banks**

	Branches (excl. post offices) (B_{11})		Branches (incl. post offices) (B_{12})		Cash dispensers (B_{2C})		Payment ATMs (B_{2P})	
	Avg	Std.dev	Avg	Std.dev	Avg	Std.dev	Avg	Std.dev
1986	502	565	926	1 064	358	249		
1987	504	561	923	1 056	558	260		
1988	500	558	917	1 053	1 317	626	3	7
1989	432	540	793	1 019	2 300	929	11	21
1990	394	492	739	972	2 479	1 002	66	118
1991	364	458	488	501	2 539	1 026	97	153
1992	331	410	455	466	2 546	1 029	123	200
1993	268	324	386	454	2 615	1 056	921	763
1994	268	339	386	424	2 474	999	1 734	701
1995	276	375	409	454	2 070	913	1 844	813
1996	287	356	403	388	1 965	866	876	423
Avg	*374*		*621*		*2 024*		*499*	

	KB**		KH**		H_1^{**}		H_2^{**}		H_3^{**}	
	Avg	Std.dev	Avg	Std.dev	Avg	Std.dev	Avg	Std.dev	Avg	Std.dev
1986					6.11	6.87	3.33	1.60		
1987					6.11	6.87	3.33	1.59		
1988					6.11	6.87	2.26	0.41	2.52	6.68
1989	5.41	6.66	5.41	6.66	5.89	6.61	1.41	0.69	3.18	6.93
1990	5.42	6.58	5.41	6.51	5.04	6.40	1.46	0.59	4.37	7.28
1991	5.40	6.63	5.39	6.61	5.01	6.21	1.50	0.62	4.24	7.10
1992	5.43	6.63	5.42	6.65	5.09	6.31	1.46	0.59	4.39	7.20
1993	5.37	6.62	5.15	6.50	5.02	6.39	1.46	0.59	1.53	1.27
1994	5.43	6.66	5.42	6.65	5.04	6.35	1.46	0.59	1.44	0.58
1995	5.90	7.02	5.89	7.03	5.49	6.72	1.63	0.75	1.71	0.76
1996	6.80	7.24	6.81	7.23	5.50	6.73	1.92	0.94	4.57	6.85
Avg	*5.54*		*5.50*		*5.49*		*1.86*		*3.19*	

Data source: Finnish Bankers' Association.

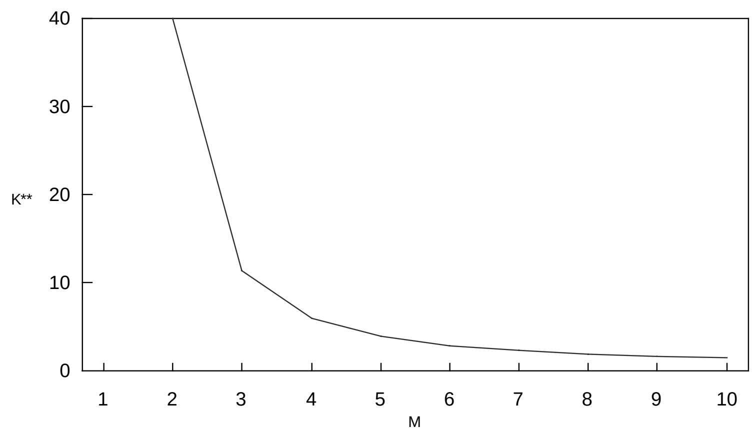
Table 4.3 **Total numbers of branches and ATMs**

	Branches (excluding post offices)	Cash dispensing ATMs	Payment ATMs
1986	3 507	798	0
1987	3 515	1 387	0
1988	3 487	1 891	18
1989	3 442	2 438	91
1990	3 137	2 653	527
1991	2 897	2 730	772
1992	2 633	2 762	982
1993	2 117	2 988	1 474
1994	2 126	2 827	1 982
1995	1 914	2 415	2 151
1996	1 708	2 292	2 353
Avg	*2 771*	*2 098*	*863*

Data source: Finnish Bankers' Association.

However, the standard deviations of household and corporate lending rates, which relate to branch networks, have tended to decrease in recent years compared to levels at the end of the 1980s and early 1990s. The variability of deposit rates increased markedly after the introduction of the withholding tax in 1991, but has since tended to decrease markedly. Hence the pricing power benefits stemming from branch networks seem to have decreased in both lending and deposit-taking, perhaps more visibly on the deposit side. Naturally, this is only preliminary and indicative evidence prior to the actual estimation of the empirical models. Due to compatibility, there are practically no differences in ATM network differentiation indices between banks for many years in the sample and hence the indices would not produce variation in deposit rates.[135]

Figure 4.2 **Symmetry-equivalent branch network differentiation index (KS**) for the Finnish banking industry; N=7, b_T = 2771** (sample period averages) (ζ=0.1)



Data source: Finnish Bankers' Association.

Figure 4.2 depicts the values of the *symmetry-equivalent branch network differentiation index*, KS**, as defined in (4.8.1), given the sample period averages for total numbers of branches and banks in the Finnish banking industry. For M(=N)=7 (all banks have a branch network), KS** equals 2.26. Hence the average difference, KD**,

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[135] The total number of cash dispensers has already reached a peak in Finland and has started to decrease (table 4.3). This would weaken the competitive position of the entire industry, though not that of banks against each other. The total number of payment ATMs is still increasing, and their utilization is growing heavily, based on Finnish Bankers' Association data.

between the average of the bank-specific K**'s and KS**, is 3.28 or 3.24 for the corporate or household lending markets respectively. Branch network differentiation vs other banks has thus represented, on average, around 60% of the network differentiation index on the lending side, and around 40% has been accounted for by the effect of network size. A similar pattern emerges as regards branches and deposit-taking activities.[136] As the average differentiation indices indicate (table 4.2b), banks' competitive standing vs other banks in terms of delivery networks remained much the same until 1995 and 1996 when the Merita merger increased asymmetry in the Finnish banking system considerably. As a result, differentiation vs other banks constituted roughly 70% of the average differentiation index values for lending and deposit-taking activities in 1996.

In the case of payment ATMs, KS** equals 2.71, and hence, on average over the sample period, only 0.49% or 15% of the payment ATM network differentiation index, H_3^{**}, is allotted to differences between banks, which is a natural consequence of the fact that extensive compatibility has destroyed the benefits to individual banks. The decision of Merita to exit from the common payment ATM network in 1996 resulted in a significant increase in the average value of the index, as well as in the average share of asymmetries between banks in the index. Due to extensive compatibility of cash dispensers, the entire differentiation index is due to the network size effect, except for the years 1986, 1987 and 1988, when banks' networks were not fully compatible.[137]

Banks' margins on loan and deposit rates vs the money market rate have correlated strongly with the level of market interest rates (table 4.2a). During the period of high rates, eg in the early 1990s, loan margins were narrow and deposit margins wide. This demonstrates the stickiness of banks' rate setting in the context of market rate changes. The negative margins on the lending side in 1989 and 1990 correspond to the years that were identified in Vesala (1995b, ch. 3), in a switching regression model, as periods in which a reversionary period in collusive conduct (price war) took place.

[136] For the median bank in the sample with respect to differentiation indices, the importance of differentiation vs other banks is somewhat lower than that implied by the average values of the indices.
[137] Even during 1986 and 1987, when the asymmetries between banks were strongest within the sample period, differentiation vs other banks accounted for only some 20% of the average cash dispenser network differentiation index.

4.5 Empirical implementation and results

In the empirical estimations, the data set is handled as pooled cross-sections, since the cross-sectional variation is of primary interest, in addition to the changes in cross-sectional relations over time.

4.5.1 Loan pricing equations

In the analysis of the loan markets, equation (4.5.1) is estimated by OLS, including the fixed effects.[138] Table 4.4 reports the estimation results concerning the average new rates in corporate (TB) and household (TH) lending for the subperiod 1990Q1–1996Q4, as earlier data are not available. Standard errors are not reported, but the significant parameters are identified. Table 4.5 gives the results for the entire credit market, for both the entire sample period, 1987Q1–1996Q4 (after adjusting the starting points), and the subperiod 1990Q1–1996Q4. GLS estimates were obtained to control for potential cross-sectional heteroscedasticity, but the estimates were unaffected by this change in estimation method.

