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Testing for Competition in Banking: Behavioral Evidence from Finland

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Contents

1 Introduction and background

The subject of this volume is empirical analysis of competition in the Finnish banking industry since deregulation in the mid-1980s. This period encompasses an exceptionally pronounced business cycle in the Finnish economy, very rapid growth of banking activities, especially lending, and finally, severe profitability problems in the banking industry in the early 1990s. The banks' distress was largely due to a sharp increase in non-performing assets and loan losses, which culminated in an acute crisis in the industry. During this crisis, the State has been forced to grant banks substantial financial support in order to maintain their solvency and stability in the Finnish financial system and to sustain the credibility of the entire economy in the international capital markets. One of our main goals in this study is to examine the impact of these developments on the banking competition in Finland.

Our research is concerned with the following topics: (1) Characterisation of banks' pricing behaviour, and measurement of the level of price competition and its evolution over time. (2) Analysis of the nature and level of oligopolistic competition and banks' strategic interactions in bank loan and deposit markets, the two primal markets in which they operate. Strategic interdependencies between the two markets are also recognized and measured. Our empirical analyses are carried out using three different econometric approaches and also different types of data in order to test different empirical hypotheses and the robustness of our results. The first of the above topics is addressed in chapters 2 and 3. Chapter 2 is concerned with a test of competition based on reduced form revenue equations and panel data for individual banks and chapter 3 with an analysis of shifts in banks' pricing behaviour in the bank loan market (dynamic oligopolistic competition) using aggregate industry-level time series data. The third and longest of our analyses is presented in chapter 4 and deals with the second research theme, i.e. oligopolistic interdependencies in the bank loan and deposit markets. It again employs bank-level panel data. Finally, chapter 5 summarizes our main findings and draws joint conclusions.

This introductory chapter begins with a description of our research methodology, new empirical industrial organization (NEIO), and its relation to the previously dominant empirical approach to the assessment of competition, the structure-conduct-performance (SCP) -paradigm. We then discuss and analyze, in terms of a simple spatial model, the effects of regulation, and in particular, the effects of lifting previously effective controls on banking competition. After that, we present the distinct competition policy issues for the banking industry, as the application of our research results falls, ultimately, within the domain of the competition policy. This chapter ends with a section describing the institutional and structural characteristics of the banking system and summarizing the liberalization process of the banking regulations in Finland. All these, rather miscellaneous topics are collected in this first chapter, since they constitute a common basis for our empirical analyses presented in the subsequent chapters 2, 3, and 4.

1.1 Research methodology

Our research applies the theory and concepts of industrial organization in analyzing and measuring econometrically competition in the Finnish banking industry, and investigating the market influences on bank behaviour. More specifically, our study belongs to the field of new empirical industrial organization (NEIO). The econometric studies of market power based on the oligopoly theory, or more generally, the theory of imperfect competition, constitute an integral part of the NEIO-studies.[1] The NEIO-approach is in many important respects different from the previously dominant empirical method in the field, the structure-conduct-performance (SCP)-paradigm, which establishes a direct link from industry structure to conduct so that the level of competition in an industry is implied by its structural features.

In this section we first discuss the basic features and problems of industrial organization, foremost oligopoly theory, when ultimately applied to competition policy issues, as in our study. The main reason why we question the traditional SCP-approach is that it does not accurately characterize the use of market power. In spite of its obvious shortcomings the SCP-paradigm continues to be used as a foundation for empirical studies, also in banking, and is still often employed for competition policy purposes.

A part of the argument against the SCP is theoretical: SCP is not unambiguously predicted by the theory of imperfect competition and the direction of causality from structure to conduct is not clear. Another part of the argument against the SCP concerns its empirical implementation: Specification of the empirical equations, measurement of the level of competition (endogenous variables) and measurement of

[1] See Bresnahan (1989) for an extensive survey of these studies.

the structural variables (exogenous variables). We will establish these arguments more thoroughly in section 1.1.3, and then shortly review empirical studies testing the validity of the SCP in the banking sector.

Finally, we will present the central ideas of the NEIO-approach in the concluding section. We do not review here the NEIO studies testing for competition in banking and examining banks' strategic interdependencies. This is not due to the large number of such studies. In fact, they are quite few, but adequately heterogeneous to be easily summarized. Traditionally the primary focus in the empirical industrial organization studies in banking has been on the measurement of banks' productive efficiency and properties of banks' production (cost) function, e.g. economies of scale and scope. Since we have conducted our analyses using quite different approaches regarding empirical specification and the type of data used, we think that it is more sensible to discuss the related NEIO studies in conjunction with each of our own analyses in subsequent chapters 2, 3 and 4.

1.1.1 Industrial organization, competition and efficiency

Industrial organization became a distinct field of economics in the USA during the 1950s, in particular due to important works of Bain. At first the focus was on empirical studies, but it has been gradually shifting toward theoretical analyses in which the microeconomic theory of the firm, consumer and demand are combined in order to understand the formation and functioning of markets. The inclination toward theoretical analyses has become much stronger since the beginning of the 1980s due to the expanding application of the game theory. Economists have recently started to test the new views on firms and markets brought about by the game theoretic industrial organization models by econometric NEIO studies. For example, tests of the predictions of the dynamic oligopoly theory have started to emerge.[2] Ultimately, the predictions of the game theoretic models should be validated by empirical studies as the predictions of any other economic models (see Sutton 1991 for further discussion on the testing of industrial organization theories).

According to the traditional SCP-approach, industrial organization analyses begin with an assessment of the evolution and features of the market structure: Number and types of firms in the industry, their market shares, market concentration, barriers to entry and free competition and constraints due to regulatory or other public policy.

[2] See e.g. Porter (1985), Slade (1989) and Aiginger (1992).

Then, market participants' competitive conduct and other business strategies are analyzed. A direct link from market structure to conduct is typically established. Finally, the performance of the firms or institutions in the industry (profitability and efficiency) and the performance of the industry itself are evaluated.

The evaluation of performance has typically social contents, i.e. whether the firms and the industry operate efficiently in a way that the overall welfare is maximized (see e.g. Dansby and Willig 1979). Efficiency requires that the allocation of resources is optimal at a given time. The broad concept of efficiency can be divided into productive (or cost) efficiency and allocative efficiency, both of which must be met in order to ensure the optimal allocation of resources (see e.g. Scherer and Ross 1990).[3]

Productive efficiency requires that firms minimize the cost of production: Potential scale economies are exploited and firms use productive resources without waste.[4] Allocative efficiency requires that services provided meet customers' needs and that they are sold at prices that correspond the marginal cost of their production. Allocative efficiency is reached in perfectly competitive or contestable markets. Productive efficiency is enhanced by competitive product markets as well, but the threat of bankruptcy or take-over, i.e. efficient corporate control, is the additional condition for productive efficiency. In sum, the prerequisite for obtaining both productive and allocative efficiency is that the firms in the industry must not have market (monopoly) power over their customers. A role for policy interventions is established if the free market mechanism fails to result in both types of efficiency. Hence, a large part of industrial organization studies have been conducted in order to assist competition policy decisions.

1.1.2 Oligopoly theory and tacit collusion

Oligopoly theory has a central role in industrial organization as it offers concepts to analyze strategic interactions between firms. Chamberlin (1929) was first to note the possibility of tacit or implicit collusion which nowadays forms the core of the oligopoly theory.

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[3] Dynamic efficiency requires improvements in product quality and production technologies over time to enhance the overall economic performance. Dynamic efficiency in an economy is a prerequisite for long term increases in the standard of living.

[4] Leibenstein (1966) has labelled the productive inefficiency as X-inefficiency representing situations when firms fail to minimize costs.

Chamberlin realized that the oligopolists should soon note in repeated competition that in an equilibrium without cooperation the industry output is too high, or prices too low, to maximize total joint profits. Chamberlin assumed that the most likely result in an industry would be the monopoly level of quantity, which would be attained even without explicit cooperation (market sharing or pricing agreements) or cartel if the firms are adequately symmetric with respect to their costs and preferences, and firms can get information about their rivals' actions without significant detection lags. Chamberlin noted that if the symmetry assumption is dropped, all firms may not be willing to collude if transfers between firms are not possible.

However, even in the case of symmetric firms, firms will always have an incentive to cheat, since they can increase their short term profits by increasing output, or by reducing price, when other firms still produce or price at the cartel levels. If some firm or firms cheat, other firms will retaliate, and the industry shifts from the joint profit maximizing outcome to a more competitive, reversionary phase called a price war. Firms decision horizon, i.e. how much weight they put on short term vs. longer term profits is decisive for firms' decisions whether or not to cheat. This idea was formalized by Friedman (1977) and Telser (1972) who showed that, with sufficiently little discounting, an output vector which yields profits in excess of the Cournot (quantity competition) or Bertrand (price competition) output vector can be supported as a noncooperative equilibrium of infinitely repeated competition. Folk theorem (see Friedman 1977) states that many possible subgame perfect Nash equilibria exist in infinitely repeated oligopoly games with sufficiently little discounting: All outcomes between Bertrand (perfect competition) and monopoly equilibria are possible, in principle. Various authors have tried to impose restrictions on the set of the subgame perfect equilibria by introducing various equilibrium refinements (see e.g. Shapiro 1989 or Fudenberg and Tirole 1989 for thorough discussions on the subject). Unfortunately, a great many equilibria still seem to survive the refinements invented so far.

In general, the success of oligopolists to support a tacitly collusive scheme depends, in the original theories of infinitely repeated games, on their ability to credibly punish any defector from the scheme (see e.g. Shapiro 1989 for a review). Stronger, swifter and more credible punishments, i.e. reversion to a more competitive price war regime, allow the firms to support a more collusive outcome. The problem with these theories in explaining dynamic oligopoly behaviour is that they do not predict price wars: They never occur in equilibrium, although credible punishments are essential for the tacitly collusive outcome to exist. The theories of oligopoly games with demand uncertainty constitute a valuable extension to the basic theories of infinitely repeated games, since they actually predict the occurrence of price wars in equilibrium. These theories are discussed more closely in section 3.1 where they are used to motivate our empirical analysis of periodic shifts in banks' competitive behaviour.

Differences in the structure of information are often the reason why many recent game theoretic oligopoly models produce conflicting results.[5] Moreover, industry-specific institutional details, especially barriers to entry including initial sunk investments in fixed capital, and the characteristics of demand, affect importantly the nature of oligopolistic competition, and emerging industry equilibrium. Hence, we do not have a general theory explaining the emergence and breakdown of tacit collusion. Maybe it is impossible to write a general theory applicable to all industries that would constitute a general theoretical basis for competition policy (see Fisher 1989).

The wide range of possible subgame perfect Nash equilibria (Folk theorem) constitutes a problem for empirical research as the theory does not adequately constrain data. Therefore, results obtained for one industry are not directly applicable for another industry, and industry-specific empirical studies are needed for competition policy purposes. A lot of studies have been already conducted that provide valuable information in regard to competition policy. Detecting tacit collusion is typically impossible without econometric research. However, in case of tacit collusion competition policy interventions are often hard to justify.

Game theory has been very fruitful in modelling a wide range of various competitive situations and strategies in a flexible way. However, as noted earlier, the general mechanisms of tacit collusion are unrevealed to an important extent. Given the level of discount rates (e.g. the real interest rate), the following general results exist concerning the probability of tacit collusion. The first one is that collusion becomes more likely when the number of firms operating in the industry decreases (see Friedman 1977 for the original analysis). Secondly, tacit collusion is more probable when detection lags are short, i.e. when price or output changes by one firm can be observed quickly by other firms. When detection lags are long retaliation by other firms is delayed and hence it is less costly to deviate from the implicit cartel (see Tirole 1988). Thirdly, the probability of tacit

[5] The most well known recent game theoretic contributions are: Green and Porter (1984) (trigger-price strategy), Rotemberg and Saloner (1986) (trigger-price strategy), Abreu (1986) ("stick and carrot" strategy), and Slade (1987) (learning strategy). All these models make different assumptions about the informational structure.

collusion is the greater the more symmetric the firms are with respect to their production costs and characteristics of their products. When they are fully symmetric, monopoly price is a natural choice for a price to coordinate on. Under asymmetric costs or product differentiation there is no "focal" price to coordinate on, and tacit collusion becomes less likely (see Fudenberg and Tirole 1989). The fourth factor, multimarket contact was formalized by Bernheim and Whinston (1990) who showed that in fairly general circumstances multimarket contact raises the incentive for collusion by changing the relative costs and benefits of cooperating versus cheating to make cooperation relatively more attractive as the potential punishments have become more severe. Moreover, they show that multimarket contact can never reduce firms' abilities to collude, since firms can always treat each market in isolation. The final factor increasing the likelihood of tacit collusion is cross-ownership between firms as shown by Farell and Shapiro (1990) and Reynolds and Snapp (1986). It is not fully uncontroversial, however. Malueg (1992) showed that under certain demand conditions cross-ownership may actually decrease the probability of collusion, since the incentive constraints to deviate from collusion in a dynamic setting are affected by cross-ownership.[6]

A less quantifiable, but albeit very general, result from the standard models of infinitely repeated games is that anything that makes more competitive behaviour feasible or credible (like unlimited capacities) actually promotes collusion. Very tight competition is reserved to punish defectors from tacit collusion. Shapiro (1989) calls this the "topsy-turvy" principle of tacit collusion. All above mentioned general results, except the last one, the effect of cross-ownership, are in accordance with this "topsy-turvy" principle: They all make more competitive behaviour both more feasible and credible.

1.1.3 Shortcomings of the SCP

Traditionally competition policy has assumed, according to the SCP, that firms' market power increases with industrial concentration as a direct link from industry structure to competitive conduct is perceived. A rise in concentration is regarded as increasing collusive

[6] Empirical evidence presented by Parker and Röller (1994) from the US mobile telephone industry indicates that cross-ownership does lead to significantly less competitive outcomes. Their study also strongly supports Bernheim and Whinston's (1990) result of less competition when firms meet in a multimarket setting.

opportunities between firms, and hence would lead to higher prices and profitability. This may, naturally, well be in line with the first result stated in the previous section, but alternative theoretical considerations can undermine it. Most importantly, the theory of contestable markets (Baumol *et.al.* 1982) states that when there are no significant barriers to entry or exit potential competition controls the behaviour of the firms in the industry. Under these conditions, even a monopoly produces a socially optimal outcome.[7] Secondly, not all standard (non-game theoretic) theories forecast a positive relationship between the use of market power and concentration. Even in a duopoly, price competition can be fully efficient as the Bertrand equilibrium is a possible outcome, as also predicted by the Folk theorem concerning repeated competition. Of course, the standard Cournot models do forecast the positive relationship between the use of market power and concentration with demand elasticity as additional determinant of the price-marginal cost margin, the Lerner index. Lerner index constitutes an index of the use of market power, since in perfect competition prices are equal to marginal costs. Finally, it is impossible to determine *a priori* by oligopoly theory which level of industrial concentration is harmful for competition. Even appropriate measurement of concentration is ambiguous: It is unclear whether the most often used Herfindahl index of industrial concentration is the most appropriate measure with respect to the theory of tacit collusion (see Fisher 1989).

New game theoretic models do not contain the direct causal relation from structure to conduct. The determination of market structure and firms' conduct is often analyzed as at least a two-stage game, where firms make their entry or investment decisions in the first, so called investment stage, and compete (either in quantity or price) in the second, so called market stage (see Tirole 1988). Hence, market structure and conduct are both endogenous and are determined by the equilibrium of the game. As a result, the causal relationship included in the SCP becomes blurred. For example, entry decisions are affected by the expectations of the degree of competition in the market

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[7] More specifically, the first-best optimum, where prices equal marginal costs and total industry costs are minimized, is attained in all sustainable industry configurations from duopoly to perfect competition. In case of monopoly, freedom of entry and exit constraints the incumbent monopolist to operate efficiently and hold its profit at minimum level so that social (Ramsey) optimum is reached. Ramsey optimality denotes Pareto-optimality under the constraint of financial viability. Perfect contestability thus assures that productive and allocative efficiency are achieved. Monopoly adheres to average cost pricing, which is as close to marginal cost as possible under financial viability. See Baumol *et.al.* (1982) (ch. 7 and 8 present the analysis of the contestable monopoly), and Tirole (1988), ch. 8.

stage. Scherer (1980) points out that the SCP-relationship is rarely clear cut, since the feedback effects from conduct back to market structure and basic industrial conditions make the SCP-relationship indefinite distorting the distinction between exogenous and endogenous variables. I.e. "everything depends on everything else". This means that in general the SCP-paradigm provides little ground for the derivation and testing of hypotheses of firm and industry behaviour.

The core of Demsetz's efficient structure postulate (see e.g. Scherer 1980) is endogenous market structure as well. The efficient structure hypothesis states that market structure is shaped endogenously by firms' performance so that concentration is a result of the superior efficiency of the leading firms. According to this view, industry's cost conditions have stipulated its evolution, and potential competition has been powerful enough to eliminate monopoly profits which indicates the absence of effective entry barriers. According to the efficient structure postulate industries look concentrated as a result of efficiency rather than collusion. Hence, it leads to a totally different view on concentration, and its harmfulness, and the policy conclusions are quite different. As a result, the efficient structure and SCP-hypotheses have been often taken as competing hypotheses in econometric work.

The problems with the SCP-hypothesis were, nonetheless, early noticed, and since the 1950s econometricians have attempted to empirically establish the validity of the SCP and discover the "critical level" of industrial concentration by studies usually containing many industries (industry-level studies). Also studies concerning only one industry but including firms operating in distinct local markets, even in different countries, have been conducted (firm-level studies) (see e.g. Fisher and McGowan 1983 for a review). The following empirical equation has been typically estimated in order to test the SCP-hypothesis:

$$\pi_i = \alpha_0 + \alpha_1 CR_i + \sum_k \alpha_k Z_{ki} + \varepsilon_i, \quad i = 1,...,n \tag{1.1}$$

where π_i is most often an accounting measure of profitability (typically return on assets or equity), or sometimes a measure of the price-cost margin. In (1.1) CR is a measure of industrial concentration, Z the vector of auxiliary exogenous variables affecting the profitability or price-cost margins, and i the index for industry (or firm). There are, nevertheless, significant specification and measurement problems associated with the studies conducted in the above manner.

Firstly, firms' profits are a poor measure of market power, since market power and profits are not necessarily positively correlated, because productive inefficiencies (managerial expense preference behaviour) can lead to lower profitability in spite of broad price-marginal cost margins. A common observation is that monopolies are not efficient, but waste at least a part of their monopoly rents in excessive input usage.[8] In some studies price-unit cost margins have been used to approximate the Lerner index. This is a better choice, but not fully appropriate, since the unit costs may not equal marginal costs. Moreover, in case of multiproduct firms (like banks) allocating total costs of production to individual outputs based on accounting information is likely not possible.

Secondly, if its is unclear whether it is the SCP- or the efficient structure hypothesis that holds, it is difficult to specify which variables are, in fact, endogenous. In a number of studies this has been tried to resolve by including firms' market shares ($\alpha_2 MS_i$) on the right hand side of the estimated equation (as equation (1.1)). If according to the estimation results $\alpha_1 > 0$, and $\alpha_2 = 0$, the SCP-hypothesis gains support. On the other hand, if $\alpha_1 = 0$, and $\alpha_2 > 0$, the efficient structure hypothesis becomes accepted. We tend to think, however, that in many industries market shares and concentration are, due to the small number of firms operating in the industry, so strongly correlated that the above inference is not possible. In any case, discrimination between the two competing hypotheses in empirical studies is hard. In fact, very often the evidence of a clear SCP-relationship has become mixed after the inclusion of additional structural variables like market shares.[9]

Thirdly, in studies testing the SCP the exact use of market power is not measured, since the alternative hypothesis that gives the level of profits when competition is perfect (economic profit equals zero) is difficult to specify.

Fourthly, as noted, the choice of the proper concentration measure is not evident based on the oligopoly theory. The specification of the Z-vector is even more unclear, since many different variables affect

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8 These notions are in line with the rent dissipation hypothesis (see Posner 1975), and X-inefficiency theory (see Leibenstein 1966 and Frantz 1988). These theories give additional reasons why concentration and profits may not be positively correlated.

9 Sometimes even negative coefficient is found for concentration (α_1) when both market shares and concentration rates are used (see Ravenskraft 1983 and Martin 1983). See also Adelman and Strangle (1985) for a critique of single equations including market shares and concentration. See further Neumann and Boebel (1985) for a model (Cournot plus fringe) where a negative concentration coefficient may be theoretically justified.

firms' profits. Hence, the SCP-equation is basically ad hoc. Moreover, in the studies containing many industries it is almost impossible to control for industry-specific factors in a satisfactory way. When international data is used it is difficult to clear firms' profits from distortions caused by differences in country-specific industry regulations. This issue has been pronounced in the traditionally heavily regulated banking industry.

Due to these specification and measurement problems, we can not regard the results of the traditional studies trying to establish the validity of the SCP-hypothesis as very reliable. Evidence that once looked quite strong in favour of the SCP-hypothesis (see e.g. Weiss 1974) has become considerably mixed by later studies. In fact, the evidence in favour of the SCP seems now quite weak in many industries (see e.g. Fisher and McGowan 1983 and Fisher 1989 for reviews of the US studies). Moreover, a recent study by Salinger (1990) found instable coefficients of concentration over time. Even in studies concerning one particular industry in one country the results of the various studies testing the validity of the SCP can be quite ambiguous, like in the case of the banking industry discussed below.

1.1.4 Review of studies testing for SCP in banking

The validity of the SCP-paradigm has been widely examined in banking. Most of the rigorous empirical studies concern, however, the US banking markets. The emerging picture from these studies is rather mixed: A positive impact of market concentration on banks' profitability is not consistently detected, and in case a positive correlation is found to exist, the estimated impact is usually fairly negligible.

Gilbert (1984) presents an extensive survey of the related literature concerning the US retail banking markets[10] over a period from 1964 to 1983 testing the hypothesis of a positive correlation between concentration in the banking markets and bank performance: profit rates or interest spreads on loans or deposits. Overall the evidence was ambiguous: About 50 % of studies rejected the hypothesis, but in any

[10] The plural is due to geographic restrictions that have prevailed in the USA precluding interstate branching. Therefore, banking markets in states that have maintained restrictions should be regarded as independent. However, significant integration of the retail banking markets has taken place over the recent years as restrictions have been gradually lifted: In 1992 47 (in 1989 36) states permitted some form of interstate banking, practically all via subsidiaries rather than branches (see Baer and Mote 1992).

case variation in market concentration had only a small impact on the performance measure employed. Gilbert criticizes strongly the fact that most of the studies did not control for the effect of rate regulation on bank performance, which suppresses the true relationship between market structure and performance.[11]

Somewhat stronger recent evidence from the USA presented by Berger and Hannan (1989) exist in favour of more market power in concentrated deposit markets. Hannan and Liang (1993) are able to confirm this conclusion, which has a theoretical grounding in a liquidity management model of a banking firm (see e.g. Santomero 1984 and Hannan 1991) which establishes an explicit link between market concentration and pricing of deposit and loan contracts. Both of the studies analyzed the rates offered by banks on money market deposit accounts and certificates of deposits of various maturities. However, Calem and Carlino (1991) present contradictionary evidence. The authors discovered non-competitive conduct in money market deposit and 3- and 6-month certificate of deposit markets by employing cross-section data for 1985, but deviations from competitive pricing were uncorrelated with market concentration. Thus, the evidence from the USA is far from conclusive.

Evidence based on formal empirical studies concerning European banking markets is scant. Molyneux and Thornton (1992) investigated the determinants of bank performance across 12 European countries between 1986 and 1989, and found a positive and significant, but very small correlation between the 10-bank concentration ratio, CR10 (with respect to total assets), and pre-tax return on assets (various specifications were used). Bourke's (1989) results, using the three-bank concentration ratio, CR3, and pre-tax profit measures for 12 North-American and European countries with Australia included over a ten year period from 1972 to 1981, are closely in agreement with Molyneux and Thornton's findings. Ruthenberg (1991) tested the SCP-paradigm on a large set of countries (EC and EFTA countries plus Israel, Canada, Australia, and the USA) using aggregate bank data for years 1984–1988. According to his findings, banks' interest rate spread increased with the Herfindahl index only in small banking markets with relatively few competitors and high entry barriers. I.e. in Finland, Ireland, Sweden, the Netherlands and Israel. The density of

[11] Ceilings on deposit rates (Regulation Q), which were abolished during the 1980's, had clearly enhanced banks' profitability independently of concentration especially when market rates were much above the ceiling rates. As regulation is not explicitly accounted for in any study, Gilbert concludes that it is not possible to infer the overall impact of regulations on the estimated relationship between concentration and profitability (see Gilbert 1984).

the bank branch network was used as a proxy for the relative size of the entry barriers.[12] Thus, an increase in potential competition following banking integration should create the largest potential gains for these particular countries. Finally, Molyneux (1993) obtains weak support in favour of the SCP over the efficient structure hypothesis in the major European banking markets.

In international banking studies regulation has had a major disturbing effect, however. Correlation between regulatory protection and concentration, as well as correlation between regulatory protection and profitability, may be the reason for the detected positive correlation between concentration and profitability.[13] Further, banks' accounting balance sheet and profit and loss account items, especially profits, are subject to varying accounting standards in different countries. Due to these reasons, and as the evidence is also quite obscure, we feel that there is no clear case for accepting the SCP-hypothesis for the banking industry.

1.1.5 NEIO-approach to studying competition

The theoretical and empirical problems of the SCP-approach were the basic motivation for the onset of the NEIO-tradition in empirical industrial organization, and testing the oligopoly theory in particular, in the late 1970s and early 1980s.[14] Testing competition and use of market power has been a central part of the NEIO-studies. When the NEIO-approach is followed the competitive conduct of firms is analyzed directly without the use of structural measures that have been found to poorly indicate the use of market power. Especially, since the exact structural form of the equations is unclear, as well as the direction of causality as apparent in the SCP-efficient structure controversy. The first direct methods of measuring the use of market power in an oligopoly were presented by Panzar and Rosse (1982) and Bresnahan (1982).[15] Panzar and Rosse's method relies on the

[12] The soundness of this assumption can be questioned. (See Vesala 1993 chapter 4.3)

[13] In general, the effect of the intensity of banking regulations on the estimated relationship is inconclusive, since regulations that create effective entry barriers tend to enhance profitability while prudential ones tend to depress it (see Bourke 1989, ch.4 for a closer discussion on the matter).

[14] See e.g Bresnahan (1989), Schmalensee (1990) and Sutton (1990) for extensive surveys.

[15] See also Lau (1982) for a related formulation.

comparative static properties of firms' reduced form revenue equations (see chapter 2), while Bresnahan's test is based on the estimates of the oligopolistic coordination terms. Bresnahan's test can be applied to single-product industries where the industry demand is not separable in exogenous variables. His method involves a simultaneous estimation of the industry demand and supply equations. Finally, in a closely related field, Iwata (1974) and Gollop and Roberts (1979) represented empirically influential original studies measuring conjectural variations.[16]

The research methods in the NEIO-studies differ in three important respects from those used in SCP-studies: (1) What is assumed to be directly observable from data, (2) how the empirical models are constructed, and (3) how the sample is put together. The most fundamental improvement brought about by the NEIO compared to the SCP is that the econometric results are usually precisely quantifiable: NEIO has a clear positive character. The basic features of NEIO are also the methodological foundations for our own research which aims at analyzing competition in the Finnish banking industry directly without recourse to structural measures. The central ideas of NEIO are discussed in more detail below.

(1) According to NEIO, firms' price-marginal cost margins are not observable from data, since economic marginal cost can not be directly observed. Therefore, one has to either estimate an econometric cost function, possibly with a multiproduct structure, from which the marginal costs are derived (as in Roberts and Samuelson 1988), or use plausible proxies for marginal costs. Empirical models can, in some cases, be specified in a manner that estimates of marginal costs are not required, as well.

(2) In NEIO the estimated equations are always derived directly from the theory of imperfect competition, most often oligopoly theory. In so called behavioral equations firm-specific or average industry conduct are viewed as unknown coordination parameters entered in the estimated behavioral equations. As a result the inference about the use of market power is precise, since the alternative hypothesis, usually perfect competition or non-collusive behaviour, is explicitly specified. An example of a simple behavioral equation is the following supply-relation for a single product firm that holds for oligopolistic quantity or price competition in homogeneous products:

[16] See also Sullivan (1985) for a presentation of an applied conjectural variations model (a test of monopoly power) which he uses to investigate the level of competition in the US cigarette industry. Sullivan's model is refined and applied again to the US cigarette industry by Ashenfelter and Sullivan (1987).

$$p_t + \frac{\partial p_t}{\partial Y_t} y_{it}\theta_{it} = \frac{\partial C_{it}}{\partial y_{it}} \iff MR_{it} = MC_{it} \tag{1.2}$$

where p_t equals the industry price, Y_t the industry output, y_{it} firm-specific output, θ_{it} the coordination parameter, and C_{it} total costs of firm i, all at time t. Profit maximization requires marginal revenue (MR_{it}) be the same as marginal cost (MC_{it}). When the above supply relation is estimated simultaneously with the industry demand function (as in Bresnahan 1982) the resulting estimate of the coordination parameter, θ_{it}, becomes an index of the use of market power or degree of collusion.[17] If it obtains the value of unity, the quantity or price setting behaviour is like that in a monopoly and the degree of collusion is perfect (perfect collusion or cartel). On the other hand, if it obtains the value of zero, perfect competition is in question. Moreover, all possible oligopoly equilibria fall between these two extreme values. As the subscripts of θ_{it}, indicate oligopoly theory does not require that conduct is congruous across the industry (see e.g. Shapiro 1989), or constant valued over time, as periodic reversions to more competitive conduct may well occur (see e.g. Slade 1989).

(3) NEIO studies concern typically only a single industry. NEIO is sceptical toward studies using cross-industry data unless the industries are very closely related. Institutional detail in various industries are likely to affect firms' conduct and empirical measurement strategy in a way that is very difficult to control for properly in econometric cross-industry studies (see Bresnahan 1989). Some economists have adopted an ultramicro -approach where the behaviour of single firms in a certain market situation is examined (see for example Hendricks and Porter 1988). As multiple Nash-equilibria are typically possible (Folk theorem), NEIO studies concern often the choice of a proper model to characterize competitive behaviour in an industry.

The most central result of the NEIO studies concerning competition policy is that there is no clear evidence that the use of market power would be greater in more concentrated industries. Competition may well be efficient even in substantially concentrated industries. What is left over from the SCP-tradition is the case study –

[17] Much more richer models have been naturally employed in empirical studies. For example, Porter (1983) and Porter (1984) apply a switching regression model to investigate the emergence and duration of price wars in a 19th century US railway cartel. Slade (1989) presents an econometric model where demand and cost parameters are stochastically determined. She uses the model to analyze gasoline price wars in the Vancouver area.

like approach to collect systematic statistical evidence of a particular industry (see e.g. Bresnahan 1989).

1.2 Deregulation and banking competition

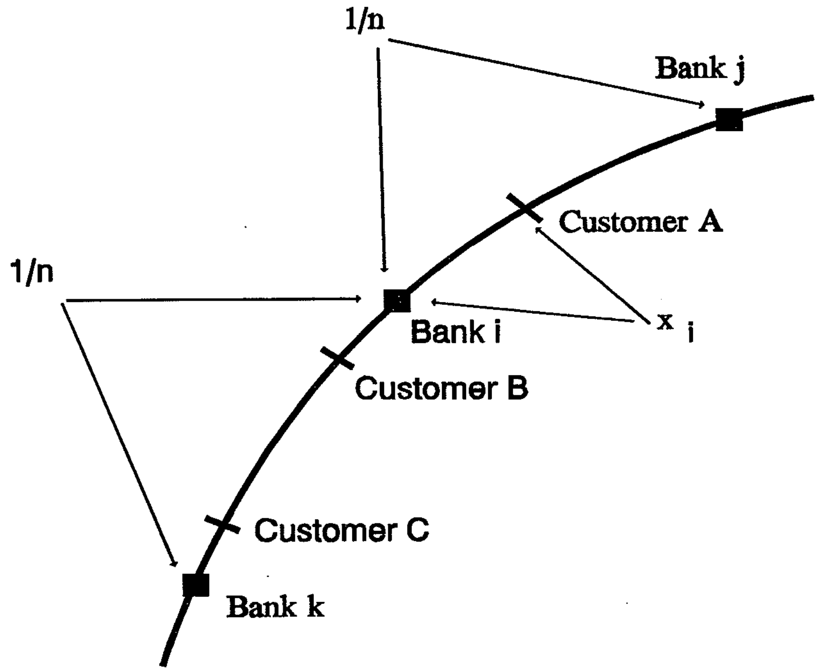
In this section we first examine the impact of the regulations that restrict banks' rate setting on the nature of banking competition. I.e. we wish to consider how banks compete when price competition is suppressed by regulations and how deregulation is likely to affect banks' competitive strategies. This analysis serves as a starting point for our empirical analyses of banking competition in Finland that concern mainly the period after lifting the major regulatory constraints on banks' competitive conduct, foremost loan and deposit rate setting.

A commonly held view is that under regulation banks compete in service proximity by expanding their branch networks which results in very dense networks. In general, branch proximity is a part of service quality as is access to convenient and cost reducing new banking technology. We examine here banks' competitive incentives to enhance service quality including both service proximity and instalment of technology in terms of a simple spatial model. If the regulations imposed on banks' rate setting had been binding we should see an increase in price competition after deregulation, and the predictions of the model presented in this section should hold. At the end of this section we will offer some evidence from major EU countries and Scandinavian countries regarding the changes in banking competition after liberalization.

1.2.1 Spatial model of banks' delivery capacity choices

We use here a simple a spatial model to analyze the competition aspect of setting up delivery capacity, and hence increasing service proximity.

Figure 1.1 **Banks and customers in the "circular city".**
(A segment of the unit circle depicted)



The model is an application of Salop's (1979) "circular city" model of monopolistic competition to the analysis of banks' delivery capacity choices. Schmid (1993) presents an extension of the Salop's model which considers the social desirability of branching restrictions. A summary and a discussion on the Salop's model can be found in Tirole (1988).

A two-stage game is considered. In the first stage, banks decide simultaneously whether or not to enter and compete in price (deposit rate) in the second stage given their locations. Banks are allowed to set outlets in only one location in the "circular city". These locations are assumed to be automatically equidistant from one another on the circle, i.e. maximal spatial differentiation is exogenously imposed.[18]

Let n denote the number of banks that establish outlets. Consequently, the outlets are symmetrically located so that the distance between any two of them is equal to 1/n (see figure 1.1).

[18] It would be more realistic to assume that banks choose their locations themselves rather than impose a particular locational pattern. However, the point of Salop's model is to study the extent of entry not locational choices. Moreover, Economides (1984) shows that a three-stage game where also locational choices are allowed yields the maximum differentiation result assumed in the Salop's model. The model could also be made more realistic if one allows sequential entry. See Tirole (1988) for a discussion on this issue.

There are no barriers to free establishment of delivery capacity other than a fixed set-up cost, f.

Banks' potential customers are assumed equally distributed over a unit circle. The transaction costs of banks' customers are measured by a unit transport cost, t (assumed identical across all customers), times their distance, x, to the service point of a particular bank. E.g. in case of bank i x_i. Hence, transaction costs are assumed to be linear with respect to customers' distance to the points of service. The interest rate on deposits offered by bank i is denoted by r_i^D. Therefore, the net benefit to the consumer (e.g. consumer A) from the use of deposit services provided by bank i is equal to $r_i^D - tx_i$.

For realism, this model can be taken to represent banks' choices to set up branches in a geographically distinct area, e.g. a small town or a section of a city where banks, if they decide to locate, establish a single branch only.

To solve the model we must first determine the Nash equilibrium of the second-stage pricing game under the given n and then determine the Nash equilibrium in the first-stage entry game. Therefore, assume than n banks have established outlets in the circular market. Assume further that customers have perfect knowledge of the rates offered by all banks, and the above net benefit is negative if customers have to travel a distance that is higher than 1/n. Under these assumptions bank i has only two real competitors, namely the two banks surrounding its own location. A customer located at the distance $x_i \in (0,1/n)$ is indifferent in terms of her net benefit between bank i and that of its neighbours that is closer to the customer, e.g. (in case of customer A) bank j offering a deposit rate r_j^D, if:

$$r_i^D - tx_i = r_j^D - t\left(\frac{1}{n} - x_i\right) \tag{1.3}$$

From which:

$$x_i = \frac{r_i^D - r_j^D + t/n}{2t}, \tag{1.4}$$

where x_i is the distance of a marginal customer, who is indifferent between the two banks, to bank i. Anyone located closer to the bank i will choose to be its customer. The market share (or demand) captured by bank i is equal to:

$$D(r_i^D, r_j^D) = 2x_i = \frac{r_i^D - r_j^D + t/n}{t}, \tag{1.5}$$

and bank i's profits (with no discounting) are given by:

$$\pi_i = (r^M - r_i^D - c)\frac{(r_i^D - r_j^D + t/n)}{t} - f, \tag{1.6}$$

where r^M represents the interbank rate. Banks are assumed price takers in the money market. Hence, r^M equals the rate at which each bank faces a perfectly elastic demand for funds generated from deposits. In (1.6) c is the constant marginal cost of providing deposit services, and f the fixed cost of setting up points of service. $(r^M - r_i^D)$ represents the price for the deposit services in terms of the interest foregone on deposit balances.

Since banks are located symmetrically, and information is symmetric, it makes sense to look for an equilibrium in which all outlets offer the same rate $r_i^D = r_j^D = r^D$ for all i,j ($i \neq j$). Differentiating π_i (equation (1.6)) with respect to r_i^D (bank i chooses r_i^D to maximize its profits) and then setting $r_i^D = r_j^D = r^D$ yields:

$$r^M - r^D - c = \frac{t}{n} \tag{1.7}$$

Hence, the profit margin $(r^M - r^D - c)$ increases with t given the number of outlets, n.

n is endogenous, however, and the main point of our interest. It is determined in free competition without barriers to entry by the following zero-profit condition for the entering firms:

$$(r^M - r^D - c)\frac{1}{n} - f = 0 \tag{1.8}$$

Thus, we can conclude that in free competition:

Result 1.1. The number of points of service, n, increases with an increase in the profit margin in the deposit market, $(r^M - r^D - c)$. Hence, the number of outlets is an increasing function of the price for banks' deposit service, or deposit margin, $(r^M - r^D)$, and decreasing function of the marginal cost of service production.

Result 1.2. An increase in the in the fixed entry cost, f, causes a decrease in the number of outlets.

Result 1.3. An increase in the unit transaction cost, t, increases the profit margin in the second-stage game (equation (1.7)) and therefore, increases the number of banks that decide to set up outlets in the first-stage entry game, and hence, increases n. Note that t is an increasing function of customers' opportunity cost of time.[19]

1.2.2 Interpretation of model predictions

We see that deposit rate regulation by imposing a ceiling rate has an important effect on the delivery capacity choices of banks by affecting their profit margin on deposit services. Higher lending rates than r^M plus the marginal operating costs of lending, which are associated with the credit evaluation, granting and monitoring activities (see Fama 1985), would imply extension of credit to risky investments. The positive margin should compensate the bank for the *ex ante* credit risk. Hence, we do not consider here the margin between average lending and deposit rates, but merely the deposit margin as decisive for delivery capacity choices.

Result 1.1 indicates that an increase in the deposit margin has a positive effect on the deposit service proximity provided. Moreover, if regulation or collusion imposes an effective ceiling on the deposit rates, banks' delivery capacity would be larger than in unrestricted price competition.[20]

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[19] *Result 1.4.* Socially efficient solution would require maximization of the net benefit of a representative consumer subject to a given level of profits. It can be shown that under these conditions free competition generates too many points of service compared to the socially desirable level (see e.g. Tirole 1988). Thus, free competition would result in higher levels of accessibility than would be socially desirable. This argument can be used in favour of branching restrictions (see Schmidt 1993). Another important result is that in Salop's model firms do not earn supranormal profits but can still price above marginal cost. Hence, looking merely at profits may not reveal the true use of market power. This is another reason for criticising the use of profits as a measure of market power (revert to section 1.1.3).

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

This has indeed been observed in international comparisons (see e.g. Neven 1993 and Vesala 1993) where the density of bank branch network has been found to correlate positively with banks' deposit margins. Branch capacity built in the regulatory phase is often regarded as even excessive in the new liberalized price competitive environment. In Finland banks' branch network density peaked in 1987,[21] i.e. before deposit rate setting was significantly liberalized at the beginning of 1989, which has had the effect of considerably narrowing banks' deposit margins (see section 1.4 for details). Banks' branch network contracted quite clearly in 1989 and 1990 although banks continued to be quite expansive otherwise, especially in their lending activities. Hence, the Finnish case provides additional evidence in favour of the positive relationship between the provision of service proximity and deposit margins.

In sum, the model captures the important effect of the degree of price competition on banks' capacity choices, and thus illustrates the importance of product market competition for productive efficiency. When price competition is suppressed by regulation or collusion, banks tend to compete in proximity resulting in higher branch network density. This can be regarded as waste in productive resources (productive inefficiency) when compared to the situation of efficient price competition. When the regulations are in the form of tax exemption rules, as in the Finnish deposit market (see section 1.4) extensive branch networks can be regarded as built by governmental subsidy in form of a publicly protected deposit margin.

However, we see that the closer banks are together following quality competition in regulated markets the more they are exposed to price competition once regulations are lifted. If banks have service points in the same neighbourhood, customers of the rival banks can be attracted by offering more favourable rates when banks are undifferentiated in terms of geographical location. Thus, when rate setting is freed by deregulation, banks are induced to locate further apart to soften emerging price competition.[22] By doing so banks are able to charge higher prices, and by means of isolation obtain greater local market power. A halt in the rise of the number of branches, and

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21 In the early 1980s the total number of branches were around 3500 in Finland. Since 1987, the peak year with 3534 branches, the number of branches has decreased until the end of 1992 in the following manner: 3282, 3175, 2884, 2652 and 2467. Of course, banks' profitability problems since 1991 have speeded up the capacity reduction process. (Source: Finnish Bankers' Association)

22 This conclusion is due to Neven (1993). He arrives at it by making reference to a standard Hotelling-type model of monopolistic competition presented by e.g. Eaton and Lipsey (1975).

even a fall in certain countries (like Finland) after the period of deregulation, might reflect this to a certain extent.[23]

The establishment of new banking technology, foremost automatic teller machines (ATM), may be used as a competitive strategy as well, since they are a positively valued part of banks' service quality. Since ATM transactions are in most countries provided free of charge,[24] 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 are likely to be transferred into time and savings deposits or other assets earning 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.

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 France, United Kingdom and Finland experienced strong competition between isolated networks. However, after a competitive start linkages between networks have been extensively established in most European countries (see Vesala 1993 ch. 4.4 for details), and banks now maintain a single joint network in many countries.[25]

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23 See Vesala (1994) for statistical evidence.

24 Based on the information obtained from the Central Banks of Belgium, Germany, the United Kingdom, Finland and Sweden for a study in progress, cash withdrawals in all of these countries are free of charge at the ATMs of the card-issuing institution. In some cases fees are introduced for withdrawals made from ATMs which, even when part of an inter-bank network, are not the bank's own machines. In Norway and the Netherlands banks have set small ATM fees. (See Vesala 1994)

25 A single ATM-network in which all domestic banks participate is now in operation for example in Denmark, Finland and Norway. In Italy almost 90 % of ATMs are linked through nationwide Bancomat network, in France an extensive Bank Card Consortium has been established. In the Netherlands the BGC network covers practically all banks except Postbank. In Belgium two competing networks (MISTER CASH and BANCONTACT) were merged in 1989 forming an entity called BANKSYS. The UK represents an exception, as there are no bridges between three principal ATM networks (LINK, MINT and FOUR BANKS). However, some bilateral arrangements between institutions belonging to different networks exist. (See BIS, Payment Systems in the Group of Ten Countries, December 1993 for further details.)

In previously heavily regulated banking markets, especially in those of France and Finland, far-reaching quality competition seems to have resulted in extensive instalment of new banking technology; also EFT-POS (electronic funds transfer at point of sale) -systems and computerized banking in addition to ATMs. In the traditionally less regulated banking markets of Germany and the Netherlands such quality competition has not taken place.[26]

The establishment of jointly supported ATM networks by merging the networks of individual banks or groups of banks reflects attempts to cut costs by deleting overlapping functions (computer systems and networks), but also to enhance customer satisfaction by extending the availability of the deposit services as customers prefer the services that are most widely available. Thus, network cooperation has been partly competition-driven as banks belonging to narrow networks have been put at a competitive disadvantage. There is a free-rider problem in network cooperation (see Katz and Shapiro 1986 for a general treatment of the problem) 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 exploit the scale economies associated with the ATMs (see Humphrey 1994). This aspect now seems, however, to be 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 installed machines in places where a single machine would suffice. The extra machines can naturally be transferred to locations where no ATMs have been installed. Network cooperation is also likely to facilitate the introduction of direct fees on ATM transactions, although the pricing of services remain in principle uncoordinated, i.e. outside the explicit "network cartel". In Finland there are already signs of both kinds of developments following closer ATM network cooperation.

Result 1.2 predicts, as also has been observed in practice, that ATM technology would increase the total number of points of service by lowering the fixed cost of setting up additional delivery capacity. The model also predicts that the lower fixed cost ATM delivery technology will be used instead of branches, as has been the case in the European countries (see Vesala 1994), provided that ATMs are, as they appear to be, as effective as branches in reducing customers' transaction costs. The use of ATMs instead of branches has been

[26] See Vesala (1993) for statistical information regarding ATM and EFT-POS networks in selected European countries.

further enhanced by their positive impact on average demand deposit balances.

Finally, result 1.3 predicts that ATM and branch network densities increase with income as income is positively correlated with customers' transaction costs via the opportunity cost of time. This is in accordance for example with international observations by Steinherr and Gilibert (1989).

1.2.3 Banking competition after deregulation – international evidence

Many observers have argued that the most important end result of the extensive domestic and external financial liberalization during the 1980s has been a strong increase in price (interest rate) competition among banks and other financial intermediaries in most OECD countries. This has involved foremost wholesale and corporate banking, while retail banking has remained less competitive and mostly business of domestic banks and other credit institutions.[27] Advances in communications and information technology and financial innovation have facilitated the process by enabling the market participants to exploit opportunities in the liberalized environment. Banks have diversified into new business areas and began to provide a much wider range of financial services. Competitive pressures have been aggravated by the emergence of non-bank competition[28] in many traditionally bank dominated businesses.[29]

Prior to liberalization regulations on rates and fees suppressed effective price competition between banks. Competition was therefore pushed into various forms of free or underpriced services (implicit interest payments) of which the most clear examples are payment and ancillary e.g. account keeping services. The costs of producing these services were cross-subsidized from the margin between lending and

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[27] Retail banking refers to banking services provided to individuals, households and small and medium sized companies. Wholesale operations are defined to comprise interbank trade in marketable securities, chiefly banks' certificates of deposit, which constitutes banks' liquidity management, i.e. raising and investing funds. Corporate banking refers to all services provided to (large) firms. (See e.g. Dixon 1991)

[28] Non-bank competitors include non-bank financial companies like credit card companies and specialized niche-banks, and non-financial companies like retailers offering e.g. consumer credit to their customers.