The results reveal quite significant differences between the corporate and household lending markets. Based on the estimates of the ν-parameters, the importance of branch network differentiation has been much greater for the pricing of household loans than for corporate loans, and consequently banks have enjoyed wider markups in the former activities. The estimates of the ν-parameters, and hence also the markups, are significantly different from zero, and Wald tests reject the exclusion of the differentiation indices for household lending, while the significance tests fail to hold for corporate lending. The estimated absolute markups are around 2.5 times larger for household lending than corporate lending, amounting to some 1.5–2 percentage points at the sample mean. Corporate lending is found to be significantly more competitive, as the corresponding markup estimates are around 0.6–0.7 percentage points. These results suggest that, in effect, informational and other obstacles and costs of transacting with more distant lenders or with many lenders have been significantly lower for banks' corporate than household customers.

[138] This is often also referred to as the least squares dummy variable (LSDV) model (eg Greene 1993).

Hence the mobility of banks' corporate customers is apparently much greater than that of the household customers. The above results are quite robust over input-price specifications.

The effect of the time trend on the estimates of the ν-parameters is negative in all cases, also in household lending. This is in line with the hypothesis that technological transformation is reducing banks' benefits from their branch networks in terms of pricing power. As a result, banks' markups are falling. In household lending, the phone banking options that all major Finnish banks have established may have been one significant contributor to this change, along with possibly already-enhanced information on competing banks' offers through the Internet. The major effects of the latter have probably been taking place after the sample period, and the widely spreading use of the Internet has probably intensified the tendency identified here.

The results imply that a disproportionately large share of banks' profits have come from household lending compared with corporate lending, where markups have been narrower. This is actually a fairly common perception in Finland and other countries as well. A narrowing of markups in the household businesses due to the transformation of banking would therefore put a particular strain on banks' future performance.

The results for the entire credit market are close to those obtained for the corporate lending market. This suggests that lending to entities other than households and corporations (basically financial institutions and central and local governments) is similar to corporate lending in terms of the significance of physical delivery networks and competitiveness. The estimates of the ν-parameter are significant for the entire period 1987Q1–1996Q4 and indicate an average absolute markup of about 0.8 percentage points, but for the subperiod 1990Q1–1996Q1 the estimates are insignificant. Again, the time trend has a negative impact on the ν-parameter estimates.

Table 4.4 **OLS-fixed effects estimation results of equation (4.5.1); dependent variables: average new corporate (TB) and household lending rates (TH)**
(A) bank-specific input prices
(B) industry-specific input prices

	TB 1990Q1–1996Q4 (A)	TB 1990Q1–1996Q4 (B)	TH 1990Q1–1996Q4 (A)	TH 1990Q1–1996Q4 (B)
Constant (β_0)	3.37**	1.60	3.95**	1.51
$PD_1(\beta_0^{PD})$ (1990)	–0.096	0.04	–0.71**	–0.47
$B_{11}(\beta_1)$	0.0007	0.00037	–0.006**	–0.0042
Trend*B_{11}	2.27E-05	–2.65E-06	0.0003**	0.00024*
Wald test (prob value)[1]	(0.97)	(0.97)	(0.020)*	(0.066)
KB**/KH**(ν)	0.13	0.12	0.36**	0.27*
Trend*KB**/KH**	–0.009	–0.0081	–0.019**	–0.016**
Wald test (prob value)[1]	(0.51)	(0.58)	(0.0010)**	(0.0049)**
LBR/LHR(β_2)[2]	–0.004**	–0.0037**	2.92E-05	–0.00057
DR(β_3)[2]	–2.94E-05	–2.10E-05	–8.30E-05	–1.26E-05
Bank-specific input prices (A):				
$w_1(\beta_{41})$	–0.0071*		5.47E-05	
$w_2(\beta_{42})$	0.00058		0.000143	
Wald test (prob value)[1]	(0.11)		(0.96)	
Industry-specific input prices (B):				
$w_4(\beta_{41})$		0.024		0.037
$w_5(\beta_{42})$		0.026*		0.026*
Wald test (prob value)[1]		(0.10)		(0.00030)**
i(β_5)	–0.38**	–0.37**	–0.36**	–0.38**
Trend*i	0.0031	–0.0011	0.00093	–0.0016
R-squared	0.53	0.53	0.83	0.84
Adjusted R-squared	0.48	0.49	0.81	0.82
S.E. of regression	1.35	1.35	0.72	0.69
Sample observations	251	251	251	251
Absolute markup at sample mean	0.71	0.67	1.98	1.49
Relative markup at sample mean	0.07	0.07	0.19	0.14
Wald test (prob value)[1]	(0.51)	(0.58)	(0.0010)*	(0.0049)**

** significant at 1% level.
* significant at 5 per cent level.

Notes: 1) Wald test for rejecting the null hypothesis that the parameters in question could be restricted to zero. 2) Deflated by CPI.

Table 4.5 **OLS-fixed effects estimation results of equation (4.5.1); dependent variable: average new lending rate (T)**
(A) bank-specific input prices
(B) industry-specific input prices

	1987Q1–1996Q4 (A)	1990Q1–1996Q4 (A)	1987Q1–1996Q4 (B)	1990Q1–1996Q4 (B)
Constant (β_0)	3.19**	3.87**	–3.24	0.50
$PD_1(\beta_0^{PD})$ (1989–1990)	–0.35*	–0.62*	0.17	–0.47
$PD_2(\beta_0^{PD})$ (1991–1996)	0.017		0.44	
$B_{11}(\beta_1)$	–0.0024*	–0.0016	–0.0022*	–0.0014
Trend*B_{11}	0.00013*	6.11E-05	0.00011*	6.63E-05
Wald test (prob value)[1]	(0.028)	(0.72)	(0.063)	(0.82)
K**(ν)	0.14*	0.19	0.11*	0.14
Trend*K**	–0.011**	–0.010	–0.0089**	–0.0085
Wald test (prob value)[1]	(0.0018)**	(0.19)	(0.011)*	(0.33)
$LR(\beta_2)$[2]	–4.81E-04**	–9.74E-04**	–4.44E-04**	–1.06E-03**
$DR(\beta_3)$[2]	–1.39E-05	–1.10E-05	–1.05E-05	–8.17E-07
Bank-specific input prices (A):				
$w_1(\beta_{41})$	–0.0042*	–0.0057**		
$w_2(\beta_{42})$	0.00035	0.00070		
Wald test (prob value)[1]	(0.058)	(0.021)*		
Industry-specific input prices (B):				
$w_4(\beta_{41})$			0.074**	0.020
$w_5(\beta_{42})$			0.031**	0.028**
Wald test (prob value)[1]			(0.000)**	(0.001)**
$i(\beta_5)$	–0.36**	–0.30**	–0.33**	–0.29**
Trend*i	0.0041**	–0.00068	–0.0013	–0.0046
R-squared	0.73	0.73	0.74	0.74
Adjusted R-squared	0.71	0.70	0.73	0.71
S.E. of regression	0.80	0.84	0.78	0.83
Sample observations	359	251	359	251
Absolute markup at sample mean	0.81	1.08	0.83	0.83
Relative markup at sample mean	0.08	0.10	0.08	0.08
Wald test (prob value)[1]	(0.0018)**	(0.18)	(0.063)	(0.82)

** significant at 1% level.
* significant at 5% level.
Notes: 1) Wald test for rejecting the null hypothesis that the parameters in question can be restricted to zero. 2) Deflated by CPI.

In case of household lending, as well as total lending, branching is found to lower the SR marginal operating cost. As changes in branch capacity shift the entire SR marginal operating cost curve, the results imply that increasing the number of branches has the effect of lowering the marginal operating cost at all output levels (lending volumes).[139] This suggests that lending has been the cheaper, the closer the bank has been to the customer. However, the impact of branching on the SR marginal operating cost is declining over time according to the estimates of the respective time trend coefficients, as should be the case under ongoing technological progress.

Tables 4.4 and 4.5 report unconstrained estimation results for the input price coefficients, where the theoretical nonnegativity requirements for a cost function are not imposed a priori in the estimations. The coefficients always meet the nonnegativity requirement when the industry-specific input price proxies are adopted, and industry-level rises in input prices increase the SR marginal operating costs significantly for household and total lending. The negative coefficients for the bank-specific labour input price variables are disturbing. They might be explained by the fact that most banks strongly reduced their staffs toward the end of the sample period.[140] This restructuring has reduced costs, although the unit cost of labour has increased.[141] The coefficients of the bank-specific input prices are however insignificant when analysed in pairs, since the Wald tests support their joint exclusion from the model.[142]

The level of the money market rate is significantly inversely related to banks' lending margins vs the money market rate. This confirms the significant stickiness of banks' loan rates with respect to movements in the market rate. The analysis in chapter 3 shows that technological transformation, in reducing the role of differentiation in terms of 'physical' delivery networks, should result in an increase in

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[139] Whether there are economies of scale related to branch expansion depends on properties of the LR cost function that are not studied here explicitly. Kim and Ben-Zion (1989) devise measures of scale economies that account for output expansion with a given number of branches and expansion of output through branching.