[29] See e.g. Banks under stress, OECD, Paris, 1992, and further Borio and Filosa (1994), Llewellyn (1993), Bryan (1991) and Pecchioli (1991).

deposit rates. Traditionally dominant share of net interest income in banks' total income (see table A1.1 in Appendix 1) implies that cross-subsidization between various banking operations has been extensive. However, since the late 1980s banks in many European countries have been extensively imposing direct service charges on e.g payment and ancillary services.

Banking liberalization has abolished most of the legal restrictions on the structure of banks' business (1), their competitive conduct (2) and international operations (3).[30]

(1): Banks are no longer explicitly restricted in selecting their investments or business activities, and the legal distinctions between various credit institutions have been largely cancelled with the aim of providing equal competitive conditions.

(2): Banks' competitive conduct is no longer directly regulated through interest rate controls on lending or deposit rates, neither through service charge or branching restrictions. None of the major EU countries, nor the Scandinavian countries, currently retains rate ceilings or other major constraints on lending.[31] The remaining restrictions on rate setting, often indirectly through taxation rules, concern usually only demand deposits or transaction accounts. In addition, reserve requirements have been importantly reduced in most EU and Scandinavian countries, though Italy (and Portugal) have maintained comparatively high requirements. Instead of direct explicit regulations, banks' freedom in choosing their assets is currently implicitly restricted by prudential capital adequacy, large exposure (asset concentration) and participation regulations. The aim of these restrictions is to secure stability in the financial system by inhibiting banks' excessive risk taking (moral hazard) that is symptomatic of the publicly provided deposit insurance and lender-of-last resort.

(3): Domestic liberalization has been accompanied by substantial external relaxation of restrictions on investors' and banks' international operations. EU legislation has pushed this to the limit: Free provision of financial services is a part of the creation of the Single Market in the European Economic Area (EEA) in force since the beginning of 1994. As a consequence of the liberalization process effective public protection through administratively set interest margins and entry restrictions has been by and large cancelled.

Abolition of the rate regulations seems to have significantly narrowed banks intermediation margins calculated as net interest

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[30] Banking liberalisation in Finland is discussed more in detail in section 1.4.

[31] For country-specific details of the deregulation process see Bröker (1989), Gual and Neven (1992) and Vesala (1993).

income per Adjusted Balance Sheet Total (ABST) which equals total assets minus interbank assets and assets held with Central Banks (see table A1.1).[32] The figures for early 1990s are, in most countries, significantly smaller than those for the early 1980s. The most substantial reduction has taken place in France. Only Italy and Sweden constitute exceptions to this trend which indicates that banks' have indeed, in general, engaged in active interest rate (price) competition. The persistence of old margins in the liberalized environment would suggest that banks have been able to replace regulatory protection by private collusive arrangements (explicit or tacit) limiting the degree of price competition, or that the rate regulations had not, in fact, been binding.

Changes in asset structure, securitization, increases in non-performing loans and credit losses can all affect the intermediation margin defined as net interest income per ABST in addition to the increases in price competition. The recent recession in the early 1990s has resulted in high aggregate loan losses and value adjustments with respect to loans and securities in the United Kingdom, and especially Norway, Sweden and Finland among the European countries. United Kingdom has met the most severe recession among the EU countries. The most dramatic increase in credit losses has taken place in Sweden, where banks' aggregate write-offs amounted to nearly five per cent of total assets in 1992. The respective figure for Finland was approximately three per cent. The recession has hit Sweden and especially Finland much more harshly than the other European countries, but also other factors related to public policies, asset prices and risk taking and competitive behaviour at banks that have similar features in Norway, Sweden and Finland have importantly contributed to the worsening of the situation into severe banking crises in these countries. In the course of these developments banks' income has been affected. (See Vesala 1994).

In spite of the above qualifications, we think that the evidence is rather clearly in favour of increased competition in the on-balance sheet intermediation services after liberalization.

Note that banks' income composition differs significantly across countries (see table A1.1). While banks' net non-interest income has

[32] The most commonly used indicator of the volume of banks' intermediation services, total assets, causes systematic bias in international comparisons as banks' business mixes differ significantly across countries. ABST corrects for the most important difference by excluding interbank assets as it represents the most significantly varying asset category. Moreover, interbank assets generate little revenue compared to other higher-yielding asset categories, and do not represent financial intermediation carried out by banks.

risen relative to net interest income in most countries, most significantly in France, the rise has not generally been strong enough with respect to asset growth to offset the fall in intermediation margins, and a downward trend, characterizes the evolution of banks' overall gross margins, as well.

1.3 Competition policy issues for banking

This section discusses the most important competition policy issues for the banking industry.

Governments have always followed the operation of banking industries very keenly, since intermediation and payment services are very important for the economic performance of other industries, and bank failures would cause severe negative externalities on all other sectors of the economy. Although guarding stability is of great importance, also productive and allocative efficiency guaranteed by effective competition policy should be among the primary government objectives for the banking industry as well as for most other industries.

In banking, price competition has been stimulated by the abolition of the regulations on the pricing of banking services, and by lifting the formal obstacles to foreign entry. For foreign banks taking over an existing domestic bank, instead of setting up extensive delivery capacity, represents the most feasible way to profitably enter a foreign (retail) banking market. Moreover, by acquiring a domestic bank a foreign bank gets a direct access to a customer base and local information. Making cross-border acquisitions and mergers free of all remaining obstacles would therefore be most consequential in raising effective potential foreign competition. The still significant state ownership in the banking industry in many countries, in spite of the recent wave of privatisation, provides opportunities for Governments to introduce new competitors into national markets. However, although no overt legal restrictions on foreign ownership exist in the Single European Financial Market, the objective of many Governments appears to be preserving national ownership of the largest domestic banks, which seems to be related to the fear that significant foreign ownership would reduce the availability of services (see e.g. Bisigano 1992).[33]

Banks have now a clear incentive to soften increasing price competition that has increased after liberalization in order to sustain intermediation margins and profitability by collusive conduct, by trying to cement their current customer base, or by attempting to strategically block entry into the industry. Actual foreign rivalry is still fairly limited in many European countries as the market shares of foreign-owned banks are quite small in most countries. Nevertheless, small overall market shares are somewhat misguiding since the foreign-owned banks have mostly positioned themselves in the wholesale and corporate banking markets where their pro-competitive effect has in most European countries been more important than that implied by their small overall market shares.

By contrast, retail banking has in general remained national business. In this market, domestic banks may strive to replace the prevailed legal and administrative barriers to foreign entry by strategic conduct now that foreign competition is freed from any legal obstacles in the Single European Financial Market. Pure strategic expansion to block entry, especially via branch proliferation, seems to be implausible as light capacity constitutes a competitive advantage in conditions of intensifying price competition. (Although in Italy, by exception, banks seem to be enlarging their networks to reinforce their home territories (see Vesala 1994). In contrast, domestic mergers or acquisitions may be effective in reducing competitive pressures by diminishing the possibilities of entry by acquisition. The increase in the number of banking mergers (see Abraham and Lierman 1991, Gual and Neven 1992, and Vesala 1993) and banking market concentration in many European countries at the end of 1980s and early 1990s may, hence, reflect the desire to limit competition. Based on the rather uncontroversial empirical evidence that scale economies

[33] According to Stiglitz and Weiss (1985) optimal behaviour on the part of banks may result in charging higher prices from and allocate less credit to unknown and distant customers. This fear, then, might rationalize the observed hesitation of Governments to allow foreign acquisitions especially of large domestic banks. This concern would not be warranted if foreign banks' local management could run local operations independently, which, however, would not most likely be the case as global optimization for the whole bank can affect the portfolio decisions in individual local markets. (See also Berg 1994)

in banking are quite small,[34] except at very small output levels, the most important goal of the mergers between banks seems to be to enhance market power and profitability. In addition, empirical investigations of bank mergers tend to indicate that they do not on average lead to significant cost savings (see e.g. Rose 1989 for a US survey, and Berg 1992 a Norwegian study). However, in certain cases, such as in Finland and Norway in recent years, mergers have been used as means to speed up capacity reductions in order to obtain operating cost savings.

In addition to mergers, also many forms of explicit cooperation between banks have increased in recent years. Currently explicit cooperation among banks ranges from marketing and pooling agreements to computer network cooperation and formal alliances strengthened by reciprocal cross-participation or unilateral acquisition of minority holdings in partners' share capital. The number of such agreements has recently increased, also between banks from different countries (see Vesala 1993).

Due to the above mentioned issues active competitive policy may be required to attain efficient operation of the banking markets, and detect and prevent harmful bank strategies aiming at limiting price competition. Muldur (1993) notes that in most European countries active policy of banking competition has been either non-existent or passive, which is worrying regarding the above objective, especially in bank dominated financial systems. This is due to the fact that Governments have also many other policy objectives than efficiency regarding the banking industries. Two major additional objectives are ensuring the availability of basic financial intermediation and payment services, and most importantly maintaining stability in the financial market and payment system. Both of these goals, discussed in turn below, may conflict with the efficiency objective.

The concern about the availability of services has two major repercussions. Firstly, in small banking markets Governments may tolerate dominant positions of large banking institutions in certain market niches, since relatively large bank size is often required in small countries with less developed capital markets to ensure the provision of the loans and other services demanded by large corporations. Small institutions would not have adequate capital bases e.g. due to prudential capital adequacy requirements. Secondly, the Government may wish to extend the provision of the financial

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[34] A partial list of the studies includes Gilligan et.al. (1984), Berger et.al. (1987), Buono and Eakin (1990), Ferrier and Lovell (1990), Berger and Humphrey (1991), and Berg et.al. (1992). See also Kuussaari (1993), Piispanen (1994) and section 4.5.3 in this volume for evidence from Finland.

intermediation and payment services beyond the point banks find profitable, for example in small remote communities, and at prices not significantly higher than those charged in large communities, where customers can be reached at a lower cost (see Berg 1994). Charging universal prices would denote cross-subsidies from customers located in densely populated areas to those living in remote locations. Trends toward less cross-subsidization and direct cost-based pricing have developed in banking during the past decade due to increasing price competition and banks' profitability problems. Furthermore, under these conditions, banks were found to have incentives to reduce the scope of their distribution networks (see Vesala 1994). Therefore, the question about the availability of the banking services could become more pronounced in the future, and public intervention may take place if the nationwide availability of the essential services is threatened. Either these services are provided through publicly owned institutions, such as post offices, or private banks are directly subsidized. The Government could restrict price competition by regulatory measures that allow the use of the cross-subsidies, but this seems unlikely under the current conditions of harmonized regulations. Under the home country control-regime adopted in the EU banking legislation, restrictive controls would put domestic banks at a disadvantage in international competition in the Single Market (see also Berg 1994).

There is a potential policy conflict between striving to enhance competition, and level-playing-field in banking and preserving stability in the financial system, since stability is enhanced by banks' financial strength, i.e. high margins and profitability. Banks' solvency can be jeopardised if they fail to maintain appropriate risk premiums in lending in a cut-throat competition. In Finland, Norway, and Sweden, in the near future after the banking crises, the priorities will be most probably on achieving stability even if it means restricting competition (see also Berg 1994). For example, authorities have allowed mergers among large domestic banks and other financial institutions in order to have stronger units.

Financially stronger institutions are better able to absorb negative external shocks, but, perhaps more importantly, excessive risk taking is less attractive for well-off institutions, since they have more at stake in the event of an adverse outcome (see e.g. Chan *et.al.* 1992). Keeley (1990) argues that positive values attached to banks' charters (i.e. being an established bank with a valid charter has value *per se*) necessarily reflect imperfect competition, and banks' market power. If it is true that banks must have positive charter values to limit their risk taking effectively (see e.g. Furlong and Keeley 1987, and Chan *et.al.*

1992), achieving stability and full efficiency would be in fundamental conflict.

Moreover, excessive risk taking due to moral hazard which is symptomatic of publicly provided deposit insurance and lender-of-last resort, is likely to be fostered by fierce competition. Moral hazard arises, because the downside losses of banks' risk taking are covered by the public safety net, while the upside gains accrue to bank owners. Milgrom and Roberts (1992) have analyzed the US Savings and Loans crisis during the 1980s and observed that in states where competition over depositors was most intense banks also engaged in most heavy lending growth with inadequate risk premiums (interest margins in lending to cover *ex ante* credit risk), and took large risk positions in the securities markets.

On the other hand, competition drives innovation and promotes efficiency through the strategic responses of banks to existing or potential threats to their markets from competitors. On balance, the ultimate problem is one of risk management by financial institutions, and it cannot be automatically assumed that increased competition will always bring along effective risk management. Recent events, for example the US Savings and Loans crisis, and the Scandinavian banking crises in the early 1990s, indicate that keen competition can indeed lead to increased financial fragility of banks. In particular if banks fail to maintain adequate risk premiums in competition for lending market share. Consequently, competition in the banking industry may well be excessive from the social perspective, and public policy should find an appropriate balance between competition and regulation to guarantee stability in the banking system.

1.4 Background facts on the Finnish banking sector

In order to give background for our subsequent empirical analyses presented in the latter parts of this volume, we (1) describe briefly the institutional framework of the Finnish banking and credit institutions, (2) summarize the liberalization process of the Finnish banking industry and its procompetitive effects, and (3) overview the structural characteristics of the Finnish Financial system. The structural features suggest the existence of competitive imperfections in the Finnish banking market and in the financial market in general.

(1) The Finnish banking and credit institutions excluding insurance institutions and securities broking firms include (1) deposit banks, (2)

other credit institutions, (3) other financial companies, and (4) unit trusts and investment trusts. The deposit banks comprise commercial, savings and cooperative banks.

(1) Five distinct deposit bank groups have covered the most of the Finnish banking market and possess nationwide branch networks. These include, the three largest commercial banks Kansallis-Osake-Pankki (KOP Bank Ltd), Suomen Yhdyspankki (SYP, the Union Bank of Finland Ltd) and state owned Postipankki Oy (PSP, Post Office Bank Ltd), which became a limited liability company in 1988. A former savings bank STS-Pankki (STS-Bank Ltd, incorporated in 1990) was merged with KOP in 1992. The remaining two groups are cooperative banks and savings banks that in conjunction with their respective central institutions, OKO (Okobank Ltd) and SKOP (Skopbank Ltd), have provided nationwide practically the same universal services as the largest commercial banks. OKO and SKOP have the legal statuses of commercial banks. Locally functioning individual cooperative and savings banks have, in particular, a major role in supplying banking services to the household sector and small and middle-sized firms. The sector of local banks has been subject to major structural changes over the recent years. Especially in the savings bank sector there was a strong trend toward larger regional units until 1992 when the major reorganizations in the savings bank sector took place.

During the crisis which has shadowed the Finnish banking industry since 1991 the savings bank sector has been most seriously affected.[35] The takeover of SKOP by the Bank of Finland in fall 1991 and following arrangements rendered SKOP and the largest savings bank, Suomen Säästöpankki (Savings Bank Finland), into the sate ownership control. Suomen Säästöpankki was established in 1992 through a merger of 41 independent savings banks. Consequently, in October 1993, Suomen Säästöpankki was sold to its four major competitors, KOP, SYP, PSP and the cooperative banks. As a result, one of the core five banking groups, the savings bank sector has by and large disappeared. The remaining independent savings banks have been left with a tiny overall market share.

(2) In Finland the regulations on banks' average lending rates were lifted step-by-step between 1983 and 1986, and since then banks have been able to freely price their new credits. However, the interest rates charged on a stock of loans tied to the Bank of Finland base rate

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[35] See Nyberg and Vihriälä (1994) for a thorough discussion on the causes and handling of the Finnish banking crisis, and Koskenkylä (1994) for an exposition of the developments in Denmark, Finland, Norway and Sweden.

can only be raised in proportion to changes in the base rate. The use of market based reference rates was liberated between 1987 and 1990. Since 1990 banks can apply their own prime rates as a reference in all lending and deposit taking. In 1984 Bank of Finland dropped quotas on banks' central bank finance, which had the effect of curbing the growth in banks' lending. This meant a shift toward the use of interest rate instruments in executing monetary policy. In 1985 banks' fee cartel was dismantled, while the interest rates on demand and time deposits were subject to a cartel-like agreement until the end of 1988 as the interest income earned on certain deposit accounts was ruled tax exempt if at least two bank groups offered these deposits on similar conditions. Since January 1989 the tax exemption of interest earnings is determined by comparison to the base rate. Furthermore, since 1991 a withholding tax is levied on taxable deposits and bonds. Today deposits may not earn more than 2 per cent to remain tax exempt. However, the ceiling of tax exemption for 24 month deposits is 4 per cent, and for 36 month deposits 5 per cent. In competition over depositors the tax exemption rules lead all banks to offer the same highest possible tax-exempt deposit rate. (See table A1.2 in Appendix 1 for the timetable of the most important decisions.)

The deregulation of capital movements and exchange rate controls started in 1980 when the forward market was liberalized. Because of the large differential prevailing between domestic and foreign interest rates, firms sought extensively to use foreign currency loans after the liberalization of long-term (exceeding five years) foreign currency borrowing by manufacturers and shipping companies in 1986. In 1987 the right to raise long-term foreign currency loans was extended to other industries, as well. Borrowing rights in foreign currencies were extended in 1989 to shorter, but still exceeding one year, terms. This piece of regulation was abolished in 1990. Finally, when the foreign borrowing by households was allowed in 1991, all exchange controls in Finland were suspended.

The establishment of representative offices and subsidiaries in Finland was permitted for foreign banks in 1979. The equity restriction of FIM 20 Million on foreign subsidiaries was removed in 1985. Foreign banks were not allowed to open branches in Finland earlier than in 1991. The foreign owned banks operating in Finland have concentrated their business to the wholesale and corporate banking markets. The scope of foreign-owned banks' operations have (so far) remained quite small in Finland. Their market share has prevailed around 1 per cent in terms of total assets since 1987.

Hence, banking deregulation along with the liberalization of capital flows has turned the heavily regulated and shielded Finnish banking industry into a more price competitive and open one. Moreover, the changes in taxation of interest earnings have significantly promoted price competition in the deposit market and raised the average interest rate paid on deposits. Furthermore, the competitive pressures from abroad are increasing as the development of the EU banking legislation principally since the White Paper has established practically unconstrained access to member countries' banking systems by means of the Internal Market Programme. The enforcement of the EEA Agreement in January 1994 extended the Internal Market to Finland and other joining EFTA states as well.

(3) The Finnish banking market is one of the highest concentrated ones in Europe as measured by the five-bank concentration ratio, CR5 (see table 1.1). Even more clearly, if individual savings and cooperative banks and their central institutions are consolidated in the calculation of the CR5 measure, it rises up to only a few percentage points below 100 per cent. Savings and cooperative banks have jointly covered more than a half of the deposit market, contrary to the loan market, which has been dominated by the commercial banks. The overall market share of other domestic commercial banks than the three largest ones KOP, SYP and PSP (and OKO and SKOP) has been insignificant, as well as that of the foreign owned banks.

The Herfindahl indices of industrial concentration display a uniform fall over a period from 1987 to 1991 (see figure 1.2) in spite of the numerous mergers in the sector of local banks. This indicates that the differences in bank sizes had reduced. However, the establishment of the Suomen Säästöpankki in 1992 has resulted in a significant rise in the Herfindahl indices. In a traditional structural analysis this would be interpreted as an increase in the degree of competition followed by a reduction in competition in 1992. The loan market has been more concentrated in Finland than the deposit market, which reflects the more important position of the small savings and cooperative banks in the deposit market. As a result of the sale of the Suomen Säästöpankki, concentration in the Finnish banking market rose considerably at the end of 1993.

Table 1.1

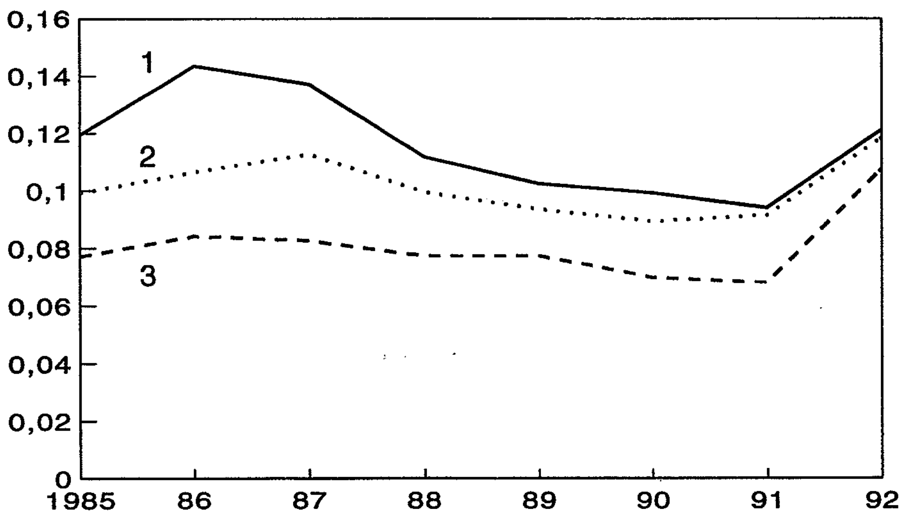
Five-bank concentration ratios (CR5) in terms of total assets in selected European countries, 1987 and 1990

	CR 5 (%)	
	1987	1990
Belgium	58.2	54.9
Denmark	74.3	77.1
France	41.4	48.8
Germany	22.0	26.0
Italy	35.0	37.8
Netherlands	86.8	84.1
Spain	28.5	35.4
The United Kingdom	33.5	31.4
Finland	68.1	65.4
Sweden	57.2	72.1

Sources: OECD and the Bankers' Almanac, own calculations

Figure 1.2

Evolution of the Herfindahl concentration indices in Finnish banking. All banks 1985–1992



1 Individual bank market share in terms of total assets,
2 ... total loans
3 ... total deposits

In addition to the high level of industrial concentration, the dominance of the five (now four) dominant deposit bank groups among the Finnish financial institutions and in the Finnish financial system in general[36] would suggest that competition is significantly imperfect. The fact that the major part of other institutions operating in the Finnish financial market are subsidiaries of the five groups enhances their position further. So far, unit trusts have not advanced a significant threat to banks in the competition for depositors' funds. However, their weight is currently growing as market interest rates have been falling and the Finnish stock market has been bullish.

[36] Deposit banks' share of claims on the domestic private non-bank sector was around 85 % and 69 % excluding or including insurance companies and pension funds, respectively, at the end of 1990 (source: OECD Financial Statistics Part 2, 1992). Moreover, the share of direct finance was only approximately 9 % in 1990 as measured by the share of claims on the non-bank public. Thus, the Finnish financial system relies on the deposit banks to an important extent. (Source: Statistics Finland, Financial Market Statistics)

2 Competition tests based on empirical reduced form revenue equations

The aim of this chapter is to test for competition and market power in the Finnish banking sector over a period from 1985 to 1992, i.e. by and large since significant liberalization of the bank loan market (see table A1.2 in Appendix 1). The method of study employed in this chapter is to estimate empirical reduced form revenue equations from cross-section data. Estimation results are then interpreted in terms of the comparative static properties of the equilibrium (reduced form) revenue functions. This technique was proposed by Panzar and Rosse in their 1982 paper. A few prior comparable studies have been conducted along these lines. We will refer to these studies in the concluding section 2.4.

Applying Panzar and Rosse's method means that banks' competitive behaviour is analyzed directly without the use of structural measures. Consequently, this method deviates significantly from the previously dominant empirical research method in industrial organization, the SCP-paradigm (see sections 1.1.3–1.1.5). Any attempts to exercise market power must be implemented in given markets. For example, the market for large corporate loans has been clearly quite competitive regardless of the level of market concentration, since large firms have many alternative sources of finance which constrains the rates domestic banks can charge on them. This constitutes a clear case against the SCP-paradigm.

In this chapter banks are treated as single-product firms producing merely loans and investments (other interest earning assets). Deposits and other funding are regarded as banks' productive inputs. This is called the intermediation approach to bank modelling which emphasises the financial intermediation role of banks. So, our analyses in this section are, by and large, related to all competition studies which treat banks as single-product firms.

Testing static oligopoly theory can be regarded as an alternative approach to the Rosse–Panzar-method. The banking applications of these studies, both single- and multiple-output specifications, are reviewed in section 4.1.

2.1 Testing for competition using reduced form revenue functions

In modern positive microeconomics (see e.g. Bresnahan 1989 and Schmalensee 1990) both endogenous and exogenous variables are combined with assumptions of firm behaviour in order to characterize market equilibrium. Then, it is examined what kind of effects changes in exogenous variables would have on some observable market variables using comparative statics given that the underlying theory was valid. This method makes it possible to formulate testable positive implications of certain types of firm behaviour. Along these lines, inference about the competitive behaviour of firms is based on the comparative static properties of the reduced form econometric revenue equations in the Rosse–Panzar-methodology used in this chapter.

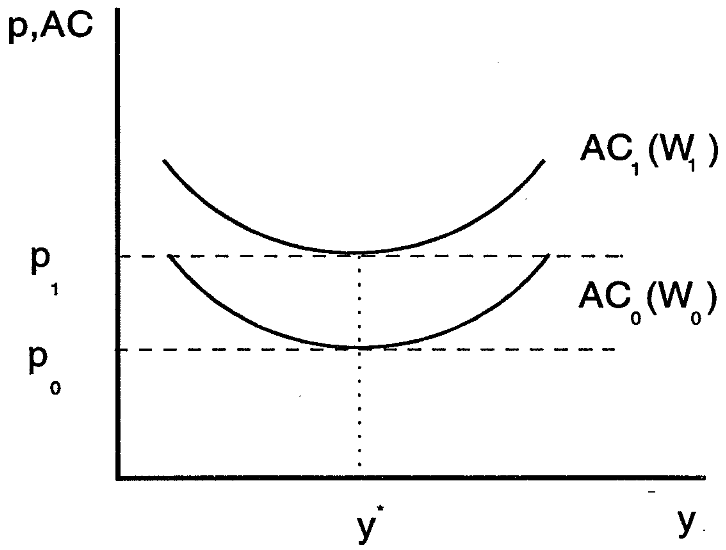
More specifically, the sum of the elasticities of the reduced form revenues with respect to factor prices is estimated. This sum is given the symbol H. Market power of firms, here banks, is measured by the extent to which changes in factor prices (unit costs) are reflected into revenues earned. This is analogous to studying the impact of a tax on output (a sales tax). Clearly, the equilibrium price and output responses depend on the slopes of the demand and supply schedules. The most intuitive case is that of perfect competition: A proportional increase in factor prices (from W_0 to W_1) results in an equiproportional rise in average and marginal costs, since they are homogeneous of degree one in factor prices (see figure 2.1). Thus, in perfect competition equilibrium output will not change, and due to the infinitely elastic demand equilibrium revenues rise equiproportionally, and H is equal to unity.

Furthermore, the properties of H allow us to distinguish empirically between the common imperfect competition theories of price formation as characterizations of the competitive behaviour of the Finnish banks: Monopoly or perfect collusion, monopolistic competition and perfect competition. However, this method is weak in measuring the actual degree of exercised market power or oligopolistic coordination unless competition is perfect. By itself it is able to indicate the direction of change over time. The point here is not to find out which model of imperfect competition has features that best characterizes the functioning of the Finnish banking market. The point is to find out which model has predictions that fit the competitive behaviour of the Finnish banks as implied by the data. Finnish banks are then interpreted as competing according to the model selected. In this light, this study can be seen as a model selection exercise.

We use yearly cross-section data of all Finnish deposit banks over a period from 1985–1992. Hence, individual bank variation in unit costs in cross-section samples is used to make inferences about the "average" competitive behaviour. Therefore, our core analysis produces an estimate of the average H in the sample for each year studied. The average conduct corresponds to a great extent to the conduct of small local banks since they dominate the sample (see Appendix 2.1).

The Rosse–Panzar-approach has been applied to study competitive conditions among unit banks in New York by Shaffer (1982), Canadian banks, trust and mortgage companies by Nathan and Neave (1989), and in banking industries of the major EC states by Molyneux *et.al.* (1992). We consider the empirical revenue equations used in these studies to be subject to serious specification problems, and thus, follow a different approach described in section 2.3 with the cost of a loss of direct comparability. We present first the properties of H more specifically in order to arrive at empirically testable hypotheses, and then turn to empirical implementation, results and conclusions in turn.

Figure 2.1 **H in perfect competition**



2.2 Derivation of testable hypotheses

Monopolistic competition and various oligopoly models represent *a priori* most plausible static models to characterize banking industry equilibrium and interaction between banks. The monopolistic competition model recognizes product differentiation, and is thus consistent with the observation that banks tend to differentiate themselves by various product quality variables and advertising, although the core services provided by them are fairly homogeneous. Furthermore, the sector of local banks is geographically differentiated. The basic motivation for the static oligopoly models is that they explicitly recognize the strategic interaction between firms. Of course, also the models of oligopolistic quantity or price competition can be formulated consistent with product differentiation.

In the following three subsections we present expressions for H in three different market equilibrium conditions as well as resulting empirical hypotheses: (1) Monopolistic competition equilibrium without threat of entry, (2) monopolistic competition free entry (Chamberlinian) equilibrium, and (3) static oligopoly equilibria. The testable empirical hypotheses that result are summarized in section 2.2.4.

2.2.1 Monopolistic competition equilibrium without threat of entry

As customary for the analysis of monopolistic competition,[37] we assume that the industry consists of a fixed number of symmetric banks (or product varieties), $\tilde{n}$. Now, even though the products are differentiated, a representative bank i can be studied diagrammatically.

The price customers are willing to pay for bank i's output depends on the output of bank i, output of other banks, and a set of exogenous variables A_i shifting the respective bank-specific demand function. Hence, the perceived inverse demand function of a representative bank i in the symmetric case is defined as $p_i(y_i,n,A_i)$ with usual assumptions: (i) $p_{y_i} < 0$, (ii) $p_n < 0$ and (iii) $e_{i_n} \geq 0$, where $e_i(y_i,n,A_i) \equiv -(p_i dy_i/dp_i)/y_i$ (> 0) is the negative of the perceived demand elasticity for bank i. The last assumption (iii) means that an emergence of new substitutes makes demand facing individual banks more elastic, i.e. reduces their market power. In assumptions (i)–(iii), as in the succeeding formulations, subscripts refer to the arguments with respect to which partial derivatives are taken.

In the equilibrium without threat of entry the number of banks (or product varieties), n, is historically predetermined $\tilde{n}$, and each bank chooses its output level y_i^* such that profits are maximized. Thus, y_i^* is chosen to satisfy:

[37] See e.g. Dixit and Stiglitz (1977) and Spence (1976).

$$R_{y_i}(y_i,\tilde{n},A_i)=C_{y_i}(y_i,W_i,K_i)\ \forall\ i,\ i=1,...,\tilde{n} \tag{2.1}$$

which solves implicitly for $y_i^*=y_i^*(W_i,A_i,K_i)$. Thus, in equilibrium each bank's marginal revenue equals its marginal cost given the actions of all other banks.[38] In equation (2.1) W_i equals the vector of m factor prices, indexed by k (k=1,...,m) faced by the bank i. This subsumes bank-specific differences in factor usage. Finally, K_i is the vector of capacities, fixed in the short run, and other exogenous variables shifting bank i's cost function.

Differentiating (2.1) with respect to w_{k_i} yields:

$$R_{y_iy_i}\frac{\partial y_i^*}{\partial w_{k_i}}-C_{y_iy_i}\frac{\partial y_i^*}{\partial w_{k_i}}-C_{y_iw_{k_i}}=0 \tag{2.2}$$

According to Shephard's lemma $C_{w_{k_i}}$ equals representative bank's conditional demand for factor k, x_{k_i}. Thus, $C_{y_iw_{k_i}}$ = $(\partial x_{k_i}/\partial y_i)$. Solving for $(\partial y_i^*/\partial w_{k_i})$ yields:

$$\frac{\partial y_i^*}{\partial w_{k_i}}=\frac{1}{\Delta}\frac{\partial x_{k_i}}{\partial y_i^*},\quad \text{where}$$

$$\Delta\equiv(R_{y_iy_i}-C_{y_iy_i})=\frac{\partial^2\pi_i}{\partial y_i^2}, \tag{2.3}$$

which is negative by the second order condition of profit maximization.

Bank i's reduced form revenue function $R_i^*(W_i, A_i, K_i)$ equals:

$$R_i^*(\tilde{n},W_i,A_i,K_i)=p_i[y_i^*(W_i,A_i,K_i),\tilde{n},A_i]y_i^*(W_i,A_i,K_i) \tag{2.4}$$

Differentiating it with respect to w_{k_i} gives:

[38] Bank i assumes that other banks' behaviour is constant: For each combination of output levels Y_{-1}, y_i^* represents an optimal output level for bank i.

$$\frac{\partial R_i^*}{\partial w_{k_i}} = [p(.) + \frac{\partial p(.)}{\partial y_i^*} y_i^*(.)] \frac{\partial y_i^*}{\partial w_{k_i}} \equiv \frac{R_{y_i}^*}{\Delta} \frac{\partial x_{k_i}}{\partial y_i^*} \tag{2.5}$$

Finally, multiplying with (w_{k_i}/R_i^*) and summing over all m inputs produces an expression for the sum of the factor price elasticities of bank i's reduced form revenue equation, H_i. It reads:

$$H_i \equiv \sum_{k=1}^{m} \frac{\partial R_i^*(\tilde{n}, W_i, A_i, K_i)}{\partial w_{k_i}} \frac{w_{k_i}}{R_i^*(\tilde{n}, W_i, A_i, K_i)} = \frac{R_{y_i}^*}{\Delta R_i^*} \sum_{k=1}^{m} w_{k_i} \frac{\partial x_{k_i}}{\partial y_i^*}$$

$$= \frac{R_{y_i}^*}{\Delta R_i^*} \frac{\partial \sum_{k=1}^{m} w_{k_i} x_{k_i}}{\partial y_i^*} = \frac{R_{y_i}^*}{\Delta R_i^*} C_{y_i} \leq 0 \tag{2.6}$$

$$\Leftrightarrow \quad H_i = [p(.)\left(1 - \frac{1}{e_i(y_i^*, \tilde{n}, A_i)}\right) C_{y_i}] \; / \; \Delta R_i^*$$

Note, that our model assumes that input prices are exogenous to banks in the industry.[39] In equation (2.6) x_{k_i}s represent the elements of the cost minimizing input vector.

> *Result 2.1.* H_i is non-positive in the monopolistic competition equilibrium without threat of entry,

since equilibrium requires marginal revenue, $R_{y_i}^*$, to be non-negative, marginal cost and equilibrium revenue are positive, and Δ is negative. Thus, this kind of monopolistic equilibrium resembles the monopoly equilibrium where the monopolist never chooses to produce on the inelastic part of the demand curve: The perceived demand elasticity, $e_i(.)$, is greater or equal to unity. This corresponds to Panzar and Rosse's Theorem 1 (1987, p. 445) stating that H for an independent monopolist is always non-positive. (Note that we get the exact monopoly case by setting $\tilde{n}$ = 1 which corresponds to the lowest value of e_i by assumption (iii), *ceteris paribus*). Accordingly, from now on we will refer to the monopolistic competition model without threat of

[39] The empirical implications of this assumption are discussed in section 2.3.3.

entry as the monopoly model. Accordingly, if the Finnish banking industry consisted of *de facto* local monopolies with perfect geographical differentiation we would observe a non-positive H.

Also the absolute magnitude of H is of interest in case a non-positive H is observed, since we see from (2.6) that H is a decreasing function of e_i, i.e. a smaller H_i is associated with less monopoly power as measured by the perceived elasticity of demand. Note that $H_i = 0$ is consistent with unitary elastic demand.

2.2.2 Monopolistic competition free entry (Chamberlinian) equilibrium

A monopolistic competition free entry equilibrium satisfies the following two familiar conditions. (1) Individual firm equilibrium: Profit maximization as under monopoly profit maximization conditions. And, (2) industry equilibrium, i.e. Chamberlinian tangency condition, whereby entry and exit of additional banks (or product varieties) takes place until zero economic profits are achieved, and price equals average cost for each bank (see e.g. Varian 1984). Industry behaviour can be alternatively seen as being constrained by potential entry resulting in contestable markets (see Baumol *et. al.* 1982).

(1) Individual bank equilibrium:

$$R_{y_i}(y_i, n, A_i) - C_{y_i}(y_i, W_i, K_i) = 0, \quad \text{and} \tag{2.7}$$

(2) Industry equilibrium:

$$R_i^*(y_i^*, n^*, A_i) - C_i^*(y_i^*, W_i, K_i) = 0 \quad \forall \ i, \qquad i = 1, ..., n^* \tag{2.8}$$

The equilibrium values of y_i^*, n^* and R_i^* are now in reduced form functions of W_i, A_i and K_i. Note that now the number of banks (or product varieties) in the industry, n, is endogenous. Differentiating the above conditions with respect to w_{k_i} produces:

$$R_{y_iy_i}\frac{\partial y_i^*}{\partial w_{k_i}} + R_{y_in}\frac{\partial n^*}{\partial w_{k_i}} - C_{y_iy_i}\frac{\partial y_i^*}{\partial w_{k_i}} - C_{y_iw_{k_i}} = 0 \tag{2.9a}$$

$$R_{y_i}\frac{\partial y_i^*}{\partial w_{k_i}} + R_n\frac{\partial n^*}{\partial w_{k_i}} - C_{y_i}\frac{\partial y_i^*}{\partial w_{k_i}} - C_{w_{k_i}} = 0 \tag{2.9b}$$

Solving for $(\partial y_i^*/\partial w_{k_i})$ yields:

$$\frac{\partial y_i^*}{\partial w_{k_i}} = \left[R_n\left(\frac{\partial x_{k_i}}{\partial y_i}\right) - R_{y_in}x_{k_i}\right]/\Delta^*, \tag{2.10}$$

where $\Delta^* = R_n(R_{yy} - C_{yy}) > 0$, since $(R_{yy} - C_{yy}) < 0$ by the second order condition of profit maximization, and $R_n < 0$ by assumption (ii). Thus, from (2.8):

$$\frac{\partial R_i^*(.)}{\partial w_{k_i}} = C_{y_i}^*(.)\frac{\partial y_i^*}{\partial w_{k_i}} + C_{w_{k_i}}^* = C_{y_i}^*(.)\frac{\partial y_i^*}{\partial w_{k_i}} + x_{k_i} \tag{2.11}$$

H_i^* can be formed from (2.11) by multiplying with (w_{k_i}/R_i^*) and summing over all m:

$$H_i^* \equiv \frac{\partial R_i^*}{\partial w_{k_i}}\frac{w_{k_i}}{R_i^*} = \left(\frac{C_{y_i}^*}{R_i^*}\right)\sum_{k=1}^{m} w_{k_i}\left(\frac{\partial y_i^*}{\partial w_{k_i}}\right) + \frac{\sum_{k=1}^{m} w_{k_i}x_{k_i}}{R_i^*}. \tag{2.12}$$

By (2.7), (2.8) and (2.10) it becomes:

$$H_i^* = 1 + R_{y_i}^*[R_n^*R_{y_i}^* - R_{y_in}^*R_i^*]/R_i^*\Delta^*, \quad \text{or} \tag{2.13}$$

$$H_i^* = 1 - \frac{R_{y_i}^* R_i^*}{\Delta^*} \frac{\partial \left(\frac{R_{y_i^*}}{R_i^*} \right)}{\partial n} \tag{2.14}$$

Now, H takes the following form which is a reformulation of Panzar and Rosse's Proposition 1 (1987, p. 451):

$$H_i^* = 1 - \left(\frac{R_{y_i}^* R_i^*(W_i, A_i, K_i)}{\Delta^* y_i^* e_i^2} \right) \frac{\partial e_i}{\partial n} \leq 1 \tag{2.15}$$

since

$$\frac{\partial \left(\frac{R_{y_i^*}}{R_i^*} \right)}{\partial n} = \frac{1}{y_i^*} \frac{\partial \left(\frac{e_i - 1}{e_i} \right)}{\partial n}$$

$$= \frac{1}{y_i^* e_i^2} \frac{\partial e_i}{\partial n}$$

Thus, only the evidently plausible assumption (iii) of $\partial e_i/\partial n \geq 0$, i.e that the emergence of new substitutes makes demand facing individual firms more elastic, is required in addition to profit maximization and conventional demand and cost assumptions for the above result.

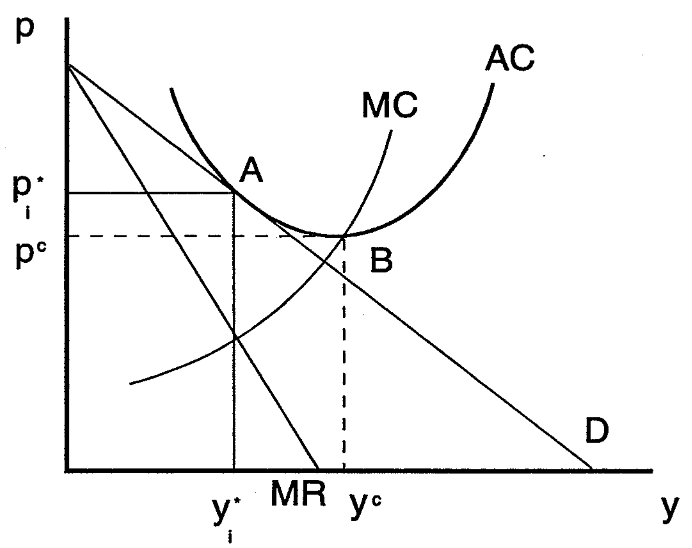
> *Result 2.2.* Observing positive H_i^* indicates that the data are consistent with monopolistic competition but not with individual profit maximization (as under monopoly conditions). I.e. banks are producing more and the price is less than would be optimal individually. In the limit (when banks' products are considered perfect substitutes) the Chamberlinian model produces the perfectly competitive solution as e_i approaches infinity. Thus, under perfect competition H_i^* as given in (2.15) is equal to unity as already shown less rigorously in figure 2.1.

The Chamberlinian model allows us to conclude more as it "nicely" represents an intermediate case between perfect competition and monopoly. We see from figure 2.2 which depicts a (textbook) monopolistic free entry equilibrium, that equilibrium exhibits "excess capacity" when firms are producing at a point where average costs (point A) are greater than minimum average costs (point B). Furthermore, price, p_i^*, exceeds marginal cost except in the competitive solution, p^c. Thus, the Chamberlinian equilibrium is not free from market power as measured by the bank-specific relative price-marginal cost margin, the Lerner index. However, supranormal profits are not earned in equilibrium, since firms price at average cost. These characteristics of equilibrium are consistent with H positive, but less than unity.

The degree of price competition implied by the Chamberlinian model depends on how close p_i^* is to p^c. Hence, Chamberlinian model is consistent with oligopolistic differentiated goods' price competition with varying degrees of collusion. Bertrand equilibrium with no collusion corresponds to the situation of perfect competition.

> *Result 2.3.* Equation (2.15) shows that H_i^* is an increasing function of e_i, i.e. the higher H_i^* we observe, the less market power is exercised on part of banks. In the limit, observing H_i^* that is not significantly different from unity indicates that the data are consistent not only with perfect competition but also with full (efficient) capacity utilization.

Figure 2.2 **Monopolistic free entry (Chamberlinian) equilibrium**



2.2.3 Static oligopoly equilibria

The standard static oligopoly equilibrium (no entry, n = ñ) in case of homogeneous goods and quantity competition satisfies the following profit maximizing first order condition for a representative bank i:

$$\frac{\partial \pi_i}{\partial y_i} = (1 + \upsilon_i) y_i P_Y(Y,A) + P(Y,A) - C_{y_i}(y_i, W_i, K_i) = 0 \quad \forall \quad i, \tag{2.16}$$

$i = 1, ..., \tilde{n}$,

where $(1 + \upsilon_i) \equiv (dY/dy_i) \equiv \tau_i$ stands for the expected quantity reaction on part of rivals to bank i's output change. P(Y,A) is now the industry price.

We restrict attention to a symmetric equilibrium, where the industry output, Y^{cv}, equals $\tilde{n}y_i^{cv}$. Totally differentiating (2.16) gives:

$$\tau_i P_Y dy_i + \tau_i \tilde{n} y_i^{cv} P_{YY} dy_i + \tilde{n} P_Y dy_i - C_{yy} dy_i - C_{yw_{k_i}} dw_{k_i} = 0 \tag{2.17}$$

From which:

$$\frac{dy_i}{dw_{k_i}} = \frac{C_{yw_{k_i}}}{[(\tau_i + \tilde{n})P_Y + \tau_i \tilde{n} y_i^{cv} P_{YY} - C_{yy}]} \equiv \frac{C_{yw_{k_i}}}{\Delta^{cv}}. \tag{2.18}$$

In (2.18) $(\partial^2 \pi / \partial y^2) = (\tau_i + \tilde{n})P_Y + \tau_i Y P_{YY} - C_{yy} \equiv \Delta^{cv} < 0$ by second order condition. (This holds, since $Y = \tilde{n}y_i$ under the symmetry assumption).

Panzar and Rosse (1987, p. 453–455) show that in general in the class of static oligopoly equilibria for a fixed number of quantity setting firms, ñ, producing homogeneous products, the sign of H is indeterminate depending on the sign of the industry marginal revenue, R_Y. R_Y is positive if industry's output lies on the elastic portion of the market demand curve, and then H obtains a non-positive value. But this need not hold for all possible oligopoly equilibria within this class. This can be seen from the following expression for H in a symmetric equilibrium. We arrive at it by first multiplying (2.18) with w_{k_i}, summing over all m and finally dividing by R_i^{cv}:

$$H_i^{cv} = (y_i^{cv}(W_i, A, K_i)ñP_Y + P)\sum_k^m w_{k_i}\left(\frac{\partial x_{k_i}}{\partial y_i^{cv}}\right) / R_i^{cv}(W_i, A, K_i)\Delta^{cv}$$
$$= \frac{R_Y C_{y_i}}{R_i^{cv}(W_i, A, K_i)\Delta^{cv}} \tag{2.19}$$

This result obtains as $R_i^{cv}(W_i, A, K_i)$ equals $y_i^{cv}P(ñy_i^{cv}, A)$, and $(\partial R_i^{cv}/\partial w_{k_i})$ equals $[\partial(y_i^{cv}P(.))/\partial y_i]/(\partial y_i/\partial w_{k_i})$.

> *Result 2.4.* Under perfect collusion oligopoly behaves like a monopoly, which ensures that R_Y is non-negative, and then H_i^{cv} is non-positive (Δ^{cv}<0). Hence in general, observing positive H_i^{cv} allows us to reject the hypothesis of perfect cartel (perfect collusion), while not other oligopoly equilibria e.g. the non-cooperative Cournot equilibrium.

2.2.4 Summary of empirical hypotheses

The core empirical hypotheses derived above are summarized in table 2.1 below. Note, that these hypotheses are free from any supplementary assumptions other than profit maximization and conventional assumptions regarding demand and costs. These results hold for any arbitrary revenue function. For example, linear pricing need not be assumed. Note that the range of the permissible values of H includes the non-positive real line and the positive unit interval.