[140] Total number of bank employees fell from a peak of around 52,000 in 1989 to less than 30,000 at the end of 1996. Staff reductions have continued thereafter.

[141] All models are quite robust with respect to the choice between all nonstaff inputs or just EDP inputs. The former specifications are reported, since in the lending activities the broad approach, which includes all operating inputs, seems more plausible than the narrow one.

[142] Formally, the Wald tests imply that the restriction of setting the coefficients of the bank-specific input prices to zero could be imposed without significantly affecting the performance of the model.

the pass-through of money market rate changes into banks' lending rates. In general, any effects that increase elasticity of loan demand would have this effect. Evidence of the increased pass-through over the sample period is however not robust across various model specifications. The coefficients of the respective time trends are also weakly significant, except in one case where significantly increased pass-through over the entire sample period is found.

The coefficients of the period dummies suggest that the levying of withholding taxes on interest income in 1991 had the effect of increasing lending margins to some extent. This would imply that loan rates were previously cross-subsidized from deposit margins. The evidence on this is however quite weak.[143] The period 1989–1990, following the break-up of the deposit cartel agreement, coincides with a potential price war in Finnish banking (Vesala 1995b, ch. 3), and the current results provide additional evidence of this shift in conduct.

Finally, the fixed effects[144] are significant and account for a large share of the SR marginal operating costs. The fixed effects are larger and more significant, when industry- rather than bank-specific input prices are used, since they then capture differences in input prices across banks, in addition to efficiency differences. Individual banks' coefficients have a priori-predicted signs based on their cost structures and lending policies.

The model fits significantly better for the pricing of household lending than corporate lending. The main reason is that the key explanatory variables are found to be less significant for corporate lending.[145]

4.5.2 Deposit pricing equations

The deposit pricing equation (4.5.2) is estimated by OLS including the fixed effects, and the results are collected in table 4.6 for the entire sample period 1987Q1–1996Q4 and the subperiod 1990Q1–1996Q4

[143] Chiappori et al (1995) show, using a spatial model of banking competition, that cross-subsidization is possible when deposit rates are regulated and tying-up of borrowers as depositors occurs.

[144] The respective parameters are not reported, but are available from the author.

[145] The estimation results concerning loan pricing are quite robust with respect to the inclusion of post offices within banks' branch network, but the fit is significantly higher than in the (a priori more plausible) case of excluding them. Use of yearly data produces qualitatively the same results, as it should, although the estimates of the ν-parameters are somewhat lower.

to facilitate comparison with the credit market analysis. Only the models with bank-specific input price proxies are presented, since models with industry-specific input prices produce inconsistent results; notably the input price coefficients are always negative. Model fit is also significantly worse when industry-specific input prices are used. The narrow specification of the price for nonstaff operating inputs (EDP expenses only) produces a significantly higher fit than the broad specification, and so I report the former results. The estimates of the key parameters are, however, quite robust with respect to specification of input prices: bank- or industry-specific, w_2 or w_3. As regards the payment and account keeping services ancillary to deposit-taking, EDP represents a key input, whose importance has increased strongly over time. Again, GLS made no difference as regards the parameter estimates.

The results imply that the significance of branch network differentiation has been lower in deposit-taking than in household lending. The estimated τ_1^*-parameter is only about a third the size of the corresponding ν^2-parameter. Moreover, the time trend has a significant negative impact on τ_1^*, and for the latter subperiod its estimate is not significantly different from zero. These results are consistent with the hypothesis that technological transformation already proceeded farther on the deposit than on the lending side. In Finland branches have apparently already lost much of their significance to deposit customers. Most transactions are currently effected via ATMs or remote banking, and branches are quite seldom visited.[146]

As to differentiation in ATM networks, taking into account both cash dispensers and payment ATMs, the estimated τ_2^*-parameter is somewhat larger than the τ_1^*-parameter. However, the former estimates are not significant. The impact of the time trend on τ_2^* is negative but not significant either. A dummy variable, ICD, is included in the model to assess the effect of ATM compatibility. It is defined as one for the period 1987Q1–1992Q4, when significant

[146] Based on Finnish Bankers' Association data, the share of ATM bill payments has increased from less than 1% to roughly 30% of all household bill payments between 1990 and 1996 and that of PC payments from 0.5% to 6% over the same period. In 1998, roughly 30% of banks' private customers had made either PC or phone-banking contracts to effect transactions. Most cash for transactions purposes is nowadays withdrawn from cash dispensers rather than over-the-counter at bank branches.

incompatibilities existed in the ATM networks, and zero otherwise. The negative and significant sign of that coefficient indicates that compatibility actually increased banks' pricing power due to improved service quality. If cash dispensers and payment ATMs are analysed separately (H_2^{**} and H_3^{**} are both inserted in the model), cash dispensers turn out to have a diminishing impact on pricing power while payment ATMs have increased their impact over time. This reflects the fact that the use of cash dispensers seems to have reached the saturation level as the use of cash has diminished, in contrast to the use of payment ATMs.

The estimated markups at the sample mean for the latter subperiod are only about a third of the estimate for the entire period. Around 70% of the markups result from branch network differentiation, as the values of the ATM-network differentiation indices are considerably smaller due to compatibility than the values of the branch network differentiation indices.

It is now possible to calculate what the value of the theoretical, two-dimensional differentiation index $H_{it}^*(\tau_1^*, \tau_2^*)$ would be for each bank and for each year, using the estimated τ*-parameters from the model where the one-dimensional simplification (4.7) was adhered to (τ_1^* = 0.084, τ_2^* = 0.14). This figure can then be compared to the sum $2(\tau_1^* H_{1it}^{**} + \tau_2^* H_{2it}^{**}) \equiv H_{it}^{**}$, which is the one-dimensional approximation. The difference $H_{it}^*(\tau_1^*, \tau_2^*) - H_{it}^{**}$ was calculated for two banks and for all years, and in each case the difference is positive and almost identically always slightly below 30% of the value of $H_{it}^*(\tau_1^*, \tau_2^*)$. This experiment suggests that the one-dimensional approximation underestimates the theoretical two-dimensional index by about a fourth to a third. Hence the estimates of the τ-parameters from the complex model, where the two-dimensional specification is used, should be smaller in absolute magnitude than the reported estimates of the τ*-parameters.

Both branches and ATMs have the effect of shifting the SR marginal cost curve downward, but this effect diminishes over time. The coefficient of branches is however unstable over time, as the estimate for the latter subperiod demonstrates. Unconstrained estimation again produces a negative coefficient for the bank-specific labour input price variable. Finally, there is again a slight indication of economies of scale and scope.

Table 4.6 **OLS-fixed effects estimation results of equation (4.5.2); dependent variable: deposit rate (R)**

	1987Q1–1996Q4	1990Q1–1996Q4
Constant (μ_0)	–0.36	–0.47
$PD_1(\mu_0^{PD})$ (1989–1990)	0.62**	
$PD_2(\mu_0^{PD})$ (1991–1996)	–0.03	0.41*
$B_{12}(\mu_{11})$	–0.00069*	0.0015**
Trend*B_1	3.98E-05**	–0.00011**
Wald test (prob value)[1]	(0.010)*	(0.000)
$B_2(\mu_{12})$	–0.00074**	–0.00094**
Trend*B_2	3.77E-05**	5.10E-05**
Wald test (prob value)[1]	(0.000)**	(0.000)**
H_1^* (τ_1^*)	0.084*	0.0023
Trend*H_1^*	–0.0043*	1.94E-05
Wald test (prob value)[1]	(0.0066)**	(0.97)
H_4^* (τ_2^*)	0.14	0.11
Trend*H_4^*	–0.0026	–0.0015
ICD*H_4^*	–0.27*	–0.094
Wald test (prob value)[1]	(0.010)*	(0.38)
$DR(\mu_2)$[2]	2.45E-06	–2.57E-05**
$LR(\mu_3)$[2]	–3.03E-04**	–1.71E-04
Bank-specific input prices:		
$w_1(\mu_{41})$	–0.0018	–0.0056**
$w_3(\mu_{42})$	2.24E-05	0.00062*
Wald test (prob value)[1]	(0.33)	(0.000)**
$i(\mu_5)$	0.97**	0.97**
Trend*i	–0.016**	–0.015**
R-squared	0.96	0.97
Adjusted R-squared	0.95	0.97
S.E. of regression	0.50	0.42
Sample observations	359	251
Absolute markup at sample mean	0.75	0.22
Relative markup at sample mean	0.17	0.06
Wald test (prob value)[1]	(0.000)**	(0.661)

** significant at 1% level.
* significant at 5% level.
Notes: 1) Wald test for rejecting the null hypothesis that the parameters in question could be restricted to zero. 2) Deflated by CPI.