Table 2.1 **Discriminatory power of H**

Estimated H	Industry equilibrium / competitive environment
$H \leq 0$	Monopoly equilibrium: each bank operates independently as under monopoly profit maximizing conditions. (H is a decreasing function of the perceived demand elasticity.) Perfect cartel
$0 < H < 1$	Monopolistic competition free entry (Chamberlinian) equilibrium. "Excess capacity" (H is an increasing function of the perceived demand elasticity.)
$H = 1$	Perfect competition Free entry equilibrium with full (efficient) capacity utilization

2.2.5 Empirical reduced form revenue equations

To implement the model empirically we proceed by assuming a constant elasticity inverse demand function for the representative bank i:

$$p_i(y_i, n, A_i) = E_0(n)(y_i)^{e_1}\xi(A_i), \tag{2.20}$$

where e_1 equals $(1/e_i)$, the inverse of the perceived demand elasticity. Then, the marginal revenue by assuming a log-linear form for exogenous variables equals:

$$\ln R_{y_i}(y_i, n, A_i) = e_0 + e_1 \ln y_i + B_2 \ln A_i, \tag{2.21}$$

where $e_0 = \ln E_0(n)$. We approximate bank i's marginal cost by the following log-linear function:

$$\ln C_{y_i}(y_i, W_i, K_i) = c_0 + c_1 \ln y_i + \sum_{k=1}^{m} f_k \ln w_{k_i} + C_2 \ln K_i, \tag{2.22}$$

where Σf_k equals 1 by the linear homogeneity requirement for (2.22) to represent a marginal cost function. Since profit maximization requires that (2.21) equals (2.22), we can solve for $\ln y_i^*$:

$$\ln y_i^*(W_i, A_i, K_i) = d_0 + \sum_{k=1}^{m} g_k \ln w_{k_i} + D_2 \ln A_i + D_3 \ln K_i, \quad \text{where} \tag{2.23}$$

$$d_0 = \frac{c_0 - e_0}{e_1 - c_1}, g_i = \frac{f_i}{e_1 - c_1}, D_2 = -\left(\frac{1}{e_1 - c_1}\right) B_2, \text{ and } D_3 = \frac{1}{(e_1 - c_1)} C_2$$

Using the above expression for $\ln y_i^*$ and the demand equation (2.20) allows us to write the reduced form revenue equation as:

$$\ln R_i^*(W_i, A_i, K_i) = j_0 + \sum_{k=1}^{m} h_k \ln w_{k_i} + J_2 \ln A_i + J_3 \ln K_i \qquad i = 1,...,n \tag{2.24}$$

2.3 Empirical implementation

2.3.1 Empirical model

Equation (2.24) represents representative bank i's reduced form revenue equation $R_i^*(W_i,A_i,K_i)$ in logarithmic form stemming from log-linear marginal revenue and cost functions. We operationalized it, with a stochastic error term, as follows in the empirical analysis:

$$\begin{aligned} TIR_i(TIRL_i) = & \, cnst + h_1 WAGE_i + h_2 DEP_i + h_3 FUND_i \\ & + j_1 EQUITY_i + j_2 FIXA_i + j_3 CDUE_i \\ & + j_4 COMML_i + j_5 BSIZE_i + j_6 DCB_i + \varepsilon_i, \; i=1,...,n \end{aligned} \tag{2.25a}$$

where Σh_k (k=1,2,3) equals H, the estimated H_i from our sample.

The definitions of the dependent and exogenous variables that constitute the equation (2.25a) are collected in table 2.2. Two different specifications are employed for banks' revenues, total annual interest revenue and total annual interest revenue from outstanding loans to public, TIR and TIRL respectively. Accordingly, banks' output, which is the decision variable in the underlying theoretical model, equals funds intermediated, i.e. loans and other interest earning assets. Hence, our approach is consistent with the intermediation approach[40] to banks' output and cost measurement familiar form the empirical banking literature. Consequently, deposits and other sources of funds are regarded as factors of production, and banks' variable costs include interest costs in addition to operating costs. The obvious shortcoming of our approach is that it excludes off-balance-sheet financial intermediation (primarily guarantees, back-up credit lines and other credit commitments).

Our model assumes that banks use three variable factors (m=3), labour, deposits and other funds to produce financial intermediation services. Note that the proportions of deposits and other funds are implicit in their prices as defined in table 2.2. Thus, changes in their relative usage are reflected into the respective factor price variables, and we do not need separate control variables for differences in banks' funding mixes. Banks' historically determined capital levels influence their short run revenues and costs, and thus reduced form equilibrium revenues.[41] Our measure for banks' capital that is taken quasi-fixed includes equity capital and premises and other fixed assets. The two capacity variables should both exert a positive impact on revenues earned. Equity due to the capital adequacy requirements, since the more equity capital banks possess the more they can extend credit, and hence collect interest revenues. Also banks' physical capital should be positively related to their loan granting capacity.

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[40] This is in contrast to the value added or production approach to bank modelling that specify all services that produce substantial value added as banks' outputs. Therefore, under the value added approach deposit and payment services are included within the output measure. Accordingly, factors of production exclude all funding and are defined to include only labour, materials and equipment and physical capital. (See e.g. Berger and Humphrey 1992)

[41] This corresponds to disequilibrium specification of banks' cost function. The primary reason for adopting this specification is the lack of a good measure of the price for physical capital, though it can be justified by economic reasons also (see section 4.5.1 for closer discussion). Here this specification might be regarded as inconsistent with the Chamberlinian model of monopolistic competition which allows entry. The Chamberlinian model can be, however, thought of as representing a contestable market where potential entry constrains the pricing of the incumbent banks to the level of average costs. Therefore, supranormal profits are not earned in equilibrium although prices deviate from marginal costs.

Table 2.2 **Empirical revenue equations.**
(All variables except DCB in ln-form)

	Specification
Dependent variables: Revenues:	
TIR	total annual interest revenue
TIRL	total annual interest revenue from outstanding loans to public
Exogenous variables: Factor prices:	
WAGE	annual wage and salary expenses (excluding social expenditure) per full time employee
DEP	ratio of annual interest expenses on non-bank deposits from public to total of these deposits
FUND	ratio of other annual interest expenses to other interest bearing liabilities
Capacity:	
EQUITY	equity capital
FIXA	balance sheet value of premises and other fixed assets
Other exogenous variables:	
CDUE	ratio of cash and due from depository institutions (included in financial assets) to total deposits (business mix)
COMML	ratio of commercial loans to total loans (business mix)
BSIZE	ratio of the number of bank's branches to total assets
DCB	= 1 for commercial banks = 0 for savings and cooperative banks

The following two business mix variables represent factors shifting cost and revenue schedules. CDUE controls for the level of correspondent banking activity and COMML for differences in banks' loan portfolios. The sign of COMML is expected to be negative, since a larger share of more competitive, lower interest rate, commercial loans should have a revenue reducing effect.[42] BSIZE controls for the (inverse of the) average size of banks' branch offices. The coefficient of BSIZE should be negative, since banks with larger branches, in terms of on-balance-sheet assets, should earn higher revenue.

[42] Informational and other reasons for less market power of banks in the pricing of commercial loans are discussed in section 4.6.

Finally, a dummy variable is included in the model to distinguish commercial banks from the local banking sector, savings and cooperative banks. The dummy is included to control for the differences in asset sizes and revenue structures between commercial and local banks not accounted for by the other exogenous variables.

2.3.2 Estimation and data

Estimations of equation (2.25a) were carried out by using bank level cross-section data of all Finnish deposit banks, i.e. commercial, savings and cooperative banks, for years 1985–1992. Thus, our sample period covers a period during which banks' competitive conduct in the loan market has been liberalized (see table A1.2). Most importantly, banks' lending rate setting was fully and predominantly liberalized in August 1986. Consequently, only the year 1985 can be classified into the regulated era, and we can test for the impact of liberalization on the level of competition.

The accounting and other bank-specific data were obtained from Statistics Finland: The Banks, Official Finnish Statistics. The details of our sample are presented in Appendix 2.1. Note that some of the smallest commercial banks were excluded, since their line of business differs markedly from that of the other deposits banks in the sample. Also STS-bank was eliminated form the 1992 cross-section, since it was merged with KOP in 1992 and the scope of its operations was significantly reduced. The number of banks in the sample falls from 631 in 1985 to 366 in 1992 due to mergers in the local banking sector, chiefly among savings banks (see section 1.4).

2.3.3 Results

2.3.3.1 Individual cross-section data

In this section we report results form the estimation of the revenue equations (2.25a) on individual cross-sections of the Finnish deposit banks over the period from 1985 to 1992. Detailed regression results are given in Appendix 2.2, while the estimated values of H are summarized in table 2.3 below and depicted in figure 2.3.

Table 2.3 **H, estimated sum of elasticities of TIR and TIRL with respect to input prices. All Finnish deposit banks, 1985–1992**

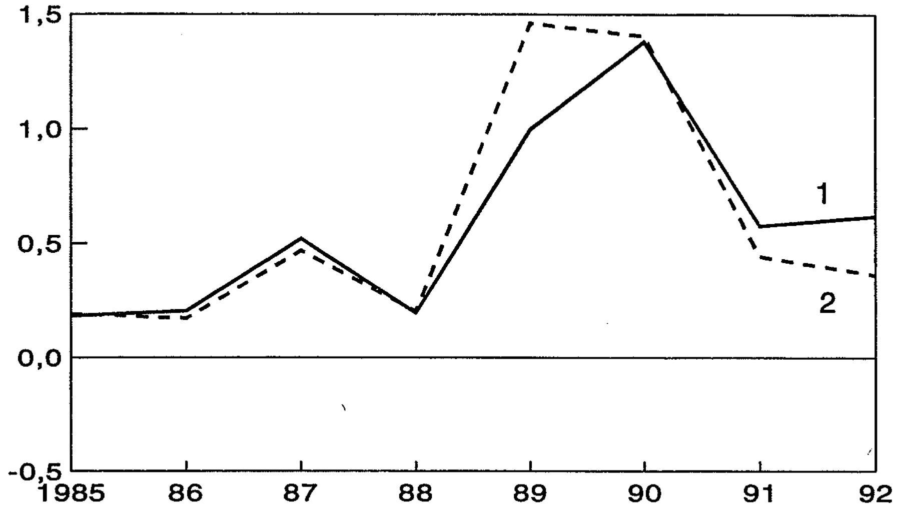
	1985	1986	1987	1988	1989	1990	1991	1992
H (TIR)	0.182	0.204	0.519	0.194	0.998**	1.381**	0.576	0.620
H (TIRL)	0.190	0.171	0.468	0.203	1.460**	1.405**	0.442	0.363

Note: ** denotes a coefficient estimate significantly different from zero (by t-statistics for the sum of the individual elasticities) at 1 % level.

The point estimates of H are always positive but significantly different from zero only in case of 1989 and 1990.[43] As clear from table 2.3, individual cross-section data support the Chamberlinian monopolistic competition model, although not unambiguously except for 1989 and 1990 when the data are consistent even with perfect competition. Note that our results are quite robust in regard to the two revenue specifications, TIR and TIRL. We are able to maintain the hypothesis of homoscedastic error terms for all cross-section estimations at 5 % level. Moreover, the fit of all equations is good.

[43] The point estimates of H fall into the permissible range in all cases, except in 1990 and 1989 in case of the TIRL specification. However, one is included within the 95 % confidence interval of these estimates. Note that the hypothesis that all coefficients summing up to H are zero is clearly rejected by F-tests in all cases except in both equations for 1988. Thus, at least one factor elasticity is almost always significantly different from zero.

Figure 2.3 **Estimated values of H.**
All Finnish deposit banks, 1985–1992



1 TIR specification, equation (2.25a)
2 TIRL specification, equation (2.25ȧ)

Two caveats should be noted. Firstly, simultaneity bias would result if banks can affect the prices for the factors they employ. Our view is that the bias should not be too severe. At least in case of labour as wages have been determined by centralized bargaining, and purchased funds as banks have been price takers to a significant extent in the money market where competition has been quite efficient. In case of deposits regulation and taxation rules have predetermined the price for deposits to significant extent until the end of 1988. However, the results for the years after could be affected somewhat by the simultaneity bias due to banks' market power in the deposit market (compare to results presented in chapter 4). Secondly, the applied Breusch-Pagan (BP) test of heteroscedasticity is quite sensitive to the assumption of normality and has somewhat limited generality.

The signs of the coefficients of the other exogenous variables are basically in line with expectations. Both capacity variables exert a fairly constant and significant positive impact on banks' revenues, the coefficients of COMML are typically, and those of BSIZE consistently negative. The coefficients of the two business mix variables are significant only in case of the total interest revenues, TIR: Variation in business mixes becomes apparent only with the broader revenue specification. Furthermore, the significance of the coefficients of the business mix variables improves toward the end of the sample period indicating that the banks have become more diverse. This naturally reflects the fact that deregulation has rendered banks with more business and funding opportunities which has resulted in more differentiated portfolios of assets and liabilities. When significant the coefficients of CDUE are positive indicating that closer links with other banks result in higher revenues in equilibrium. The evidence in this regard is, however, weak.

The unit price of deposits shows very little variation until 1988. This is reflected in the weak significance of the coefficient estimates of DEP for this period. This mirrors the constraints that pertained to the deposit rates (refer to section 1.4). Most importantly, a cartel-like agreement concerning the tax exemption of interest earnings from deposits was in place until the end of 1988 which effectively curtailed price competition in the deposit market and enabled banks to offer very low rates. The changes in taxation have significantly raised the average interest paid on deposits since then.

The dummy variable for commercial banks is significant and positive in all cases which is intuitively clear as commercial banks have typically had a larger amount of interest earning assets than the local banks on their balance sheets.

2.3.3.2 Pooled cross-section data

The individual cross-section estimates of H show a marked jump in years 1989 and 1990 up to the level which is consistent with perfect competition, and fall back down in 1991 and 1992 indicating a fall in the level of competition. However, there is no way to infer whether these changes over time are statistically significant. Thus, we needed to consolidate the individual cross-sections into a single panel data set in order to test for the significance of the breaks in the H-estimates. All money variables are converted into fixed 1985 prices in order to deflate the revenue and other series. Moreover, the pooling procedure has the effect of improving the parameter estimates as the sample size becomes substantially enlarged.

However, the pooling procedure presumes constant parameter values over time. Thus, the proper way to aggregate the individual cross-sections must be estimated from the data. Appendix 2.3 describes the two-step aggregation test we conducted. The aggregation procedure was continued as far as allowed by the statistical tests of coefficient stability. The resulting patterns of aggregation are framed in tables A2.3.1a and b. The corresponding models where the significant shifts in parameter values are controlled for are given below. The models turned out to be the same for both revenue specifications:

$$TIR_i\ (TIRL_i) = cnst + h_1 WAGE_i + h_2 DEP_i + h_3 FUND_i$$

$$+ \sum_{yr=1}^{3} D_{yr} h_1 WAGE_i + \sum_{yr=1}^{3} D_{yr} h_2 DEP_i$$

$$+ \sum_{yr=1}^{3} D_{yr} h_3 FUND_i + j_1 EQUITY_i$$

$$+ \sum_{yr=1}^{3} D_{yr} j_1 EQUITY_i + j_2 FIXA_i + j_3 CDUE_i \qquad (2.25b)$$

$$+ j_4 COMML_i + \sum_{yr=1}^{3} D_{yr} j_4 COMML_i$$

$$+ j_5 BSIZE_i + j_6 DCB + \varepsilon_i\ ,$$

$$i = 1,...,n$$

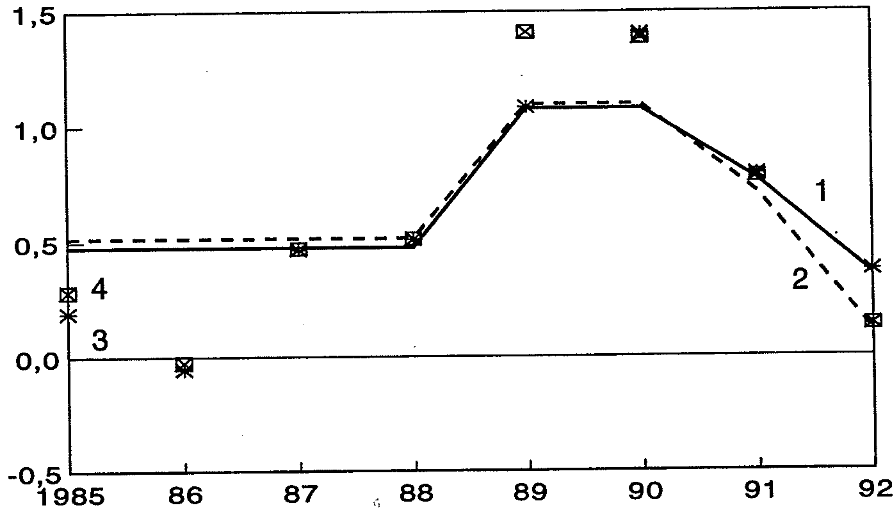
Thus, (2.25a) is augmented with multiplicative dummies to control for the breaks in the coefficients of the factor prices and EQUITY and COMML as implied by the aggregation tests. In (2.25b) D_1 equals unity for years 1985–1988, and D_2 and D_3 for the years 1991 and 1992, respectively. D_1, D_2 and D_3 equal to zero otherwise. Thus, the model uses the years of indicated keen competition, 1989 and 1990 as benchmark years. The key results from the estimation of the equation (2.25b) are given below in table 2.4 and figure 2.4, while the detailed results are reported in Appendix 2.3. Figure 2.4 depicts also the results from estimating the dissaggregated version of the equation (2.25b) corresponding the equation (A2.3.2) given in Appendix 2.3[44] where all parameter values that were found unstable are allowed to vary across all individual cross-sections. These estimates correspond, as they should, quite well the estimates derived independently from individual cross-sections (see figure 2.3).

Furthermore, we constructed a pooled subsample of banks that have made up 80 per cent of the market in terms of total assets (refer to Appendix 2.1) to test whether the competitive conditions among the largest banks differ from those prevailing in the industry as a whole. The pooling procedure guarantees the sufficiency of degrees of freedom, whereas the number of observations is too small to carry out the individual cross-section estimations. The somewhat arbitrary rule

[44] To save space complete results from these estimations are not reported.

of 80 per cent[45] results from a trade-off between ensuring enough observations, and concentrating on the large banks exclusively.

Figure 2.4 **Estimated values of H. Pooled data of all Finnish deposit banks, 1985–1992**



1 TIR, equation (2.25b)
2 TIRL, equation (2.25b)
3 TIR, equation (A2.3.2)
4 TIRL, equation (A2.3.2)

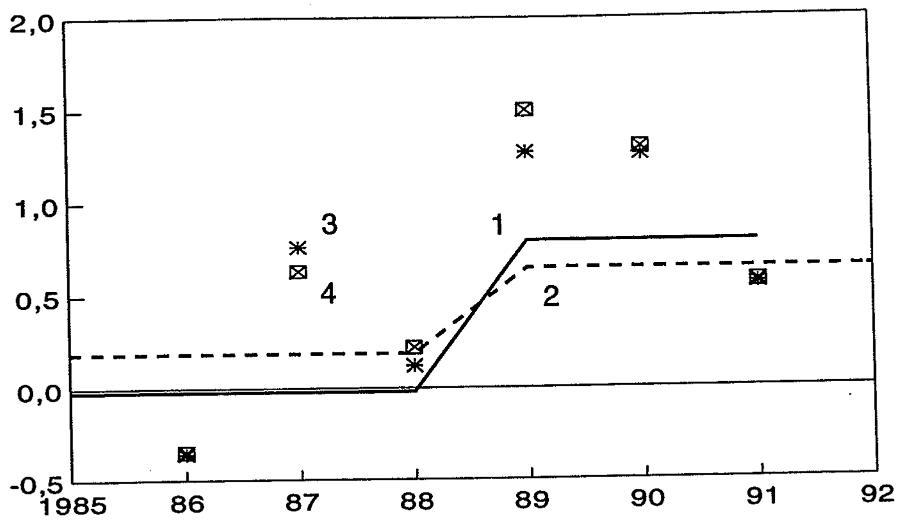
For the sample of the largest banks the aggregation test procedure (see Appendix 2.3) was identical to that for the whole sample. The resulting aggregation pattern was, however, slightly different:

[45] For the year 1992 we had to increase the limit up to 90 per cent, since the formation of the Suomen Säästöpankki had caused the number of banks making 80 per cent of the market to decrease down to 7.

$$
\begin{aligned}
TIR_i\ (TIRL_i) = & \ cnst + h_1 WAGE_i + h_2 DEP_i + h_3 FUND_i \\
& + \sum_{yr=1}^{2} D_{yr} h_1 WAGE_i + \sum_{yr=1}^{2} D_{yr} h_2 DEP_i \\
& + \sum_{yr=1}^{2} D_{yr} h_3 FUND_i + j_1 EQUITY_i \\
& + \sum_{yr=1}^{2} D_{yr} j_1 EQUITY_i + j_2 FIXA_i + j_3 CDUE_i \\
& + \sum_{yr=1}^{2} D_{yr} j_3 CDUE_i + j_4 COMML_i + j_5 BSIZE_i \\
& + j_6 DCB + \varepsilon_i, \\
& i = 1,\ldots,n
\end{aligned}
\tag{2.25c}
$$

In (2.25c) D_1 is set at unity for years 1985–1988, and D_2 for the year 1992, respectively. Otherwise D_1 and D_2 equal zero. The detailed results from the estimation of (2.25c) on the pooled sample of the largest banks are given again in Appendix 2.3, while the estimated values of H are summarized in table 2.4 and figure 2.5 below. The results from estimating the fully disaggregated version of the equation (2.25c) corresponding the equation (A2.3.3) are again depicted in figure 2.5.

Figure 2.5 **Estimated values of H. Pooled data of the largest Finnish banks, 1985–1992**



1 TIR, equation (2.25c)
2 TIRL, equation (2.25c)
3 TIR, equation (A2.3.3)
4 TIRL, equation (A2.3.3)

The first result emerging from table 2.4 is that the Chamberlinian equilibrium is again accepted as a characterization of the competitive behaviour of the average deposit bank. Now, however, this conclusion is definite as the estimates are significantly positive in all cases. This conclusion can also be made for the subgroup of the largest banks for all years.

Secondly, the estimates of H show a significant rise to the neighbourhood of unity in 1989–1990 in the whole sample, and a subsequent fall back down in 1991, and further in 1992, but the latter drop is not statistically significant. In case of the largest banks the indicated rise is in 1988–1990 even larger in absolute terms, particularly if one looks at the point estimates from the disaggregated version of the model (see figure 2.5). Thus, the competitive conditions among the largest banks seem to have been subject to a more significant change, although the change is apparent for the whole industry as well. However, this change is not statistically significant. Similarly, we are not able to detect a significant downward shift in the early 1990's in analyzing the subgroup of the largest banks although the point estimates point downwards. These reflect the identification problems with small sample sizes.

Table 2.4

H, estimated sum of elasticities of TIR and TIRL with respect to input prices. Pooled data sets 1985–1992.

	TIR	TIRL
All banks[1]		
1985–1988:		
$H_1 = \Sigma h_k + D_1 \Sigma h_k$	0.476**	0.518**
(t-statistics)[3]	(4.332)	(4.591)
1989–1990:		
$H = \Sigma h_k$	1.079**	1.097**
(t-statistics)[3]	(6.820)	(6.753)
1991:		
$H_2 = H + D_2 \Sigma h_k$	0.772**	0.715**
(t-statistics)[3]	(2.893)	(2.609)
1992:		
$H_3 = H + D_3 \Sigma h_k$	0.359	0.110
(t-statistics)[3]	(1.088)	(0.326)
Large banks (8d)[2]		
1985–1988:		
$H_1 = \Sigma h_k + D_1 \Sigma h_k$	–0.021	0.187
(t-statistics)[3]	(-0.061)	(0.528)
1989–1991(1992,TIRL):		
$H = \Sigma h_k$	0.792*	0.644*
(t-statistics)[3]	(2.234)	(1.956)
1992 (only TIR):		
$H_2 = H + D_2 \Sigma h_k$	not signif.	

Notes:
D_1 = 1 for 1985–88
= 0 otherwise
All banks:
D_2 = 1 for 1991
= 0 otherwise
D_3 = 1 for 1992
= 0 otherwise
Largest banks:
D_2 = 1 for 1992
= 0 otherwise

[1] Number of observations 4290

[2] Number of observations 259

[3] H_0: the sum of the coefficients of the multiplicative dummy variables equals zero. * denotes rejection at 5 %, and ** at 1 % level, respectively.

Thirdly, the pooling procedure leads to improved significance of all parameter estimates by reducing their standard errors when the whole sample is analyzed. Moreover, the coefficients of all factor price variables are now significant and bear the same sign, which constitutes the most natural case.[46] Thus, pooling has resulted in more reliable estimates. The pooling procedure, as carried out here, smooths out non-significant fluctuation in parameter estimates.

The interpretation of the coefficients of the exogenous variables other than factor prices is by and large the same as in case of the individual cross-section estimates. Two observations, nevertheless, deserve a remark. Firstly, the coefficient of COMML is larger in absolute terms, and its significance higher for the largest banks indicating more divergent asset portfolios among the largest banks than in the industry as a whole. Secondly, the coefficient of the dummy variable is significant even for the subsample of the largest banks which implies that the operations of the large commercial and large savings and cooperative banks are still importantly dissimilar[47] although the distinction has become less apparent during the recent years.

2.4 Conclusions

2.4.1 Competitive changes in Finnish banking

Our data proposes that bank revenues behave *as if* earned under the Chamberlinian monopolistic competition equilibrium, which is certainly better from the social perspective than (local) monopoly or perfect cartel equilibria which are clearly rejected. The results from estimations using the pooled data set, which are statistically more reliable, confirm this picture. Furthermore, our data is consistent with perfect competition for years 1989–1990 regarding the whole industry. These years seem to constitute a period of exceptionally keen competition as a large and significant jump in the estimated value of

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[46] We see from equation (2.3) that the sign of $\partial x_{ki}/\partial y_i$ is decisive for the sign of the individual factor price elasticities of the reduced form revenue function. $\partial x_{ki}/\partial y_i > 0$ would represent a normal input and < 0 an inferior input. Therefore, in theory, varying signs of the individual elasticities is possible, but more natural would be to observe equal signs.

[47] This means that there are differences in the revenue structures that are not captured by other exogenous variables in the model (see table 2.2).

H is detected in the analysis with the pooled cross-section data. More specifically, competition in the Finnish bank loan market seems to had increased quite markedly after deregulation. This conclusion can also be made for the subgroup of the largest banks (covering 80 per cent of the market) with hindsight to the estimates from the disaggregated model version, in particular (see figure 2.5). Moreover, the rise in H-statistics is even higher in absolute terms in case of the largest banks. These results reflect the fact that deregulation and lifting of capital controls have changed more fundamentally the business strategies of large banks, opened new markets for them, and hence had a greater influence on competitive behaviour.

In terms of the accepted Chamberlinian model, our results imply that the mobility of banks' customers increased significantly until 1990, and consequently banks' use of market power in the bank loan market (as in the market for other interest bearing assets implied by the broader TIR specification) reduced down to the level which corresponds the perfectly competitive outcome. Hence, banks' customers propensity to seek for the best loan offerings had significantly increased. Furthermore, our results indicate a rise in the level of capacity utilization toward the end of 1990 up to a level which is not significantly different from efficient utilization. These conclusions hold, by and large, for both the largest banks and the industry as a whole.

The improvement in capacity utilization is naturally due to the steep rise in bank lending in 1987, 1988 and 1989 which increased the throughput of branch and human resources. During these years bank lending grew by some 18, 31, and 19 per cent in nominal terms, respectively (see Koskenkylä and Vesala 1994). Especially the investments in branches were mainly made in the regulatory era, i.e. before the beginning of our sample period. The implied overinvestment in branches resulting in excess capacity can be understood in terms of the spatial model presented in section 1.2.1. as quality competition in service proximity due to regulated deposit rates. However, the *ex post* observations indicate that the output expansion of Finnish banks occurred at the expense of the quality of loans granted and appropriate *ex ante* risk premiums in lending. Finnish banks appear to had assumed too much credit risk, not covered by adequate lending margins, which simultaneously with a deep recession resulted in a surge in credit losses.[48] Finnish banks' aggregate credit

[48] Our research, as most empirical studies regarding banks as productive units, suffers from the failure to incorporate the quality of the output (credit risk) into the output measure.

losses were in 1992 2.87, and in 1993 2.61 per cent of their balance sheet total (see Koskenkylä and Vesala 1994).

The individual cross-section estimates of H imply a fall in the degree of competition in 1991 as compared to years 1989 and 1990. Tests performed on the pooled data set confirm this drop statistically significant. For 1992 the point estimates of H display almost uniformly a further weakening in competition. The decline in the estimated H in 1991 coincides with the beginning of banks' problems: Finnish banks' results turned red in 1991 mainly due to large credit losses. Thus, hard times seem to had resulted in less competition. The difficulties of banks' numerous customers to meet their loan servicing obligations and financial problems of many enterprises during the latest recession resulted in less competition in the loan market as other banks did not naturally desire to take over these clients. Furthermore, a fall in collateral values due to the fall in asset values diminished the possibilities of households and enterprises to change banks. In our model, the fall in the estimated value of H reflects these developments.

Further explanations to this observed pattern of competitive behaviour are presented in the concluding chapter 5 which summarizes and interprets the joint findings from all empirical analyses.

Note that keen competition in the Finnish credit market is indicated for years 1989 and 1990 in spite of high industrial concentration as measured by e.g. the 5-bank concentration ratio, or other structural imperfections (see section 1.4). This is in accordance with Gardener and Teppet's (1992) findings of relatively low interest margins on consumer credits and residential mortgages in Finland. Nevertheless, recent events appear to have reduced the level of competition, which can result in welfare losses in regard to the whole economy.

The obvious direction of further research is to incorporate the deposit market into the model. I.e. to capture the multiproduct nature of banks in order to test for competition in credit and deposit markets separately. This is done in chapter 4. We have interpreted the empirical results here in terms of the Chamberlinian monopolistic competition model. However, a positive H is also consistent with oligopolistic price competition. The differentiated goods' oligopolistic price competition model and the Chamberlinian monopolistic competition model have a lot of similar features. Accordingly, the Bertrand outcome is consistent with perfect competition and H equal to unity, and cooperative equilibria with H positive, but less than unity. Therefore, the basic interpretation of our results would not change if an oligopoly model of price setting banks was employed.

However, the fact that empirical studies usually indicate fairly constant bank level returns to scale suggests that an oligopoly model of price setting firms would be more preferable than the Chamberlinian model. This notion is honoured in chapter 4 where banks are viewed as price setting oligopolists.

2.4.2 Previous studies

Molyneux *et.al.* (1992) were able to accept Chamberlinian monopolistic competition for Germany, the UK, France and Spain for years 1986–1989, while the competitive behaviour of the Italian banks was found to resemble the monopoly model. Chamberlinian model was accepted also by Shaffer (1982) and Nathan and Neave (1989) for a sample of unit banks in New York and Canadian banks, respectively. However, we find the empirical equations employed in these studies to be subject to serious specification problems. All above studies employ total assets, i.e. banks's output as an exogenous variable, in order to account for the revenue increasing effect of banks' (asset) sizes. Nevertheless, in the underlying theoretical model output is the endogenous choice variable of banks. Therefore, using total assets as an exogenous variable may lead to severe simultaneity bias. Molyneux *et.al* (1992) used revenues scaled with banks' total assets as a dependent variable. This is no longer a revenue equation, but a price equation whose behaviour compared to equilibrium revenues is not explored. Thus, our results can not be directly compared with these studies.[49]

Specification issues aside, the competitive conditions in the Finnish banking market are captured by the same theoretical model, the Chamberlinian model, as in all other cases analyzed, except Italy. This implies that the Finnish market for financial intermediation services does not represent a significant deviation from those in other countries with respect to the mode of competition at the onset of the Single Market in Europe.

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[49] Note that none of these studies is interested in the absolute size of H, which as shown before is negatively correlated with banks' use of market power in case H is found positive.

3 Testing for shifts in competitive conduct: a switching regression model

3.1 Motivation

There was a period of very rapid extension of bank loans (see figure A3.2 in Appendix 3) in Finland after the lifting of the final interest controls on bank lending in 1986 and gradual liberalization of the foreign currency denominated loans to the Finnish industry since 1986 (see table A1.2). Expansion in lending was vast as deregulation had freed previously effectively rationed demand and the Finnish economy was booming at one of the highest rates among the industrialized countries. Banks were able to finance their domestic clients by extensive foreign borrowing without taking large exchange rate exposures by granting them foreign currency denominated credits. Simultaneously, the money market expanded considerably in Finland. As a result of these two developments, banks could grant large amounts of loans without corresponding growth in deposits.

This expansionary period appears to had been associated with significant underpricing of credit (see figures A3.1 and 2). Following explanations could be given to this behaviour on part of banks:

(1) Banks exploited the economic boom in market share competition and growth was adopted as business target in place of short term profitability. This resulted in biased managerial incentives toward growth which was even explicit in some cases in wage and salary schemes (see Koskenkylä and Vesala 1994).

(2) Banks' cross-subsidized loans from their interest margins on deposits that were effectively protected through the tax exemption rules until 1989, and still quite importantly until 1991. Banks used the deposit margin to finance competition for market share in the loan market. In fact, the major part of Finnish banks' net interest income has come from the deposit market since the mid 1980s.[50]

[50] See e.g. Silvonen (1994) for a decomposition of banks' net interest income and its evolution in Finland.

(3) Banks' risk awareness was insufficient due to inexperienced management, inadequate credit risk control systems and insufficient evaluation and monitoring of borrower candidates. These resulted in too narrow margins (risk premiums) in lending. Additionally, adverse selection led, at times of rising interest rates, to deterioration of banks' lending portfolio.[51]

(4) Banks' risk taking was excessive due to presumed status of too-large-to-fail, i.e. moral hazard (see e.g. Diamond and Dybvig 1986).

In this chapter we try to identify whether a shift in banks' competitive behaviour in the loan market (explanation (1)) actually occurred in the late 1980s. We base our empirical analysis on the theory of repeated games and price wars (see e.g. Shapiro 1989 and Slade 1989).

In certain dynamic oligopoly models price wars, i.e. periodic reversions to more competitive phases, can be an occasional equilibrium outcome. The two models of infinitely repeated competition which originally predicted price wars are those of Green and Porter (1984) and Rotemberg and Saloner (1986). Still, the term "price war" is somewhat misleading, since in either model no firm will choose to deviate from the tacitly collusive outcome, but periodic reversions to tighter competition occur due to demand related reasons and something like price wars can be observed in equilibrium. This is the central contribution of these two models, since in the previous theories of infinitely repeated games (see e.g. Friedman 1977, and Shapiro 1989 for a review) price wars never actually occurred in equilibrium, although the credibility and size of potential punishments was critical to sustain the tacitly collusive outcome. This constituted a serious drawback in modelling tacit collusion.

Green and Porter's model is an infinitely repeated quantity setting game, in which firms do not observe the outputs of their rivals (imperfect monitoring). Instead, they observe the market price, which is affected by a stochastic disturbance. Their model is restricted to trigger-price strategies and has a family of subgame perfect trigger-

[51] Adverse selection can affect the quality of banks' loan portfolio at times of rising interest rates in the following way. As the financial compensation, rate of interest on supplied funds, required by the creditor increases, only the projects that are riskier (in a class of projects that have the same expected return but different probability distributions) earn positive returns in case of favourable outcomes, and become financed. Thus, safe projects are withdrawn from the market and the quality of the projects financed in terms of risk contained decreases when the cost of funds rises. (See e.g. Stiglitz 1987)

price Nash equilibria characterized by a triplet of the collusive output level, trigger level of industry price and duration of the punishment period after which firms return to the cooperative phase. In Green and Porter's model the (implicit) cartel is expected to select an optimal enforcement mechanism (the triplet) such that maximum expected discounted profits are earned by the firms in the industry. In such an equilibrium the marginal gains from cheating must exactly offset the marginal losses from the following reversion to the non-collusive output level. Green and Porter show that if the (implicit) cartel selects an optimal enforcement mechanism, output in collusive periods will (as long as there is some discounting) generally exceed the perfectly collusive level, and therefore, the industry price will be lower than the monopoly price. Note that in their model no firm will choose voluntarily to defect by expanding output, but occasional punishments still occur. On seeing a low price (due to an adverse demand shock) all firms expand output, not out of concern that someone had deviated, but rather in knowledge that if low prices did not sometimes trigger punishment the collusive scheme would not be self-enforcing.

Abreu *et.al.* (1986) provide a significant generalization of Green and Porter's analysis by characterizing fully optimal tacitly collusive equilibria with imperfect monitoring that are not restricted to trigger-price strategies. Pure strategy symmetric sequential equilibria of their model are Markov chains with two states, the best and the worst equilibrium output from the point of view of the oligopolists, and a transition rule from one state to another depending on the price observed in the previous period.

Rotemberg and Saloner's (1986) model studies the presence of tacit collusion under observable but temporary shifts in industry demand. Their main result is that tacit collusion becomes more difficult in high-demand states in the sense that prices must be lowered in order to sustain collusion. In the strict sense, actual price wars never occur: Oligopolists just collude less in order to prevent the collapse of the implicit cartel under boom conditions.[52]

Our results presented in chapter 2 suggested a significant increase in the level of competition at the end of the 1980's and a subsequent drop in the early 1990's in the Finnish credit market. This dynamic pattern might be consistent with a price war. In this chapter we test this shift in competitive behaviour, by using different econometric approach, and different type of data. The hypothesis of behavioral

[52] Rotemberg and Saloner's model (since it is a price setting game) is sensitive to the assumption of constant marginal cost, and the results do not carry over, in general, to the case of non-constant marginal cost (see Shapiro 1989).

shifts from more collusive outcome to more competitive phase and a subsequent reversion to more collusive behaviour is tested by means of a simultaneous equation switching regression model. The model is devised to detect the behavioral switches implied by the optimal cartel enforcement mechanism (trigger-price strategy) as in Green and Porter's (1984) model. We wish to find out whether shifts in the industry supply function can be detected, what are the lengths of the possible reversionary periods, and more generally, whether the behaviour of the Finnish banking industry in the late 1980s and early 1990s fits the dynamic oligopoly model with periodic reversions to more competitive behaviour. Observed low lending margins can be interpreted in terms of this model if significant shifts in competitive conduct are detected over time.[53] The switching regression technique employed in this chapter has been developed by Kiefer (1980), and applied to studies of cartel stability by Porter (1983) and Lee and Porter (1984).

We use here monthly time series industry-level data. Due to their limitations we can not allow competitive conduct to differ by banks, and, therefore, our results refer to average conduct in the industry. Note that oligopoly theories do not, by no means, insist on the same conduct across all firms in the industry (see e.g. Shapiro 1989). The intermediation (single-product) approach, which treats deposits as banks' productive inputs, is used here as the empirical modelling strategy. Hence, we focus on banks' behaviour in the loan market, in particular, as in the preceding chapter.

Another question is what set off a potential price war in the Finnish credit market. Obvious candidates are deregulation and boom, and a rapid growth in the demand for bank loans. This would be in line with Rotemberg and Saloner's (1986) model. We evaluate this and the alternative Green and Porter's (1984) hypothesis of price wars following adverse demand shocks in the concluding section 3.4.

3.2 Empirical model

A use of a switching regression model is appropriate when industry supply relation shifts occasionally as firms revert from more collusive to more competitive behaviour. In the employed switching regression model presented below the industry supply relation is specified

[53] In many studies that test competition and market power in banking the use of market power or oligopolistic coordination is assumed constant over time. In this chapter this implausible assumption is dropped.

separately for both regimes. The parameter estimates are obtained by a simultaneous estimation of the demand and supply relations characterizing industry equilibrium. This method of identifying behavioral parameters has been proposed by Bresnahan (1982) (see section 1.1.5).

If a correct regime classification sequence were *a priori* known consistent estimates of the parameters could be obtained by the two-stage least squares technique (2SLS). We make an experiment using one possible regime classification based on the evolution of banks' average lending margins over the three months money market rate (see figure A3.1.) However, in our case reliable regime classification can not be imposed. Moreover, Lee and Porter (1984) show that when an imperfect regime classification is used least squares bias are substantial in models containing switching relations. Therefore we estimate the respective probabilities of each data item being generated by the more collusive regime by applying an algorithm proposed by Kiefer (1980), from now on referred to as Kiefer's algorithm. This procedure yields maximum likelihood (ML) estimates of the parameters of the demand and supply relations associated with these probabilities.

3.2.1 Industry demand and supply relations

The dependent variables of the model are the market price, p_t, each bank's quantity, y_{it}, and the industry supply, $Y_t = \Sigma_i y_{it}$. i indexes banks (i=1,...,n), and t observations (t=1,...,T) consistently. The industry demand function in inverse form reads:

$$p_t = D(Y_t, A_t, \alpha, \varepsilon_{D_t}) \tag{3.1}$$

The auxiliary variables on the right hand side (RHS) are: exogenous variables shifting the demand function (A_t), parameters of the demand function (α), and econometric error term (ε_{Dt}).

Total cost function of the ith bank equals:

$$c_{it} = c_{it}(y_{it}, W_{it}, K_{it}, \beta, \varepsilon_{C_{it}}),\ i = 1,...,n \tag{3.2}$$

The supplementary RHS variables are: factor prices (W_t), exogenous variables shifting the cost function (K_t), parameters of the cost function (β), and econometric error terms (ε_{Ct}).

The variety of all static oligopoly models yielding all possible outcomes between perfect competition and monopoly can be nested by writing the perceived marginal revenue as (see Bresnahan 1989):

$$MR_{it} = p_t + D_Y y_{it}\theta_{it} = p_t\left(1 + \frac{\theta_{it}}{\alpha_1}\right),\ i = 1,\ldots,n, \tag{3.3a}$$

where θ_{it} represent the conduct parameters of individual banks which can be interpreted as indices of the use of market power. The values of θ_{it} of 0, s_{it} (individual bank market shares) and 1 represent Bertrand (perfect) competition, Cournot competition and monopoly (perfect collusion), respectively. In perfect competition MR_t equals the industry price, and the monopoly MR_t equals $p_t + D_Y y_{it}$. In equation (3.3a) α_1 is the price elasticity of industry demand, and presumably negative ($\alpha_1 = p(dY/dp)/Y$). The above formulation assumes that the products provided by banks are of approximately homogeneous quality, and all firms charge equal prices in equilibrium. This assumption should not be too restrictive for the Finnish banking industry, and thus, the supply relation not significantly misspecified.[54]

All oligopoly equilibria satisfy the following first order condition:

$$p_t\left(1 + \frac{\theta_{it}}{\alpha_1}\right) = c_{it_y}(y_{it}, W_{it}, K_{it}, \beta, \varepsilon_{C_{it}}) \tag{3.3b}$$

If (3.3b) is aggregated at the industry level by using banks' market shares as weights the following industry supply relation results. It can characterize either price or quantity setting behaviour:

$$p_t\left(1 + \frac{\sum_{i=1}^{n} s_{it}\theta_{it}}{\alpha_1}\right) = p_t\left(1 + \frac{\Theta_t}{\alpha_1}\right) = \sum_{i=1}^{n} s_{it}c_{it_y}(.) = C_{t_Y}(Y_t, W_t, K_t, \beta, \varepsilon_{Ct}), \tag{3.4}$$

where Θ_t is the weighted average of the conduct parameters in the industry. It equals 0, HI (the Herfindahl concentration index), and 1,

54 See Appendix 4.3 for the evolution of the bank group-specific lending margins in Finland.

for Bertrand, Cournot and perfect collusion respectively. Note that in equilibrium there may be variation in price-marginal cost margins in the industry, since a stable industry marginal cost may not exist.

More structure to the model could be imposed by specifying the way the thetas enter the supply relation. Here, however, we concentrate on the pattern of the industry equilibrium over time, i.e. models of implicit collusion involving an optimal trigger-price strategy. Two kinds of conduct are assumed: (1) tacit collusion (peace), Θ_p, and (2) price war, Θ_w. This gives rise to the following structure of the industry supply relation.

$$p_t\left(1+\frac{\Theta_p}{\alpha_1}\right)=C_{t_Y}(Y_t,W_t,K_t,\beta,\varepsilon_{Ct}),\ \text{with prob}\ \mu \tag{3.5a}$$

$$p_t\left(1+\frac{\Theta_w}{\alpha_1}\right)=C_{t_Y}(Y_t,W_t,K_t,\beta,\varepsilon_{Ct}),\ \text{with prob}\ (1-\mu), \tag{3.5b}$$

where μ equals the probability of colluding (see Porter 1983 and Lee and Porter 1984). μ is assumed to follow Bernoulli distribution, i.e. it is not constrained to follow any particular process. For example, we are not imposing any prior restrictions on the length of the revisionary periods.

3.2.2 Empirical specification

The demand function is assumed to take a log-linear constant elasticity form:

$$\ln Y_t=\alpha_0+\alpha_1\ln p_t+\alpha_2 SD_t+\sum_{j=1}^{r}\alpha_{j3}\ln a_{jt}+\varepsilon_{Dt},$$

$$\text{where}\quad p_t\equiv\left(\frac{r_t^L}{r_t^M}\right) \tag{3.1'}$$

with r demand shifting variables included. r^L is the interest rate on new loans and r^M the market reference rate. SD is a seasonal dummy that controls for two exceptional observations in loan supply: 1988:12 and 1992:12 (see figure A3.2). The demand function is now written in direct form in order to escape the identification problems in simultaneous equilibrium models with identical dependent variables.

Marginal costs are assumed log-linear which gives rise to the following aggregate supply relations:

$$\ln p_t = \beta_0 + \delta^w + \delta^p + \beta_1 \ln Y_t + \beta_2 SD_t + \sum_{k=1}^{m} \beta_{k3} \ln w_{kt} + \sum_{l=1}^{q} \beta_{l4} \ln k_{lt} + \varepsilon_{Ct}^{p}, \quad \text{with prob } \mu \qquad (3.5a')$$

$$\ln p_t = \beta_0 + \delta^w + \beta_1 \ln Y_t + \beta_2 SD_t + \sum_{k=1}^{m} \beta_{k3} \ln w_{kt} + \sum_{l=1}^{q} \beta_{l4} \ln k_{lt} + \varepsilon_{Ct}^{w}, \quad \text{with prob } (1-\mu), \qquad (3.5b')$$

In equation (3.5a') $\delta^w + \delta^p$ equals $-\ln(1 + \Theta_p/\alpha_1)$, and $\delta^w - \ln(1 + \Theta_w/\alpha_1)$. Hence, δ^p equals the percentage amount by which tacit collusion increases prices compared to the reversionary phase, and should be greater than zero.[55] Note that we can not estimate simultaneously both δ^p and δ^w, since either of these can not be separated from the intercept term of the marginal cost function. Direct estimation of the thetas is not possible, since we do not have direct information about marginal costs.[56]

Equations (3.5a') and (3.5b') can be summarized into a single supply equation by specifying an indicator variable I_t to distinguish the cooperative regime ($I_t = 1$) from the reversionary one ($I_t = 0$). In the following supply relation I_t obtains the value of unity with probability μ and zero otherwise.[57]

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[55] Since α_1 should be negative, and the degree of coordination is greater in the cooperative phase: $\Theta_p > \Theta_w \geq 0$, $-\ln(1 + \Theta_p/\alpha_1) > -\ln(1 + \Theta_w/\alpha_1) \equiv \delta^p + \delta^w > \delta^w$ $\Leftrightarrow \delta^p > 0$.