The impact of the level of the money market rate on banks' deposit margins is significant and very large, and deposit rates exhibit much more stickiness in responding to money market rate changes than do lending rates. Weaker price competition, as discussed in the next section (ie lower perceived price elasticities), would account for this difference. However, the sensitivity of deposit rates has significantly increased, particularly in the latter subperiod, which is marked by deposit rate setting that is freer of tax exemption rules. According to the theory, this is what we should observe under ongoing technological transformation. Since deposit rates are stickier than lending rates, an upward movement in the money market rate widens banks' margins between lending and deposit rates, ceteris paribus. However, based on the estimation results here, this effect should be diminishing in the future.

The empirical pricing model fits deposit rates better than lending rates, and the R-squared figures are quite high.[147] Fixed SR marginal operating cost effects are again significant and account for a large share of the marginal costs.

4.5.3 System estimation to identify coordination parameters

The systems of demand and pricing equations, (4.10.1) and (4.10.2), and (4.13.1) and (4.13.2), are estimated by nonlinear three stage least squares (3SLS), including the fixed effects and yearly dummies in the demand relations. The results are reported in tables 4.7 and 4.8 for corporate and household lending and for deposit markets respectively.[148]

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[147] The estimation results concerning deposit pricing are quite robust with respect to the exclusion of post offices, though their exclusion produces somewhat lower estimates of the τ^*-parameters. The fit is worse when post offices are excluded, which is in line with a priori reasoning. Use of yearly data results in quite similar estimates eg of the τ^*-parameters.

[148] Due to poor convergence of the estimates, the unrestricted model versions (conduct not restricted to Bertrand-Nash) had to be estimated by first fixing the values of $(\alpha_1^{LDm}, \alpha_1^{DD})$ to those obtained from estimating restricted (conduct restricted to Bertrand-Nash) versions of the models.

Table 4.7 **3SLS-fixed effects system estimation results of loan demand (4.10.1) and pricing equations (4.13.1); dependent variables: ln(LB), TB and ln(LH), TH; 1991Q1–1996Q4**

	Ln(LB), TB	Ln(LH), TH
α_1^{LD}	0.0187	0.00241
Restricted ν (Bertrand-Nash conduct)	0.123**	0.278**
Trend*KB**/KH**	–0.0020**	–0.116**
Unrestricted ν (general oligopoly conduct)	0.117**	0.229**
Trend*KB**/KH**	–0.0017**	–0.012**
θ_L (whole period)	0.025	0.166
$X(\alpha_3^{LD})$	0.0394**	0.0202
$X\times TB/X\times TH(\alpha_4^{LD})$	–0.0021**	–0.0013**
Unrestricted models:		
R-squared ln(LB)-/ln(LH)-equation	0.753	0.922
Adjusted R-squared ln(LB)-/Ln(LH)-equation	0.722	0.912
R-squared TB-/TH-equation	0.472	0.820
Adjusted R-squared TB-/TH-equation	0.404	0.799
Sample observations	215	215
‘Own-rate’ price elasticity of demand at sample mean	–2.419	–1.249
‘Cross-rate’ price elasticity at sample mean	0.151	0.0185

** significant at 1% level.

Table 4.8 **3SLS-fixed effects system estimation results of deposit supply (4.10.2) and pricing equations (4.13.2); dependent variables: ln(D) and R; 1991Q1–1996Q4**

α_1^{DD}	–0.0013
Restricted τ_1^* (Bertrand-Nash conduct)	0.020**
Trend* H_{11}^*	–0.0006**
Unrestricted τ_1^* (general oligopoly conduct)	–0.026
Restricted τ_2^* (Bertrand-Nash conduct)	–0.045**
Trend* H_4^*	0.0017**
Unrestricted τ_2^* (general oligopoly conduct)	–0.059
θ_D (whole period)	0.789
θ_D (1991–1994)	0.571
θ_D (1995–1996)	0.894
$Y(\alpha_3^{DD})$	0.0015
$Y \times R(\alpha_4^{DD})$	0.0026**
Unrestricted models:	
R-squared (ln(D))	0.961
Adjusted R-squared (ln(D))	0.954
R-squared (R)	0.950
Adjusted R-squared (R)	0.941
Sample observations	215
‘Own-rate’ price elasticity of demand at sample mean	1.255
‘Cross-rate’ price elasticity at sample mean	0.0511

** significant at 1% level.

Before interpreting the results, some caveats are in order. It turned out that the system models fit poorly for the early part of the data, which exhibits a strong lending boom and an apparent price war (Vesala 1995b, ch. 3). Also deposit rates were strongly regulated via tax rules. The demand-side models based on first-order approximations may not be flexible or rich enough to predict demand for this peculiar period. The difficulties materialize in a lack of convergence of the estimates and failure of the parameter estimates to pass the consistency checks described below. For these reasons, the results are only reported for the subperiod of more liberalized deposit rate setting, 1991Q1–

1996Q4, for which the results are quite in line with the consistency checks, especially as regards the loan market results.

Since a considerable amount of structure has been imposed in the system models, there are a number of conditions that need to be satisfied for the results to be consistent with the theory, but which conditions have not been imposed a priori in the estimations. The purpose of the consistency checks is thus to investigate whether the 'data accept or reject the models', ie whether the theory is supported by the data.

First, based on the estimation results, the 'own-rate' and 'cross-rate' price elastiticies all have the expected signs, except the cross-rate elasticity of deposit demand.[149] Since there is differentiation in the model, according to a well-know result, firms should be pricing in the elastic parts of their demand schedules (eg Panzar and Rosse 1987). All models satisfy this condition at the sample mean. The absolute value of the estimated price elasticity is highest for corporate loans at the sample mean (around 2.4), while being significantly lower for household lending and deposit supply (both around 1.2). This is consistent with earlier results for the keenest competition in corporate lending. In addition, the 'cross-rate' price elasticities are lower in absolute value than the 'own-rate' elasticities, which is a plausible result. This means that changing own loan and deposit rates has a bigger impact on the demand for loans and supply of deposits than changes in rivals' rates. Finally, Wald-tests maintain the restrictions imposed by the theory ($\alpha_1^{LDm} = \alpha_2^{LDm}$, m = 1, 2 and $\alpha_1^{DD} = \alpha_2^{DD}$).

[149] The signs of the α_4^{LD}–parameters are negative, and those of the α_1^{LD}-parameters positive, all consistent with the theory. The estimate of α_4^{DD} is positive, as it should be, while the sign of α_1^{DD} is inconsistently negative. These parameters characterize the 'own-rate' price elasticities as defined in (4.11).

The results imply a much lower degree of oligopolistic price coordination among banks in lending than in deposit taking.[150] However, the estimates of the coordination parameters are never significant as single parameters, but the Wald test rejects the exclusion of the entire set of coefficients that determine the elasticities and conduct parameters in all cases. Furthermore, baring in mind the uncertainties, the results indicate that the degree of coordination has been higher in household than in corporate lending. The estimated conduct parameter is however only 0.17, even for household lending, which implies that roughly 80% of banks' pricing power has been due to differentiation and only 20% to collusion. In corporate lending, the point estimate of the coordination parameter is close to zero and practically all of the (weak) pricing power is attributed to differentiation.

These results mean that the unrestricted estimates of the ν-parameters are close to the restricted estimates, forcing conduct to be Bertrand-Nash and that the estimates from the loan pricing equations are not significantly biased due to this restriction. This means that the loan pricing equations produce useful insights when estimated on their own. Inserting yearly dummy variables to assess changes in the value of the coordination-in-lending parameters over time indicates that significant changes do not occur during the sample period. That is, there is no clear indication of a regime shift in oligopolistic conduct during this period.

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[150] Hyde and Perloff (1996) criticize the use of structural models to estimate the extent of pricing power (conduct parameters), since their simulations suggest significant sensitivity of the results to model mis-specification. Boyer (1996) explains this result by noting that the structural model may over-simplify the diversity and true complexity of oligopoly pricing. He concludes that the structural model should '…take its place as one more tool for understanding oligopoly behaviour, but it should not be seen as the only logical tool for understanding that behaviour'. Since considerably more structure has been imposed here on oligopoly behaviour than in the standard applications of the structural model, I feel that the analysis here should be able to capture the diversity of true oligopoly pricing, at least to some extent better than the simpler applications, and so reduce the sensitivity of the results concerning oligopolistic conduct. Finally, Corts (1999) cricicizes the empirically estimated conduct parameters, after conducting simulations, since the estimated conduct parameters are found to underestimate the degree of pricing power when the demand shocks are not lasting and the equilibrium behaviour results from efficient supergame collusion. A small empirical literature has emerged to test the reliability of the conduct parameters for those industries for which price-marginal cost margins can be established and the conduct parameters estimated. Wolfram (1997) (UK electricity spot market) and Genesove and Mullin (1997) (historical US sugar industry) do not find big discrepancies, but the conduct estimates based on the two methodologies are not the equal.

On the deposit side, the situation is reversed. According to the results, banks' pricing power has resulted mainly from price coordination during the sub-sample period 1991Q1–1996Q4 reported in table 4.8. The results even point to increased coordination toward the end of the sample period when concentration in the Finnish banking system increased due to the Merita merger and restructuring of the savings banks, but this result should be viewed with caution due to the weak significance of the respective coefficients.

The above results are in line with the findings in Vesala (1995b, ch. 4) indicating that price coordination has been significantly higher in deposit-taking than in lending. They also are broadly in agreement with Suominen's (1994) results indicating 4% – 56% use of monopoly power in the loan market and 18% – 100% in the deposit market. He uses aggregate time series data (1986–1989) on the Finnish banking industry and bases his analysis on a two-product quantity-setting model that incorporates linear demand and marginal cost functions. Suominen's analysis is a two-product extension of Bresnahan's (1982) test of competition or Shaffer's (1989) application of Bresnahan's test to the US banking industry.[151]

The findings here suggest that price competition among banks in setting deposit rates has not been highly effective in Finland in recent years on average. The indirect regulation of deposit pricing via taxation rules seems to be the primary explanation, because these rules still seem to strongly guide banks in setting deposit rates. It can be envisioned that the highest tax-exempt deposit rate serves as a 'focal price' for banks in pricing deposits, which supports the apparent emergence of fairly strong price coordination. Since deposit account types have been quite homogeneous across banks, the existence of such a 'focal price' could become quite decisive. The highest tax-exempt deposit rate has been (until June 2000) a natural deposit rate for banks to expect of rival banks' offers. There is no such obvious 'focal price'[152] for the pricing of corporate loans in particular, which require close credit risk evaluation, ie a lot of customer-specific judgement.

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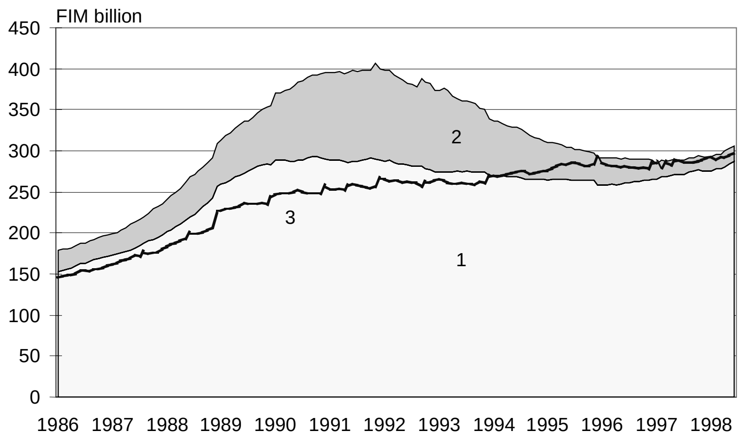
[151] The range for the estimated use of monopoly power in Suominen (1994) is due to the use of various instrumental variables-methods to correct simultaneous-equation biases in the OLS estimates. The use of instrumental variables seems however questionable, as he notes, since the sample size is quite small.

[152] In general, the existence of a 'focal price', on which it would be natural for oligopolists to coordinate, is found in the theoretical industrial organization literature to support the emergence of price collusion (eg Tirole 1988, ch. 6).

Secondly, the result of the smaller extent of price coordination in lending can be explained, at least to some extent, by the stronger effect of delivery network differentiation on lending than on deposit-taking, as already found in the estimations of the pricing equations. In the extreme case, when firms are completely differentiated from each other, there is no real price competition anyway and the problem of collusive conduct does not arise at all. In general, the perceived heterogeneity of firms constitutes a factor that reduces the likelihood of price coordination (eg Tirole 1988, ch. 6), again as there is a lack of a suitable 'focal price'.

Thirdly, the introduction of the withholding tax in 1991 opened up new possibilities to compete for customers via offering higher-yielding taxable deposit accounts. Changes in these deposit rates represent moves that can be quickly executed. In fact, the existence of this kind of a feasible and credible reserve for keen competition has the effect of deepening collusion.[153]

Figure 4.3 **Finnish bank's total loans (markka- and foreign currency-denominated) and total deposits, 1986–1998, FIM billion**
1. Total markka-denominated loans;
2. Total foreign currency-denominated loans;
3. Total markka-denominated deposits.



Data source: Bank of Finland.

[153] A general result from the standard models of infinitely repeated games is that anything that makes more competitive behaviour more feasible or credible (like unlimited capacities or other options to engage in fierce competition) actually promote collusion. Namely, very tight competition is reserved to punish defectors from 'tacit' collusion, and collusion is the stronger, the more severe the punishment from defection. Shapiro (1989) calls this the 'topsy-turvy' principle of 'tacit' collusion. He states that all general factors that are found to deepen collusion are in line with this principle.

Finally, the subsample period 1991Q1 to 1996Q4 has been characterized by a potential oversupply of bank credit in Finland. As figure 4.3 shows, banks in Finland have not, in the aggregate, needed additional deposit funding to finance their lending activities, since their deposit base has exceeded the value of their loan books as regards domestic currency-denominated items. In other words, banks could have met increasing demand for loans without having to resort to new and more expensive funding sources than deposits. This situation could explain in part why price competition in deposits has seemingly been weak (holding the effect of network differentiation constant).

Parameter estimates from system models restricted to Bertrand–Nash conduct are generally quite consistent with the results from estimating the pricing equations individually, which supports the consistency and robustness of the estimates. As to the results obtainable only from the system estimations, the demand for corporate loans has been found to be the most, and deposit supply the least, dependent on the cyclical position of the economy, with the demand for household loans being the intermediate case. These results are quite reasonable, since corporate investments that are to a large extent financed by bank loans are the most variable component of GDP, and the elements of private consumption are not as variable as investments.

The demand-side equations actually fit the data quite well. The deposit pricing relations again have the best fit and the corporate loan pricing relations the worst. The coefficients of the year dummies are significant in the demand relations, as they pick up the unmodelled components that are correlated with time.

4.6 Conclusion of chapter 4

The purpose of this chapter was to estimate empirical models characterizing the pricing of loans and deposits in order to examine the effects of banks' differentiation in terms of branch and ATM networks on their markups, and changes in this relation over time. To this end, a relatively simple way to measure the extent of network differentiation was presented. System models of loan and deposit demand and pricing relations were also estimated in order to separate network differentiation effects from collusion in prices. The empirical models were constructed according to the theoretical model presented in chapter 3, and, in the first instance, the empirical results obtained from the Finnish banking system (1986Q1–1996Q4) provide support for the theory as a suitable description of the pricing of loans and deposits. The demand relations based on the theory fit the data satisfactorily for the subperiod 1991Q1–1996Q4, while the models do not seem to be flexible enough to predict loan demand or deposit supply for the earlier subperiod, 1986Q1–1990Q4, due to the extraordinarily strong boom in bank lending and other peculiarities associated with this period.

The results indicate that pricing power due to branch network differentiation has existed mostly in household lending, where banks have enjoyed substantially wider markups than in corporate lending. However, in line with the predictions concerning the effects of the technological change, ie the reducing of customers' utility cost of weakened access to branches, this pricing advantage was found to be diminishing over time in all lending and deposit-taking activities. Hence, a tendency of eroding rents was detected to be putting strain on banks' profitability. This tendency is likely to intensify particularly due to the progressive current adoption of Internet banking.

Branch network differentiation was found to generate a significantly smaller pricing advantage with respect to deposits than household loans, which indicates that technological transformation has advanced farther in the former activity. ATM networks were found to contribute quite similarly to markups on the deposit side as were branch networks. In case of the ATMs the effect of the time trend was ambiguous: cash dispensers losing significance and payment ATMs increasing in importance.