[56] Auxiliary estimates of marginal costs are needed in order to identify the conduct parameters. This is done in chapter 4 where bank-specific marginal costs are derived by using an empirical translog specification for the cost function.

[57] Linear homogeneity of the cost function with respect to input prices would require $\Sigma_k \beta_{k3} = 1$. However, we can not impose this restriction, since one input price, rate on purchased funds proxied by the money market rate, is included in the endogenous price variable.

$$\ln p_t = \beta_0 + \delta^w + \delta^p I_t + \beta_1 \ln Y_t + \beta_2 SD_t + \sum_{k=1}^{m} \beta_{k3} \ln w_{kt} + \sum_{l=1}^{q} \beta_{l4} \ln k_{lt} + \varepsilon_{Ct} \qquad (3.5')$$

Equations (3.1') and (3.5') constitute our simultaneous equation model. The estimate of δ^p is of most interest, in addition to the regime classification sequence, I_t.

When *a priori* assumed regime classification is used, (3.1') and (3.5') can be estimated directly by 2SLS. Estimation results using one seemingly plausible classification, the CA sequence (see figure A3.1) are reported in table 3.2. Let us first present the procedure yielding an appropriate ML regime classification before commenting on the empirical results.

Our model can be presented by using a simplifying two-stage procedure as:

$$\ln p_t = \Delta X_t + \Gamma I_t + E_t, \qquad (3.6)$$

where

$$X_t = \begin{pmatrix} 1 \\ \ln \hat{Y}_t \\ SD_t \\ \sum_{k=1}^{m} \ln w_{kt} \\ \sum_{l=1}^{q} \ln k_{lt} \end{pmatrix}, \quad E_t = \begin{pmatrix} \varepsilon_{Ct}^{p} \\ \varepsilon_{Ct}^{w} \end{pmatrix}, \quad \Delta = \begin{pmatrix} \Delta^1 \\ \Delta^2 \end{pmatrix} = \begin{pmatrix} \beta_0 + \delta^w & \beta_1 & \beta_2 & \sum_{k=1}^{m} \beta_{k3} & \sum_{l=1}^{q} \beta_{l4} \\ \beta_0 + \delta^w & \beta_1 & \beta_2 & \sum_{k=1}^{m} \beta_{k3} & \sum_{l=1}^{q} \beta_{l4} \end{pmatrix},$$

$$\Gamma = \begin{pmatrix} \delta^p \\ 0 \end{pmatrix}, \text{ and } \ln \hat{Y}_t = \alpha_0 + \alpha_1 \ln p_t + \alpha_2 SD_t + \sum_{j=1}^{r} \alpha_{j3} \ln a_{jt}$$

E_t is i.i.d distributed $N(0,\Sigma)$, and:

$$\Sigma = \begin{pmatrix} \sigma_C^{p^2} & \sigma_C^{pw} \\ \sigma_C^{wp} & \sigma_C^{w^2} \end{pmatrix}$$

The probability density function of the multivariate normal distribution (see e.g. Greene 1990), given that the regime classification sequence equals I_t, reads:

$$f(\ln p_t | I_t) = (2\pi)^{-1} |\Sigma|^{-½} \exp(-½(\ln p_t - \Delta X_t - \Gamma I_t)\Sigma^{-1}(\ln p_t - \Delta X_t - \Gamma I_t)) \tag{3.7}$$

Then, the likelihood function equals:

$$L^f(I_1, ..., I_T) = \prod_{t=1}^{T} f(\ln p_t | I_t), \; t = 1, ..., T \tag{3.8}$$

When the classification sequence is *a priori* unknown, and the respective probabilities of cooperation and reversion are obtained from the Bernoulli distribution, the probability density function for $\ln p_t$ takes the following form (see Kiefer 1980):

$$\phi(\ln p_t) = \mu\phi^1(\ln p_t) + (1 - \mu)\phi^2(\ln p_t)$$

$$\phi(\ln p_t) = (2\pi)^{-1} \frac{1}{\sigma_C^{p^2}} * \tag{3.9}$$

$$\left[\mu \exp\left(\frac{-½(\ln p_t - X_t\Delta^1 - \delta^p)^2}{\sigma_C^{p^2}} \right) + (1 - \mu)\exp\left(\frac{-½(\ln p_t - X_t\Delta^2)^2}{\sigma_C^{w^2}} \right) \right]$$

And the likelihood function equals:

$$L^\phi = \prod_{t=1}^{T} \phi(\ln p_t) \tag{3.10}$$

Kiefer shows that the ML estimate of $\Psi = (\Delta, \Gamma, \Sigma, I_t)$ and μ can be obtained by the following algorithm. Given an initial arbitrary probability sequence $\{\upsilon^0_t\} = \{\upsilon^0_1, ..., \upsilon^0_T\}$ of the probability $\text{Prob}\{I_t = 1\}$ (t = 1, ..., T), the initial estimate of μ, μ^0, equals:

$$\mu^0 = \frac{\sum_{t=1}^{T} \upsilon^0_t}{T}, \tag{3.11}$$

and the initial estimate of Ψ, $\Psi^0 = (\Delta^0, \Gamma^0, \Sigma^0, I^0_t)$, can be generated by maximizing $L^f(\{\upsilon^0_t\})$ with respect to Ψ. Kiefer's algorithm uses the Bayes' rule to update the initial $\{\upsilon^0_t\}$ sequence:

$$\begin{aligned}\upsilon^1_t &= \text{Prob}\{I_t = 1 \,|\, \ln p_t, X_t, \Psi^0, \mu^0\} \\ &= \frac{\mu^0 f(\ln p_t \,|\, I_t = 1, X_t, \Psi^0)}{\mu^0 f(\ln p_t \,|\, I_t = 1, X_t, \Psi^0) + (1-\mu^0) f(\ln p_t \,|\, I_t = 0, X_t, \Psi^0)}, \quad t = 1, ..., T\end{aligned} \tag{3.12}$$

Now, a new estimate of Ψ, Ψ^1, is obtained by maximizing $L^f(\{\upsilon^1_t\})$, and a new estimate of μ, μ^1, is got from the $\{\upsilon^1_t\}$ sequence by equation (3.11). Iterations are continued until convergence occurs. Full correlation between two successive $\{\upsilon_t\}$ sequences, correlation coefficient $r_{\upsilon_{t-1}\upsilon_t}$, is used as a criterion for convergence. The resulting estimates $\hat{\Psi}$ and $\hat{\mu}$ maximize, as shown by Kiefer (1980), the likelihood function L^ϕ.

As in Lee and Porter (1984), we classify the sample into collusive and revisionary periods by setting $\hat{I}_t = 1$, if in the resulting $\{\hat{\upsilon}_t\}$ -sequence $\hat{\upsilon}_t \geq 0.5$, and $\hat{I}_t = 0$ otherwise (t = 1, ..., T). Lee and Porter show that this method minimizes the probability of misclassification. The CE sequence (see figure A3.1) is a result of this exercise.

3.3 Variables, estimation and results

The variables used in estimations are specified in the table 3.1 below.

Table 3.1 **List of variables**

	Specification
Endogenous variables:	
r_t^L	The average interest rate on new bank loans
r_t^M	Three months Helibor
Y_t	Real new bank lending
Regime classification (I_t):	
CA_t	*A priori* assumed regime classification sequence (=1 in a more collusive period, and 0 otherwise)
CE_t	Estimated (ML) regime classification sequence (=1 in a more collusive period, and 0 otherwise)
Demand shifting variables (A_t):	
$RGDP_t$	Real GDP
CPI_t	Monthly inflation rate
$DEMR_t$	DEM three months interest rate (price for foreign substitute)
HEX_t	The Helsinki stock index (asset prices)
Factor prices (W_t):	
$RWAGE_t$	Real wage rate (index) in the banking sector
$DEPR_t$	Average deposit interest rate
Cost shifting variable (K_t)	
DSH_t	Ratio of deposits to total funding

Data source: Bank of Finland

Short term market interest rate is used as the reference rate since the long term markets have been rather undeveloped in Finland. New lending rates and new lending are used instead of average interest rates on the loan stock and the total stock of loans, respectively, because the rate on new loans is the decision variable of banks to which their customers react. Loan stocks reflect largely past decisions.

Only variable factors are included in the factor price vector. Note that the price for purchased funds, which is approximately the market interest rate, is implicit in the price for loans (the dependent variable in the supply relations). This corresponds to variable cost (disequilibrium) specification, under which banks are assumed to minimize costs subject to the level of physical capital in place.[58] The cost burden of banks is expected to be the greater the more they have to rely on market sources in their funding. Therefore, DSH is expected to have a negative sign. The seasonal dummy (SD) is included to control for the two periods when the demand for loans increased substantially: (1) 1988:12, due to a change in the capital income tax rules which was preceded by an acquisition boom of enterprises, and (2) 1992:12.

Table 3.2 reports the results from estimating the system of equations (3.6) with both assumed (CA) and estimated (CE) regime classification sequences that are depicted in figure A3.1. The estimated CE sequence seems quite sensible compared to the evolution of the average lending margin. However, in the CE sequence some observations at the beginning and end of the sample period are classified as reversionary. After remaining relatively unchanged during 1987, just after the opening of the proper money market in Finland, the lending margin increased rapidly in the early 1988. Similarly, a decrease took place at the end of the year 1993. Our iterative technique classified these observations that are preceded by rapid changes in the lending margin into the revisionary regime, to which they seem not to belong when the whole sample period is considered. Therefore, we have classified these observations as collusive in the CER sequence (see figure A3.1), and reported the results obtained by using CER as the regime classification sequence in the last column of table 3.2. Note that the log of the likelihood function is only slightly lower for CER than CE. Hence, our revision of CE does not seem to result in a significant loss of information.

The industry demand is found significantly inelastic: The estimate of the price elasticity is around –0.6. All other parameters of the demand function have also predicted signs, except DEMR. The negative sign is most likely due to the fact that the r^M and DEMR series have been significantly contemporously correlated.

[58] See section 4.5.1 for reasons and discussion on this assumption.

Table 3.2 **Equation (3.6), estimation results.**
All variables (except the dichotomous variables, SD, CA, CE and CER) in ln-form

Variable	2SLS using CA Demand	2SLS using CA Supply	ML yielding CE[1] Demand (OLS)	ML yielding CE[1] Supply (ML)	ML using CER Supply(ML)
Constant	0.725	−4.853*	0.936	−2.914	−2.952
	(0.280)	(−2.01)	(0.346)	(−0.956)	(−0.931)
SD[2]	0.668**	0.0039	0.670**	0.160**	0.134*
	(7.45)	(0.824)	(7.15)	(3.27)	(2.51)
$\hat{Y}$		−0.040		−0.215**	−0.173**
		(−1.16)		(−3.96)	(−2.71)
$p=(r^L/r^M)$	−0.598**		−0.550*		
	(−2.678)		(−2.34)		
CA/CE/CER		0.102**		0.063**	0.083**
		(4.79)		(3.31)	(4.02)
RGDP	1.079**		1.080**		
	(3.68)		(3.51)		
CPI	0.183		0.124		
	(0.364)		(0.236)		
DEMR	−0.497**		−0.480**		
	(−3.95)		(−3.63)		
HEX	0.466**		0.471**		
	(7.49)		(7.23)		
RWAGE		1.016*		1.010*	0.907
		(2.44)		(2.09)	(1.87)
DEPR		−0.433**		−0.549**	−0.455**
		(−8.83)		(−7.81)	(−5.71)
DSH		−0.014		0.339	0.107
		(−0.069)		(1.57)	(0.481)
Adj R^2	0.853	0.686	0.853		
SEE	0.338	0.106	0.129		
Log of likelihood				263.41	263.40
μ				0.663	0.812
$r_{\upsilon_{t-1}\upsilon_t}$				1.000	

Notes: * denotes coefficient significant at 5 %, and ** at 1 % level, respectively. (t-statistics in parentheses)
[1] Obtained by Kiefer's algorithm described in section 3.2.2
[2] Seasonal Dummies, SD, 1988:12 and 1992:12

Sample period: 1987:4–1993:11 (monthly data).

In the supply relation the coefficient of $\hat{Y}$, β_1, equals the elasticity of variable costs with respect to output minus one. Small negative estimates of β_1 would thus indicate slight economies of scale. However, the cost function is not thoroughly appropriately specified in our model as it does not exhibit linear homogeneity. Hence, we would not take this as serious evidence of scale economies. The structure of funding (or cost of funds) does not seem to have had a significant effect on the lending margin as the coefficient of DSH is never significant. Given the comparative static results presented in section 4.2.3 of the next chapter this presents evidence in favour of rather competitive conduct in the loan market.

The significant negative sign of DEPR is rather counterintuitive. It indicates that, at the industry level, rises in deposit rates have not been passed through to the lending margin, quite the contrary. In terms of the data, the negative sign results as the average rate on deposits rose rather steadily throughout the period 1988–1990 while banks lending margins were narrowing (compare figures A3.1 and figure 4.1 in chapter 4). And during 1993 the deposit rate was decreasing at the same time when banks' lending margins were on an increasing trend. In general, this finding supports our conclusions in chapter 4: Changes in deposit rates have a minor effect in the bank loan market, since the degree of price competition is much higher in the loan market than in the deposit market (see our comparative static results in section 4.2.3). We leave this topic here and return to it in chapter 4 where it constitutes one of the major issues.

Significant shifts in the supply relation are indicated by the CE sequence obtained by Kiefer's iterative technique. The log of the likelihood function for a restricted model where no shifts in conduct are allowed is 254.84. Consequently, the likelihood ratio test statistics obtains the value of 17.15. The critical value for this statistics at 1 per cent level is 6.63.[59] Hence, we can strongly reject the null-hypothesis of no-shifts in the supply relation. The probability of colluding, μ, was found approximately 2/3 over the estimation period (0.812 when the CER sequence was used). Also the results from using the *a priori* imposed CA sequence imply a significant shift in conduct. The parameter estimates obtained by using the CA sequence should be, however, significantly biased, since it deviates from the optimally derived CE sequence (see Lee and Porter 1984).

The estimates of δ^p indicate that the industry price has been higher in the more collusive phase than in the reversionary phase in

[59] The likelihood ratio test statistics is chi-squared distributed with as many degrees of freedom as imposed parameter restrictions, here one.

statistically significant manner. The implied percentage price rises due to tacit collusion are given in table 3.3 below for the three regime classification sequences.

Table 3.3 **Implied price rise in the more collusive phase** ($\exp(\delta^p)$)

CE	6.50 %
CER	8.65 %
CA	10.74 %

Alternatively, given an estimate of α_1, we can infer the relationship between the use of market power in the more collusive regime and that in the reversionary period by using the following formula:

$$\delta^p = \ln\left[\frac{\left(1+\frac{\Theta_w}{\alpha_1}\right)}{\left(1+\frac{\Theta_p}{\alpha_1}\right)}\right] <=> \exp(\delta^p) = \frac{\alpha_1 + \Theta_w}{\alpha_1 + \Theta_p} \tag{3.13}$$

$$<=> \Theta_p = \frac{(1-\exp(\delta^p))\alpha_1 + \Theta_w}{\exp(\delta^p)}$$

Hence, if the reversionary periods are Bertrand (perfect competition) less than 10 per cent use of market power is implied for the more collusive phases. Regardless of the magnitude of the theta in the reversionary phase, the use of market power does not seem to rise tremendously when banks revert to the more collusive phases.

We are unable to identify exactly the conduct parameters, but it should be clear in light of our other econometric results using different econometric techniques that the use of market power in the more collusive phases has been unquestionably well below the monopoly level (see chapters 2 and 4). Hence, quite competitive picture of the Finnish credit market is painted. These results are in line with the predictions of Green and Porter's (1984) model, namely that the optimal cartel enforcement mechanism should result in lower prices than would be charged in a fully collusive industry which behaves like a monopoly.

3.4 Conclusions

The econometric evidence presented in this chapter indicates that reversions in competitive conduct of the Finnish deposit banks have occurred during 1987:4–1993:11. The efficient maximum likelihood estimate of the regime classification sequence (CE) obtained by Kiefer's iterative technique indicates that the longest reversion to more competitive conduct took place during the latter half of 1989 for a period of eight months (see figure A3.1). Price competition in the loan market seems to have been exceptionally tight during this period. This result is in line with our preceding results presented in chapter 2 concerning the timing of the increase in competition. Short reversions seem to have taken place also at the end of 1991 and during 1992. These latter observations can be, however, due to extraordinarily aggressive pricing by those savings banks who had met serious financial difficulties: Extensive risk taking (moral hazard) in a situation when things are so bad that risky bets are attractive. The significant shift toward more aggressive conduct during 1989 can be understood, in part, as an element of the optimal (implicit) cartel enforcement mechanism, and therefore, rational behaviour on part of banks.

Rotember and Saloner's (1986) model predicts that colluding oligopolists are likely to behave more competitively in periods of high demand (revert to section 3.1). This is since the benefit to a single firm from undercutting the price that maximizes joint profits is larger when demand is high and when the economy booms, i.e. short term gains from cheating are higher, and prices need to be lowered in order to sustain the tacitly collusive scheme. In Finland, GDP growth was greatest during the late 1989, i.e. at the time of the longest reversionary period indicated by the CE (and CER) sequences. Hence, anecdotal evidence in favour of Rotemberg and Saloner's hypothesis is presented.[60]

However, lending growth was already slowing down in 1989 and 1990 (see figure A3.2). The greatest expansion in lending took place in 1988 after the liberalization of lending rate regulations and foreign

[60] The coefficient of the LGDP lagged by one month is −1.523 (t-statistic −2.13) in an equation where the CER sequence is explained by a constant and LGDP(−1). Hence, reversionary periods have been significantly more likely after a period of strong GDP growth.

currency borrowing by the Finnish industry. Hence, banks seem to have engaged in keenest price competition in the situation of most rapid economic expansion but slowing demand for credit. When demand for bank loans was growing fast in 1987 and 1988 banks had apparently not to price as aggressively, since all banks were faced with ample demand. Bank of Finland placed in March 1989 a supplementary cash reserve requirement for those banks that did not control their lending growth. Certain banks bore the costs of the extra reserves rather than curtailed their lending. Hence, it seems that banks engaged in the most aggressive pricing in the loan market when they thought that others would slow down their lending, and, thus, rewards in terms of market share would have been greatest.

Loosely interpreted, Green and Porter's (1984) model predicts that the reversionary periods are caused by unanticipated changes in demand that are reflected, for example, in unexpected changes in the market share of at least one firm. This kind of a situation is most likely to arise in a case of contracting demand if firms can not tell whether prices are low due to a general downward pressure on prices or due to cheating by some firm or firms on the tacitly collusive agreement. Hence, the predictions of Green and Porter's and Rotemberg and Saloner's models are opposite.[61] We checked whether the regime changes indicated by the maximum likelihood CE sequence are correlated with exceptionally large changes in market shares, measured by the sum of the squared changes in lending shares of commercial, savings and cooperative banks. The answer is that no clear correlation can be detected either visually (see figure A3.3) or statistically.

Hence, by and large, cyclical conditions seem to have been in Finland a more powerful explanation to the changes in banks' competitive conduct than rapid changes in market shares. Murto (1993) found out by studying econometrically banks' pricing that the evolution of the credit risk premiums (loan rates minus corresponding reference rates) has followed economic cycles in Finland: During the boom in the late 1980's credit risk premiums were lower than during the following slump, other things equal. There is also some international evidence that support this behavioural pattern (see e.g. Mishkin 1991).

Finally, according to our results, competition in the loan market seems to have been quite intensive throughout the period 1987–1993.

[61] This is due to the different informational structure in the two models. In Green and Porter's model players are not able to perfectly observe others' actions. This imperfection is absent in Rotemberg and Saloner's model.

Tacit collusion is found to raise prices by only some 7–9 per cent during our sample period (the ML estimates). Nevertheless, during 1993 banks' lending margins appear to have been higher than earlier (see figure A3.1). Banks have tried, apparently, to recoup some of their huge credit losses by increasing lending margins. Unfortunately, pricing in the bank loan market can not be analyzed before 1987 in terms of the model presented in this chapter in order to test for the effect of deregulation on competition, since a proper money market for banks' CDs was not yet developed in Finland.

4 Oligopolistic interdependence in bank loan and deposit markets

4.1 Foreword

In this chapter we analyze the nature of oligopolistic competition in Finnish bank loan and deposit markets. Both markets are highly concentrated in Finland which suggests the existence of significant oligopolistic interdependencies between banks. We measure the degree of price competition and retaliatory behaviour in both markets, and in addition, the magnitude of cross-market retaliation. By cross-market retaliation we mean the competitive response of bank's rivals in a market in response to its initial action in the other market. Hence, our analysis recognizes the two key aspects of banking competition. Firstly, banks produce multiple outputs (of which loans and deposits are most important). And secondly, as a consequence of the first one, banks compete against each other in multiple markets. Our empirical analyses use cross-section data of all Finnish deposit banks from 1988 to 1991.[62]

As the final regulations on banks average lending rates were abolished in August 1986 (see table A1.2 in Appendix 1), banks' lending rate setting has been free of explicit regulations over the whole period of study. On the deposit side, the "indirect rate regulation" through taxation rules has been gradually eased since the beginning 1989 when the cartel-like agreement on the determination of tax exemption was cancelled and the tax exemption was based on the comparison to the Bank of Finland base rate. This has had the effect of exposing taxable time and savings accounts to price competition to increasing extent. Nevertheless, the remaining regulatory constraints on deposit rate setting need to be kept in mind when interpreting the empirical results.

As noted in section 1.1, there are only a few studies that present tests of ologopolistic competition and use of market power in banking, or examine the market influences on bank behaviour. Of these the closest references for this study are the studies using multi-product

[62] Years prior to 1988 are excluded, since the money market did not function well prior to 1988. A proper money market was established in 1987, and the early months of its operation were not smooth. Significant structural changes in the banking sector in 1992 affect our estimations as explained more in detail in section 4.5.1. Therefore, we have excluded the year 1992 from the analysis presented in this chapter.

formulation, e.g. Gelfand and Spiller (1987), Suominen (1994) and Berg and Kim (1993b). First two of the above studies use time series data. The advantage of our cross-section approach compared to the time series one is that we can track the evolution of oligopolistic coordination (the use of market power) over time. Moreover, by dividing the sample into subgroups of banks depending on the bank type and size we allow banks' reactions to competitors' actions to vary across the different groups of banks.

Arguably, single- or "composite"-product formulations can lead to a significant loss of information due to misspecification of banks' supply function. Nevertheless, in banking applications these formulations have been used more often than the multi-product ones. Shaffer (1989) employed Bresnahan's (1982) one product test of competition (see section 1.1.5) to the US banking industry. His study gave support to perfect competition and clearly rejected collusion. The same methodology led Shaffer (1993) to support perfect competition also in the Canadian banking system, even in spite of significantly higher concentration than in the US banking industry. Spiller and Favaro (1984) augmented Bresnahan's analysis by testing alternative oligopoly models on the Uruguayan banking sector.