The indices characterizing differentiation are mostly due to differences across banks (*network differentiation effect*), as regards branches, while the competitive advantage vs 'outside' competition is relatively more important as regards ATMs (*network size effects*), due to the compatibility agreements among banks. When all banks are involved in the compatibility agreement, the *total network size effect* captures the competitive advantage to all banks due to the total ATM network size. When fewer banks are involved, the total network size effect concerns only the respective banks.

Deposit margins with respect to the money market rate have been strongly affected by the level of the market rate, much more so than the lending margins. This stickiness is likely due to the still existing control of deposit rates through tax exemption rules, and significant price coordination among banks, while the determination of lending rates has been fully deregulated during the sample period.

The estimation of the price coordination parameters revealed that oligopolistic price coordination has been quite insignificant in lending activities, implying that banks have engaged in effective price competition. Thus in lending, differentiation, rather than collusion is found to be the primary source of pricing power. The contrary is found with respect to deposit pricing. This means that the importance of branching has still been lower than that implied by the results from the pricing models.

Coordination in deposit pricing has probably been supported by the stickiness caused by tax rules and an apparent oversupply of credit during the later subperiod (1991Q1–1996Q4) covered by the system estimations. The highest tax- exempt deposit rate seems to serve as a 'focal price' for banks' coordinating. Hence the removal of the tax regulation will likely intensify price competition in the deposit market. Finally, the empirical results concerning the decomposition of the sources of banks' pricing power into differentiation and collusion support the general industrial organization theory in that the two sources are mutually exclusive. The greater the differentiation, the less likely the collusion. Lending is found here to exhibit more effective differentiation and a low degree of collusion, while deposit-taking exhibits little differentiation and strong collusion.

The apparent differences in conduct between the Finnish loan and deposit markets, where market concentrations are approximately the same, illustrates the general problems with using only concentration as an indicator or predictor of competitive behaviour, as in the traditional SCPP approach, which predicts extensive price coordination in concentrated markets. Other influences like product differentiation, demand conditions etc may be more significant in actual oligopolistic markets, and thus the NEIO approach to analyse conduct directly is more appropriate. In fact, the evidence of weak price coordination in the Finnish loan markets in spite of high market concentration provides evidence against the SCPP approach. Focusing only on market concentration may thus generate biased conclusions eg for competition policy purposes.

What do the empirical results presented here imply for Finland as regards the potential effects of European liberalization, namely harmonized banking regulations, free cross-border banking within the single market, and the adoption of the single currency? All these factors increase the possibilities and likelihood of foreign banks increasing their operations in Finland and strengthen their competitive pressure on Finnish banks. The results imply that most benefits for customers would come from the elimination of cost differences on the lending side, rather than from reductions in the scope of collusive conduct among Finnish banks. Only more cost efficient lenders could undercut the domestic banks. On the deposit side, in contrast, consumer benefits could be obtained also from reduced possibilities for the incumbent domestic banks to exercise collusion without attracting foreign competition. That is, the contestability of the Finnish deposit market would likely increase in the future due to pro-competitive developments in Europe.

The need for extensive branching, and the sunk costs related to incumbent banks' existing branch networks, have been traditionally regarded as the most important barriers for banks as regards entry into new markets. Building up a branch network or acquiring a branch-bank in a target country are considered much more expensive entry methods than entry via establishment of one or a few branches. The results concerning the importance of branching indicate that Finnish deposit customers no longer place much value on 'physical' delivery outlets and hence the latter entry method could be successfully used by foreign or domestic bank or nonbank entrants into the Finnish banking market. Hence, entry barriers to the Finnish deposit (and asset management) market may not be very high, and substantial increases in competition and contestability,[154] might be achieved, which would generate significant customer benefits.

On the lending side, household lending was found to exhibit attractive markups for new entrants, but branching still seems to deliver an important, albeit diminishing competitive edge. Hence household lending would be the most difficult area for new entrants, and increases in competition and contestability would likely be realized more slowly than in the case of the deposit market. Corporate lending seems to be already quite competitive, which naturally restricts the scope of further customer benefits through increased competition.

There are several other implications of the findings, given the theoretical results presented in chapter 3. First, the declining value of network differentiation due to technological change would result in customer benefits even without new entry or changes in the contestability of the banking markets, unless banks succeed in differentiating in some novel aspects of service quality. Regaining

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[154] *Perfect contestability* is a market paradigm under which allocative, productive and dynamic efficiency are achieved as in a *perfectly competitive market*. In a perfectly contestable market there are no sunk costs of entry or exit, which means that effective threat of entry (potential competition) constrains even a monopoly to behave in a socially optimal manner (Baumol et al 1982).

pricing power might be difficult, through any means, in the liberalized environment with free cross-border banking and increasing nonbank competition. Diminishing variability of loan and deposit rates across banks would be another result of the technological development, as is already visible in the data. Moreover, lower markups for banks would result in a lower optimal number of branches, thus causing continuous pressure to restructure branch networks.

In terms of policy implications, the results indicate that the pass-through of money market rates to lending rates should increase in the future, which would increase the efficiency of monetary policy. In a cross-country comparison, differences in bank differentiation and in developmental stage of banking technology would result in varying pass-through across countries. In the framework of the single monetary policy in the EMU, these differences would cause monetary policy to have varying effects on the real economy. These differences will however diminish if competitive conditions and technologies converge within the single currency area.

The finding here of more rapid effects of technological transformation on deposits than on lending indicates that the loan rates would in the future become relatively stickier in respect to money market rate changes than would deposit rates. Moreover, if this situation continues to hold, deposit rate changes, eg due to further deregulation, would over time have weaker effects on lending rates.

5 Summary and conclusion

The analysis of developments in European banking since the early 1980s in section 2.2 provided evidence that the liberalization of bank conduct regulations and their replacement by indirect prudential limits for risk taking produced tangible pro-competitive effects in most European banking systems. This study started from the notion that, in the context of liberalized and open banking markets in Europe, the new ways by which bank clients get remote access to banking services (phone banking, PC banking using Internet) and disseminate information for credit risk evaluation and monitoring (phone, e-mail) will be the primary force changing competition in the future.

Sections 2.3 and 2.4 reported substantial changes that have already taken place as regards access to banking services and dissemination of information and currently progressive adoption of the Internet-based solutions. Both established banks and new entrants have been active in promoting the new technologies. Apparently, these changes have so far had a greater impact on deposits-taking and deposit-related payment and other services than on lending, though there have been visible changes and prospects for change also with respect to the latter activity.

5.1 Theoretical and empirical results

In the literature, retail banking competition is usually modelled as spatial (or horizontal) differentiation in a geographic sphere, where banks have pricing power over their ‘local’ customer base. Chapter 1 outlined the basic reasons why this approach may no longer be appropriate. The technological transformation process is increasing customer information on competing offers, allows customers to change banks easily, and supports banking relations with distant suppliers of financial services. Consequently, customers become substantially more mobile than before and more responsive to price differentials in the market as a whole. Consequently, the spatial framework does not seem well-suited any longer as the impact of remote access technologies and competition outside the traditional banking system gain in importance.

A two-stage model of retail banking competition involving branch and ATM network decisions (first stage) and loan and deposit rate setting decisions (second stage) was developed in chapter 3 to suggest a way to handle the identified shortcomings of the spatial approach. The model was also devised to capture the (falling) pricing power benefits accruing due to differentiation in terms of the extent of branch and ATM networks. Hence, the resulting model was more general than the spatial applications, but the basic predictions from the spatial models still held, namely that pricing power is increasing in market share.

ATMs are explicitly included in the model as a part of the 'physical' delivery capacity for the deposit market, but not necessarily as a complete substitute for branches. Section 2.3 however indicated that, based on the European evidence, the substitution effect of ATMs replacing branches has been significant. The inclusion of ATMs accounts for the fact that ATMs deliver and are indeed used for the most frequently demanded deposit-related services.

Summing the main theoretical results, banks' markups in both deposit and loan markets over the money market rate and the respective marginal operating costs were shown to tend to zero when the banks do not enjoy competitive advantages due to *network differentiation or size*. Technological transformation reduces these benefits of the banks with large networks against banks with smaller networks as well as against the "outside" competitors without these networks. Both network differentiation and size effects vanish when: (1) customers' marginal utilities related to branches and ATMs fall to zero; (2) there is no utility loss to customers when accessibility to branches or ATMs worsens (ie transaction costs do not increase); (3) the banking system as a whole does not enjoy a special service quality advantage (eg better payment services or credit risk evaluation methods) against the 'outside' nonbank competitors.

To have zero markups, all these factors, modelled as specific customer 'utility parameters', have to go to zero simultaneously, ie one single factor of the three can alone maintain some pricing power for banks. The diffusion of the remote access and information dissemination options and the lowering of their cost have a reducing effect on all three parameters, which would generate a permanent and structural increase in competition. Expansion in nonbanks' activities has the same effect of reducing banks' pricing power, since banks' markups are decreasing in nonbanks' market shares and service quality. Finally, with given sizes of branch and ATM networks, the variation in deposit and loan rate offerings across banks diminishes with technological development.

As regards branch and ATM establishment, the technological transformation process has the effect of reducing the optimal sizes of branch and ATM networks under plausible assumptions. In general, the wider the envisaged margins in price competition, the more outlets are established. Hence the increased price competition after liberalization and technological development resulting in narrower margins should constitute the major underlying reason why banks have started to downsize their branch networks in many countries. Moreover, ongoing technological transformation would maintain this trend. In Finland, the rapid and large reductions in numbers of branches also reflect rapid advances in banking technologies.

ATM networks have increased much in size in Europe as ATMs represent a smaller-cost delivery method (sections 1.1, 2.3 and 3.4). To the extent that remote access techniques also substitute for services via ATMs, ATM networks also will tend to diminish in size in the future.

Capacity collusion was shown to reduce the sizes of branch and ATM networks in section 3.4. ATM compatibility has the same effect (the network differentiation effect vanishes), but leads to a greater number of machines compared to collusion without compatibility, as the total network size effect comes into play. The reduction in the number of machines in Finland the followed the extensive compatibility agreements and establishment of a joint management company seems to have considerably reduced the size of the Finnish cash dispenser network, in line with the theory.

In chapter 4, empirical models characterizing the pricing of loans and deposits were presented, in line with the theory, and estimated in order to examine the impact of network differentiation and size effects, in terms of banks' branch and ATM networks, on their markups and changes in these relations over time due to technological change. System models of loan and deposit demand and pricing relations were also estimated in order to separate these effects from possible collusion in loan and deposit rates as sources of banks' pricing power. In the first instance, the empirical results for the Finnish banking system (1986Q1–1996Q4) supported the theory as a suitable description of the pricing of loans and deposits.

The results indicate that pricing power due to branch network differentiation has existed mostly in household lending, where banks have enjoyed substantially wider markups than in corporate lending. Branches have apparently not constituted a significant information-collection advantage in the case of corporate loans. However, the empirical models performed better in describing household loan pricing than corporate loan pricing, due to more significant unmodelled effects in the latter case.

In line with predictions on the effects of technological change, ie customers' utility losses due to reduced access to branches, this pricing advantage was found to be diminishing over time in all lending and deposit-taking. The results also supported the contention that technological transformation has advanced farther in deposit-taking than in lending activities (as regards lending to households). Given that the trend of diminishing pricing advantages due to branch and ATM networks is likely to continue and intensify due to the progressive adoption of Internet banking, the still-quite-substantial margins estimated for household lending and deposit taking are likely to narrow in the future, reducing bank profitability.

Branches and ATMs were found to have similar-sized effects on banks' pricing power in deposit taking, but the advantages from branching were found to result mainly from network differentiation effects (advantage vs other banks), while those from ATMs resulted from the (total) network size effects (advantage to the banking system as a whole) due to extensive compatibility. In the case of ATMs, the effect of the time trend was two-fold: cash dispensers declined in importance and payment ATMs increased in importance over the sample period.

For the first time in the empirical literature, to my knowledge, an attempt was made to separate differentiation from price coordination as the source of banks' pricing power. The estimation of price coordination parameters revealed that oligopolistic price coordination has been quite insignificant in lending activities, while significantly present on the deposit side. The general result from the industrial organization literature that differentiation reduces the probability of price coordination was thus established for Finnish banking. Price coordination in deposit pricing was probably supported by the stickiness caused by tax exemption rules (in force until June 2000), as the highest tax- exempt deposit rate seems to serve as a 'focal price' for banks' coordinating in the class of tax-exempt deposit accounts (section 4.4.1). Thus the removal of the tax-exemption probably increased competition in deposit rates. In addition, an apparent oversupply of credit during the period covered by the system estimations supported the argument that price coordination suppresses competition in deposits, because deposit funding is not a scarce resource.

Finnish deposit margins vis-à-vis the money market rate were found to have been affected to a much greater degree by the level of the market rate than were lending margins. This stickiness was likely due to the control of deposit rates through tax exemption rules and significant price coordination among banks, while the determination of lending rates was fully deregulated over the sample period.

5.2 Policy implications

5.2.1 Monetary policy efficiency

The theoretical model was applied in section 3.5.1 to address the issue of the pass-though of money market rate changes into banks' lending rates. This captures the efficiency of monetary policy changes in affecting the financing conditions of firms and households and hence the impact of monetary policy on aggregate demand via investment and consumption. The issue was broken into two parts: (1) banks' incentives to change lending rates, depending on the impact on profits if the rates were not adjusted; (2) the absolute size of the adjustment, given that it takes place, derived from the comparative static analysis of the price competition (second stage) equilibrium. The pass-through of money market rate changes into deposit rates was examined in the similar fashion as well.

Under strategic complementarity, which always holds in the model, technological transformation was found to enhance the transmission of monetary policy into lending rates (as well as into deposit rates) to the extent that: (1) borrowers' marginal utility related to branches falls; (2) borrowers' utility loss due to imperfect accessibility to branches diminishes; (3) the quality difference favouring banks against nonbank suppliers of credit is reduced. Declining differences among banks in the sizes of branch networks (network differentiation effect), growing nonbank supply of credit and weakening collusion among banks were also shown to have a positive effect on monetary policy efficiency. All these results can be summarized as increasing the price elasticity of the perceived loan demand curves (increasing price competition). The results obtain unambiguously, because both banks' incentives to change their rates and the sizes of the optimal responses depend on the above factors in a similar fashion.

Differences across banking systems in the future euro area as to the extent of pass-throughs of money market rate changes into banks' lending rates will produce complications for the conduct of single monetary policy. The model is able to formalize the idea that the structure of the banking system matters for transmission efficiency. The relevant structural differences, based on the results of chapter 3, will derive from differences in technological states of the banking systems, banking structures (network asymmetries) and nonbank competitors' market shares. Euro area-wide technological development in banking would enhance the pass-through of monetary policy changes to lending rates and would produce convergence in the effects of the single monetary policy, as the structural differences across countries would diminish in importance. Enhanced integration of European credit markets due to EMU would also have the same consequence for the extent that competition increases throughout the euro area and that competitive conditions become more congruous.

Similarly, increased use of the capital market in firms' funding (captured by nonbank competition in the credit market) would make monetary policy transmission more effective. The single currency is likely to promote the disintermediation of corporate funding, since the presently quite underdeveloped European private bond and equity markets are likely to grow and become more liquid.[155] Liquidity gains derive mainly from increases in the number of investors and issuers operating in the same currency. In addition, the currency-matching rules for institutional investors will lose significance, which is likely to lead to portfolio allocations across borders, and the new monetary policy framework might increase the demand for private paper (eg Davis 1996).

Widespread trust in stable monetary conditions and less crowding out by government bonds, due to the Stability and Growth Pact restrictions on government debt levels, would also support private bond issuance. Finally, in the absence of currency risk, investors looking for higher yields might take on higher risks through corporate bonds. Weak rating activities can slow developments in the first stage, but increasing demand should boost rating activity in the longer term. Since wholesale banking activities (especially in the money and currency markets) under the single currency will exhibit strong economies of scale and a need for a 'critical mass' to operate in the unified markets, a plausible scenario is a significant polarization of banks in Europe (eg Pietrabissa 1996). In this scenario, only a few Europe-based global players in wholesale activities coexist with a large number of retail-oriented and niche banks, supporting the integration of banks' capital market-related activities, as also the capital market access conditions for firms.

The empirical evidence for Finland indicated that the effects of technological change have also been felt in the loan market, which support enhanced pass-through of money market rate changes to

[155] See eg Dermine (1996), Hakkarainen (1996), Malkamäki and Vesala (1996), McCauley and White (1997), Niskanen and Vesala (1995), and Schinasi and Prati (1997).

lending rates. The apparent recent shift in Finland to more variable rate lending tied to banks' prime rates and money market rates supports this conclusion, since banks' reference rate choices can be considered endogenous and affected by their incentives to change loan rates when money market conditions change.

5.2.2 Effects of further deregulation of deposit rate setting

The deepening integration of the European banking markets could be expected to speed-up the abolition of any remaining frictions or explicit regulations on banks' deposit rate setting. In Finland, limits in effect until June 2000 on interest rates that can be earned free of tax on interest income reduced the interest cost of banks at least by the amount of the tax benefit to customers, which generated a competitive advantage to banks. Eg Belgium and France still have official ceilings on deposit rates. The tax exemption rules do not eliminate competition in deposit rates as direct rate regulations, since tax-exempt deposits compete against taxable deposits and investments.

All factors that increase the reaction of loan rates to money market rate changes were found to increase the reaction of loan rates to changes in deposit rates, based on comparative static analysis of the second stage equilibrium (section 3.5.2). Conversely, all factors that increase the reaction of deposit rates to money market rate changes were found to decrease the reaction of loan rates to changes in deposit rates. In the first instance, further deregulation of deposit rates and allowing market forces to operate freely in the deposit market as well would keep loan rates more insulated from changes in deposit rates. Deposit rate regulation has thus in fact the effect of making loan rates more responsive to shocks in the deposit market that affect banks' funding costs, which is against the idea of using deposit regulation to shield borrowers.

Therefore, faster technological development in deposit taking, as compared to lending, would have two effects: (1) loan rates become relatively stickier than deposit rates with respect to the money market rate changes; (2) deposit rate changes would have smaller and smaller impacts on optimal loan rates. Faster nonbank expansion in the deposit than loan market would produce the same results. If this asymmetric trend strengthens or persists, the end result would be increased volatility of banks' net interest income, and money market rate rises would have an increasingly adverse impact on banks' overall profitability.

5.2.3 Outlook for competition and contestability in retail banking

The theoretical results indicate that unless banks are able to regain market power through differentiating in some novel service quality aspects, competition in retail banking will increase considerably, due to the emergence of new remote access and information dissemination techniques. Technological change certainly provides new possibilities for product innovation and striving to obtain a solid customer base by expanding the range of services offered to clients. However, the possibilities for regaining market power seem quite limited, since retail banks seem to be developing their services in along similar lines, and the competitive threat from small institutions within and outside the traditional banking industry is increasing in importance. These competitors can potentially reach the entire customer base with the modern technologies.

The general outlook is that banks will increasingly attract customers through price competition and thus allow customers to participate in cost savings due to technological advancements in banking. The fact that banks' profits have usually derived mainly from retail banking suggests that banks have indeed been able to capture rents in these activities. Hence the pro-competitive effects of technological transformation and nonbank competition are probably strongest in the area of private retail deposit customers, in which banks' have traditionally enjoyed the widest margins and from which the bulk of banks' profits have come.

The competition policy concern of the adverse impacts of increased banking concentration in many countries would be reduced if technological development were to reduce the possibilities of large incumbent banks to exploit their market position in national or more narrowly defined local markets. The analysis in this study supports a broad view of competition, rather than by strict geographic or institutional area, as the actual or potential competition from outside these areas can constitute an effective disciplining force upon the incumbent institutions that reduces the possibilities for collusive conduct.

Section 2.2 detected signs of increasing competition, as well as some convergence in the costs of service production in the European countries under study. However, retail banking markets seem still to be quite fragmented in terms of national structural characteristics, banks' margins and costs. For example, the simple measures of productive efficiency and underlying profitability still differ significantly across countries. This evidence implies a lack of perfect contestability and room for future increases in retail banking competition. Some early observers expressed even strong scepticism as to whether retail markets are or can become contestable and whether the Single Market can produce substantial real effects.[156]

The Single Market legislation has relaxed most of the *legal and regulatory barriers* as regards entry from another Member State, although differences in 'conduct of business rules' in each domestic market may still prevent foreign entry to some extent. The euro could reduce the costs of foreign operations for banks in the euro area, as eg lending can be funded from euro-denominated markets or the domestic retail deposit base. However, as underlined by the above-mentioned studies, which cast doubt on the welfare benefits of the Single Market programme in banking, there are also *economic barriers to entry* stemming from exogenous supply or demand factors that render market power and excessive profits to established firms (Gilbert 1989). In addition, strategic actions of incumbents may be aimed at obstructing entry and protecting market position, which will generate *strategic barriers to entry* (Tirole 1988).

The need for extensive branching, and the sunk costs related to incumbent banks' existing branch networks have been traditionally regarded as the most important economic entry barrier for banks. Building up a branch network or acquiring a branch-bank have been considered too expensive, which hinders entry into new markets. It has also been thought that strategic expansion by incumbent banks through extensive branching could constitute a strategic barrier that deters entry.

I would think that the importance of this barrier has already diminished and will continue to diminish substantially, since the provision of many retail services can be increasingly dissociated from branches. The emergence of specialized institutions and smaller banks relying on remote access delivery supports this conclusion. A single branch or a small number of branches, or even remote supply without any branches using phone- or Internet-based delivery, can be sufficient to provide many of the deposit and asset management services and many, especially standardized, lower-risk loans, even to large numbers of customers.

[156] See eg Conti and Maccarinelli (1992), Mercenier and Schmitt (1992), Neven (1993), Ryan (1992), and Vives (1991).

The empirical results on the importance of branching presented in section 4.5 support the above conclusion as well, in particular for the deposit market. Namely, the results indicate that Finnish deposit customers no longer place much value on branches. Hence, the entry barriers related to existing branch networks may not be very high for domestic or foreign entrants, and substantial increases in competition and contestability might be achieved.

On the lending side, household lending was found to exhibit markups that might attract new entrants, but branching still seems to deliver an important, albeit diminishing, competitive edge. Hence household lending would be the most difficult area for new entrants, and increases in competition are likely to be realized more slowly than in the deposit market. Corporate lending seems to be already quite competitive, which naturally restricts the scope of further customer benefits through increased competition.

Consumer switching costs constitute a potentially significant demand-related barrier to entry and expansion[157] (eg Lindberg 1992). However, switching costs should be decreasing with technological change, as the costs associated with the transfer of accounts to another bank decrease. Moreover, Vives (1991) argues that the importance of switching costs is decreasing in customers' wealth. This implies, firstly, that the switching-cost related entry barriers should be lowest in respect of services and products targeted at wealthy clients, rather than at the mass retail market and, secondly, that the importance of switching costs should be decreasing over time, as the standard of living improves.

Various reputation effects, eg lack of name recognition or mistrust, could discriminate against newcomers, since risk averse clients prefer long-standing relationships with familiar incumbent banks. However, in the Single Market these additional demand-related barriers are likely to be quite limited due to the harmonization of prudential regulations. At least the well-known and highly rated large international banks should be well positioned to operate throughout the Single Market, also via remote access channels.

Finally, to the extent that domestic universal banks hold monopoly power over their customer base in mass retail services, they have a competitive edge against specialized domestic and foreign entrants. Wide margins in the less competitive segments allow them to compete intensively in other segments, and even to incur temporary losses.

[157] Lindberg (1992) presents Finnish examples of switching costs.

This kind of pricing means cross-subsidization between the different segments. When cross-subsidization is viable, the threat of tight post-entry competition can be credible, which in turn can deter entry.

However, universal banks' competitive advantage in being able to cross-subsidize might be relatively easily offset by the competitive disadvantage of the large and costly branch network and staff. Moreover, a significant increase in contestability in a number of segments of the retail market has already limited the possibilities for cross-subsidization. My conclusion is then that the possibilities for successful entry-deterring strategies based on cross-subsidization are likely quite limited and will diminish further in the future.

In sum, technological development seems to be decreasing the significance of economic and strategic barriers to entry, which suggests that significant increases in competition could come via this channel as well. There is naturally much uncertainty as regards the evolution of company structures in banking, as only time will tell how banks and nonbanks react strategically to the challenges and opportunities brought about by the new delivery technologies and also by the Single Market and the euro.

The empirical results imply that most benefits for customers due to greater competition would come on the lending side from a further elimination of rents accruing to banks due to pricing advantages related to wide branch networks, rather than from reductions in the scope of collusive conduct among Finnish banks. This concerns mainly household lending, since corporate lending margins are already quite thin. On the deposit side, in contrast, consumer benefits could be obtained also from increased contestability, as the possibilities for incumbent domestic banks to exercise collusion without attracting foreign competition would diminish.

As regards specific competition policy issues, the analysis of section 3.4 was used to evaluate the desirability of network compatibility (sharing) agreements among banks, more specifically, ATM compatibility, which is a wide-spread form of compatibility. All in all, ATM compatibility agreements can be viewed quite favourably from the competition policy viewpoint, as it is unlikely that the potential undesirable effects on consumers will be realized. In general, the more effective 'outside' competition and the threat of new entry alleviate concerns that cooperation agreements among banks will suppress effective competition.

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