This chapter is organized as follows. Section 4.2 presents a model of two firms in duopolistic competition in two separate markets in order to characterize the basic features of oligopolistic interdependence when the oligopolists compete in a multimarket setting. The duopoly model draws on the fundamental works of Fudenberg and Tirole (1984) and Bulow *et.al.* (1985). Section 4.3 presents our "core" empirical model: The behavioral equations for both bank loan and deposit markets. The degree of oligopolistic coordination is measured by means of parametrized "expected response" terms entered in the behavioral equations. This empirical modelling strategy originates from Iwata (1974), Gollop and Roberts (1979) and Bresnahan (1982) (see section 1.1.5). The behavioral equations need auxiliary estimates of the parameters of banks' cost and demand functions. These estimations are, in part, of an interest of their own, and represent a rather long detour from our main analysis. Most importantly, the duality between the cost and the production functions allows us to obtain information about banks' production technology: overall and product specific economies of scale and cost complementarities in the production of loans and deposit services. Data used in estimations and empirical results are given in sections 4.4, 4.5 and 4.6. Finally, section 4.7 concludes the chapter.

4.2 Multimarket oligopoly

4.2.1 Implications of multimarket contact

Multimarket contact arises when any multiproduct firms encounter each other in two or more markets. This definition includes also single-product firms that operate in a number of distinct geographic markets (see Bernheim and Whinston 1990). Multimarket operations and multimarket contact can lead to significantly different strategic behaviour in each market compared to the case when firms produce for one particular market only. Bulow *et.al.* (1985) show that cross-market interdependencies result in a static oligopolistic framework if: (1) The multiproduct production technology exhibits non-zero cost complementarities, or, (2) the demand functions for the various products are interdependent (see also Tirole 1988).

We assume here that the demand functions for the two products are independent, and hence, any cross-market effects result from either positive or negative cost complementarity. We show this first in terms of a general two-product duopoly model. In order to derive more specific comparative static predictions regarding both players' actions in the two markets, and their effects on profits, a specific type for the game and a specific form for the demand function need to be assumed. We have selected here the differentiated products' price setting model with linear demand in line with the formulation of our empirical model.

Bulow *et.al.* (1985) show how cost- or demand-based linkages across markets give rise, in the context of a static oligopoly model, to strategic linkages across markets. Their analysis does not address the question how the multimarket contact affects the characteristics of dynamic repeated competition, foremost firms' ability to sustain collusive outcomes. It has been recognized by many authors that multimarket contact does tend to affect these factors. Edwards (1955) noted first that a multimarket contact can give rise to "mutual forbearance" which means that multimarket competitors can abstain from an aggressive action (e.g. a price cut) knowing that they may suffer from retaliation in many markets. Retaliation with simultaneous attacks can be much more severe than retaliation within a single market. Porter (1980) notices this possibility, but adds a further one: A firm will be most likely punished in a market where the retaliator's potential losses are small and those of the aggressor large forcing the aggressor to bear a larger relative cost for its actions.[63] This market need not be the initial market in a multimarket contact situation. Naturally, according to the theory of contestable markets (see Baumol *et.al.* 1982), oligopolistic multimarket interactions rely on the existence of barriers to entry in all different markets.[64]

The above changes in strategic conduct suggest that multimarket contact can increase the probability of tacit collusion. This idea was formalized by Bernheim and Whinston (1990) who showed that in fairly general circumstances multimarket contact does indeed raise firms' incentives to collude (see section 1.1.2). This finding is very important, since game theoretic oligopoly models have not been able to establish many general factors deepening tacit collusion that are robust across various industries.

Hence, in sum, cross-market retaliation may arise from a cross-market punishment strategy in a repeated game situation in addition to the cost- or demand-based interdependencies. This possibility is, however, beyond the scope of the inherently static duopoly model presented in this section.

4.2.2 General duopoly model

4.2.2.1 Direct and strategic effects

Assume that there are two players (firm A, firm B) that both operate in two markets (1,2). Players' actions in the two markets are A: (a_1, a_2) and B: (b_1, b_2). An action is defined aggressive if a higher level of the action variable is chosen. For example, if $da_1 > 0$. We investigate the effects of player A's aggressive action in market 1. Firm A is assumed to have a Stackelberg-type first-mover-advantage in market 1. Therefore, it chooses $a_1^* = a_1^*(b_1^*(a_1))$ that maximizes its overall profits, π^A, anticipating the response of B. Market 2 adjusts as the reaction curves in market 2 are assumed to be dependent on actions in market 1 due to cost-related reasons (see discussion below). The Nash equilibria in market 1, $\{a_1^*, b_1^*(a_1^*)\}$, and market 2, $\{a_2^*(b_2^*(a_1^*)),$

[63] Areda and Turner (1979) refer to this type of response as "spoiling".

[64] The importance of legal entry barriers was found significant by Gelfand and Spiller (1987) in providing for noncompetitive conduct and oligopolistic cross-market interdependencies in the Uruguayan Banking Sector.

$b_2^*(a_2^*(b_2^*(a_1^*)))\}$, are assumed unique and stable.[65] In an interior Nash equilibrium the following first order condition for profit maximization (FOC) with respect to a_1 needs to be satisfied:

$$\frac{d\pi^A}{da_1}=\frac{\partial\pi^A}{\partial a_1}+\frac{\partial\pi^A}{\partial b_1}\frac{db_1^*}{da_1}+\frac{\partial\pi^A}{\partial a_2}\frac{\partial a_2^*}{\partial b_2}\frac{db_2^*}{da_1}+\frac{\partial\pi^A}{\partial b_2}\frac{\partial b_2^*}{\partial a_2}\frac{\partial a_2^*}{\partial b_2}\frac{db_2^*}{da_1}=0, \tag{4.1}$$

which simplifies to:

$$\frac{d\pi^A}{da_1}=\frac{\partial\pi^A}{\partial a_1}+\frac{\partial\pi^A}{\partial a_2}\frac{da_2}{da_1}+\frac{\partial\pi^A}{\partial b_1}g_1^{B\prime}(a_1)+\frac{\partial\pi^A}{\partial b_2}g_2^{B\prime}(a_2)\frac{da_2}{da_1}=0 \tag{4.2}$$

$$DE=\frac{\partial\pi^A}{\partial a_1}+\frac{\partial\pi^A}{\partial a_2}\frac{da_2}{da_1},\quad CE=\frac{\partial\pi^A}{\partial a_2}\frac{da_2}{da_1},$$

$$SE=\frac{\partial\pi^A}{\partial b_1}g_1^{B\prime}(a_1)+\frac{\partial\pi^A}{\partial b_2}g_2^{B\prime}(a_2)\frac{da_2}{da_1}$$

where $g_k^{B'}(a_k) = db_k/da_k$ $(k = 1,2)$ represent the slopes of B's reaction functions.

Using the terminology of Fudenberg and Tirole (1984) (4.2) is decomposed into a direct effect (DE), including a cost complementarity effect (CE), and a strategic effect (SE) in both markets. A part of the DE is labelled a CE, since if A disregards its rival's actions altogether we get by taking a total differential from the FOC $(\partial\pi^A/\partial a_1 = 0)$:

[65] The stability conditions for the two markets in isolation are:

$$\frac{\partial^2\pi^A}{\partial a_1^2}\frac{\partial^2\pi^B}{\partial b_1^2}-\frac{\partial^2\pi^A}{\partial a_1\partial b_1}\frac{\partial^2\pi^B}{\partial b_1\partial a_1}>0,\quad \text{and}\quad \frac{\partial^2\pi_A}{\partial a_2^2}\frac{\partial^2\pi^B}{\partial b_2^2}-\frac{\partial^2\pi^A}{\partial a_2\partial b_2}\frac{\partial^2\pi^B}{\partial b_2\partial a_2}>0$$

The "universal" stability condition is that the (4x4) determinant of profit functions' second derivatives with respect to actions a_1, a_2, b_1, and b_2 is negative.

$$\frac{da_2}{da_1} = \frac{-\dfrac{\partial^2 \pi^A}{\partial a_1^2}}{\dfrac{\partial^2 \pi^A}{\partial a_1 \partial a_2}} \tag{4.3a}$$

$$\begin{aligned} \text{sign}\left(\frac{da_2}{da_1}\right) &= \text{sign}\left(\frac{\partial^2 \pi^A}{\partial a_1 \partial a_2}\right) \\ &= \text{sign}\left(-\frac{\partial C^A(a_1, b_1, a_2, b_2)}{\partial a_1 \partial a_2}\right) \end{aligned} \tag{4.3b}$$

The numerator in (4.3a) is positive by the second order condition for profit maximization which implies (4.3b). Hence, the sign of the CE (the part of the DE coming via the action in market 2) depends on the sign of the cost complementarity associated with the actions a_1 and a_2. For example, when the action variables are output levels, a positive cost complementarity exist if the unit cost of producing for market 2 decreases with the output in market 1. Then CE would be positive. Note that if the unit costs of producing for the two markets are independent the DE of a_1 comes only from market 1 (reaction curves in market 2 stay put), as we have assumed that demands, and hence revenues, are independent in the two markets.

In order to sign the SE we make the following notions:

$$\text{sign}\left[\frac{\partial \pi^A}{\partial b_k}\right] = \text{sign}\left[\frac{\partial \pi^B}{\partial a_k}\right], \tag{4.4a}$$

$$g_k^{B'}(a_k) = -\frac{\dfrac{\partial^2\pi^B}{\partial a_k \partial b_k}}{\dfrac{\partial^2\pi^B}{\partial b_k^2}}, \quad \text{and} \tag{4.4b}$$

$$\text{sign}\left[g_k^{B'}(a_k)\right] = \text{sign}\left[\frac{\partial^2\pi^B}{\partial a_k \partial b_k}\right], \quad k=1,2 \tag{4.4c}$$

The denominator in (4.4b) is negative by the second order condition, which implies (4.4c). If the slopes of the reaction curves are positive the players regard their products as strategic complements. If the slopes are negative strategic substitutes are in question (see Bulow *et.al.* 1985). The first condition, (4.4a), holds if we assume that the firms are of the same nature. Thus, we can write the SE without changing its sign as:

$$SE = \frac{\partial\pi^B}{\partial a_1} g_1^{B'}(a_1) + \frac{\partial\pi^B}{\partial a_2}\frac{da_2}{da_1} g_2^{B'}(a_2) \tag{4.5}$$

Firm A is said to be "tough" is its action in market 1 has a negative impact effect on rival's profit (see Fudenberg and Tirole 1984). That is if:

$$\frac{\partial\pi^B}{\partial a_1} < 0 \tag{4.6}$$

If the opposite occurs, A is said to be "soft".

4.2.2.2 Characterization of strategic behaviour

We see from (4.5) that the sign and magnitude of the SE depend crucially on the slopes of the reaction functions in both markets if one assumes that an aggressive action has always a detrimental impact effect on rival's profit and the strategic nature of the both markets is the same (the slopes of the reaction functions bear the same sign in both markets).[66] In case of strategic substitutes a positive cost complementarity amplifies the aggressive action in market 1, and a negative one "softens" it. Under strategic complementarity a positive cost complementarity makes firm A softer in market 1, and a negative one more aggressive. Note that if cost complementarities do not exist the SE comes only from the initial market 1 under our assumption of independent demands. The resolving question, whether the competitors think of their products as strategic substitutes or complements, is ultimately empirical, and thus one of the key concerns in our empirical analysis.

In sum, the above model demonstrates that both the DE and SE from market 2 arising from an aggressive action in market 1 are zero if the costs of producing for the two markets are independent of each other. Hence, a positive or negative cost complementarity is a necessary condition for any cross-market effects to arise in a multi-output oligopoly if the demand functions for the various products are independent, and retaliatory strategies are not affected by the multimarket contact.

4.2.3 Model of price setting duopolists – comparative statics

4.2.3.1 Linear demand and strategic complementarity

The stability conditions given in footnote 65 are not sufficient to sign (da_2/da_1), (db_1/da_1) and (db_2/da_1): The expressions for them depend on profit functions' second derivatives in an intractable manner. To circumvent this problem, we limit generality by assuming linear demand. Further, we employ a model of price setting oligopolists, and assume strategic complementarity (rivals' products in markets 1 and 2 are substitutes), which is the most plausible case. Hence, let the demands for both firms' (differentiated) products be:

[66] Typically an aggressive quantity increase decreases rival's profits making A "tough", and the duopolists regard their products as strategic substitutes; $g_k^{B'}(a_k) < 0$. Thus, in quantity competition "overaggressive" action in market 1 is the most plausible prediction, since SE (at least from market 1) is now positive, and DE negative, meaning that a higher quantity in market 1 would be chosen than the condition $(\partial\pi^A/\partial a_1) = 0$ would stipulate. In price competition the most plausible assumption is that of strategic complementarity. In order to analyze price competition, set $a_1 = 1/p_1^A$ to preserve $da_1 > 0$ denoting an aggressive action.

$$y_i^k = d^k - e^k p_i^k - f^k p_j^k; \quad d^k>0,\ e^k>0,\ f^k<0, \qquad (4.7)$$
$$k=1,2,\ i,j=A,B,\ i\neq j$$

We assume here that no demand interdependence between the two markets exist. Then, the profits of the both duopolists are equal to:

$$\pi_i = \sum_{k=1}^{2} R_i^k - C_i = \sum_{k=1}^{2} p_i^k (d^k - e^k p_i^k - f^k p_j^k) - C_i(y_i^k(p_i^k, p_j^k), y_i^q(p_i^q, p_j^q))$$
$$\frac{\partial C_i}{\partial y_i^k} = c_i^k(y_i^q(p_i^q, p_j^q))>0,\ \frac{\partial c_i^k}{\partial y_i^q} = \hat{c}\ \forall k,q=1,2,\ k\neq q,\ \forall i,j=A,B,\ i\neq j \qquad (4.8)$$

Thus, a further assumption is made that the marginal cost of producing k is positive and constant in regard to the level of production,[67] but depends on the output level of the other product in question, which allows for non-zero cost complementarities. Furthermore, the production technologies of the two firms are assumed similar and the cross-derivatives of the marginal costs constant valued. Negative $\hat{c}$ indicates that a positive cost complementarity exists. Note, that

$$\frac{\partial^2 \pi_i}{\partial p_i^k \partial p_j^k} = -f^k>0,\ k=1,2,\ i,j=A,B,\ i\neq j \qquad (4.9)$$

have the same sign as the slopes of the price reaction functions (compare with (4.4b) and (4.4c)). Hence, $f^k < 0$ ($k = 1,2$) indicates strategic complementarity. The Bertrand-Nash equilibrium equals (when there is no price-leadership-advantage to either firm):

[67] This assumption is required to get tractable results from the ensuing comparative static exercise.

$$p_i^{k*}(c_i^k(y_i^q),c_j^k(y_j^q)) = \frac{\frac{1}{2}\left[\frac{d^k}{e^k}+c_i^k(y_i^q)-\frac{f^k}{2e^k}\left(\frac{d^k}{e^k}+c_j^k(y_j^q)\right)\right]}{1-\frac{f^{k^2}}{4e^{k^2}}}, \tag{4.10}$$

$$k,q=1,2,\ k\neq q,\ i,j=A,B,\ i\neq j$$

We see that an increase in own marginal cost increases the equilibrium price unambiguously, as well as an increase in competitor's marginal cost, since the equilibrium prices are positive if abs[e^k] > abs[$f^k/2$]. These conditions represent also stability conditions for the two markets in isolation (see inequality (4.14) below).

4.2.3.2 Equilibrium price effects

Now, let us examine firm B's reactions to A's aggressive price reduction in market 1. The aggressive action is assumed to result from a cost reducing shock, which shifts firm A's marginal cost schedule downwards by s units. (Equivalently a positive firm-specific demand shock shifting the marginal revenue curve could be assumed). As a result firm A's total profits increase by $sy_A^1(p_A^1,p_B^1)$. This method of generating comparative static predictions is due to Bulow *et.al.* (1985). They analyze quantity competition and the case where a monopolist in one market is a duopolist in another market. Our case of duopolists in price competition in two separate markets is analytically more complicated. But, as a result, we are able to examine the impact of the degree of competition in one market on the strategic conduct in the another market.

We must assume here that the characteristics of the production technology are known to both players, and that B can identify the shock touching A (e.g. a demand increase, technological improvement or a subsidy). The following FOCs must be satisfied in an interior Bertrand-Nash equilibrium:

$$\frac{\partial \pi_A}{\partial p_A^1} = \frac{\partial R_A^1}{\partial p_A^1} - \frac{\partial C_A}{\partial p_A^1} + s\frac{\partial y_A^1}{\partial p_A^1} = 0 \tag{4.11a}$$

$$\frac{\partial \pi_A}{\partial p_A^2} = \frac{\partial R_A^2}{\partial p_A^2} - \frac{\partial C_A}{\partial p_A^2} = 0 \qquad (4.11b)$$

$$\frac{\partial \pi_B}{\partial p_B^1} = \frac{\partial R_B^1}{\partial p_B^1} - \frac{\partial C_B}{\partial p_B^1} = 0 \qquad (4.11c)$$

$$\frac{\partial \pi_B}{\partial p_B^2} = \frac{\partial R_B^2}{\partial p_B^2} - \frac{\partial C_B}{\partial p_B^2} = 0 \qquad (4.11d)$$

Total differentiation of the FOCs and multiplication by (–1), produces:

$$\underbrace{\begin{pmatrix} 2e^1 & e^1e^2\hat{c} & f^1 & e^1f^2\hat{c} \\ e^2e^1\hat{c} & 2e^2 & e^2f^1\hat{c} & f^2 \\ f^1 & e^1f^2\hat{c} & 2e^1 & e^1e^2\hat{c} \\ e^2f^1\hat{c} & f^2 & e^2e^1\hat{c} & 2e^2 \end{pmatrix}}_{(\Pi)} \begin{pmatrix} dp_A^1 \\ dp_A^2 \\ dp_B^1 \\ dp_B^2 \end{pmatrix} = \begin{pmatrix} -e^1 \\ 0 \\ 0 \\ 0 \end{pmatrix} ds \qquad (4.12)$$

Now, the effects of the cost reducing shock (ds = 1) on A's and B's optimal prices in both markets can be solved analytically:

$$\frac{dp_A^1}{ds} = \frac{1}{\det[\Pi]}\left[e^{1^2}(-8e^{2^2} + 2\hat{c}^2e^1e^{2^3} + 2f^{2^2} - \hat{c}^2e^1e^2f^{2^2})\right] \qquad (4.13a)$$

$$\frac{dp_B^1}{ds} = \frac{1}{\det[\Pi]}\left[e^1(4e^{2^2}f^1 - 2\hat{c}^2e^1e^{2^3}f^1 - \hat{c}^2e^1e^2f^2 - f^1f^{2^2} + \hat{c}^2e^1e^2f^1f^{2^2})\right] \tag{4.13b}$$

$$\frac{dp_A^2}{ds} = \frac{1}{\det[\Pi]}\left[\hat{c}e^1e^2(4e^{1^2}e^2 - \hat{c}^2e^{1^3}e^{2^2} - 2e^2f^{1^2} + \hat{c}^2e^1e^{2^2}f^{1^2} - e^1f^1f^2)\right] \tag{4.13c}$$

$$\frac{dp_B^2}{ds} = \frac{1}{\det[\Pi]}\left[\hat{c}e^1e^2(\hat{c}^2e^{1^3}e^{2^2} + 2e^1e^2f^1 - \hat{c}^2e^1e^{2^2}f^{1^2} - 2e^{1^2}f^2 + f^{1^2}f^2)\right] \tag{4.13d}$$

We can see right away that the price responses in market 1, where the initial shock took place, do not depend on the sign of the cost complementarity, while the cross-market responses in market 2 do. Stability of the equilibrium in both markets simultaneously requires that the determinant of the Π matrix is positive[68] (determinant of the original matrix $(-1)\Pi$ is negative). If the cost complementarity is reasonable small in absolute value $\hat{c}^2$ is close to zero, and the effects of the $\hat{c}$ parameter on the price responses in market 1 are very small. Moreover, in this case the stability conditions for the individual markets in isolation:

$$\frac{\partial^2\pi_i}{\partial p_i^{k^2}}\frac{\partial^2\pi_j}{\partial p_j^{k^2}} > \frac{\partial^2\pi_i}{\partial p_i^k\partial p_j^k}\frac{\partial^2\pi_j}{\partial p_j^k p_i^k} \Leftrightarrow \left|e^k\right| > \left|\frac{f^k}{2}\right|, \tag{4.14}$$

$$k = 1,2,\ i,j = A,B,\ i \neq j,$$

are sufficient to sign the price responses in market 1:

68

$$\det[\Pi] = 16e^{1^2}e^{2^2} - 8\hat{c}^2e^{1^3}e^{2^3} + \hat{c}^4e^{1^4}e^{2^4} - 4e^{2^2}f^{1^2} + 4\hat{c}^2e^1e^{2^3}f^{1^2} - \hat{c}^4e^{1^2}e^{2^4}f^{1^2} - 2\hat{c}^2e^{1^2}e^2f^1f_2 - 4e^{1^2}f^{2^2} + 4\hat{c}^2e^{1^3}e^2f^{2^2} - \hat{c}^4e^{1^4}e^{2^2}f^{2^2} - 2\hat{c}^2e^1e^2f^{1^2}f^{2^2} + \hat{c}^4e^{1^2}e^{2^2}f^{1^2}f^{2^2} > 0$$

$$\left[\frac{dp_A^1}{ds}\right],\left[\frac{dp_B^1}{ds}\right]<0 \qquad (4.15a)$$

Hence, the own market price reactions to the cost reducing shock are negative in equilibrium. This is evident also from the expression for the equilibrium prices (equation (4.10)).

Similarly, if (4.14) holds for market 2 (and $\hat{c}^2$ is sufficiently close to zero):

$$\left[\frac{dp_A^1}{ds}\right]-\left[\frac{dp_B^1}{ds}\right]= \qquad (4.15b)$$

$$\frac{e^1(-2e^2+f^2)}{4e^1e^2-\hat{c}^2{e^1}^2{e^2}^2-2e^2f^1+\hat{c}^2e^1{e^2}^2f^1-2e^1f^2+\hat{c}^2{e^1}^2e^2f^2+f^1f^2-\hat{c}^2e^1e^2f^1f^2}<0$$

Meaning that the firm A who was hit by the favourable shock in market 1 reduces its price more in market 1 than the firm B who was not.

The signs of the cross-market price effects in market 2 depend on the sign of the cost complementarity regardless of its absolute magnitude. Unfortunately, their signs are generally ambiguous depending on the values of the underlying demand parameters. Nevertheless, under plausible parameter values:[69]

$$\text{sign}\left[\frac{dp_A^2}{ds}\right] = \text{sign}\left[\hat{c}\right] = \text{sign}\left[\frac{dp_B^2}{ds}\right] \qquad (4.15c)$$

If a positive cost complementarity exists the positive shock leads, under plausible parameter values, to a reduction in the prices of both firms in the market 2 as well. Table 4.1. below gives the magnitudes of the equilibrium price responses under one possible set of values of the demand parameters and cost complementarity.

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69 The first equation in (4.15c) holds (the sign of the effect of ds = 1 in market 1 on A's price in market 2 is equal to the sign of $\hat{c}$) if ${e^1}^2>\frac{1}{2}{f^1}^2+\sqrt{\frac{e^1f^1f^2}{e^2}}$. The second equation in (4.15c) holds if $e^1f^2<e^2f^1+({f^1}^2f^2/2e^1)$.

Table 4.1 **Equilibrium price effects when ds = 1, $e^1 = 2.0$, $e^2 = 0.5$, $f^1 = -1.0$, and $f^2 = -0.3$**
(ref. tables A4.3.1 and A4.3.2 in Appendix 4.3)

	$\hat{c} = -0.1$	$\hat{c} = 0.1$
$[dp_A^1 / ds]$	−0.534	−0.534
$[dp_B^1 / ds]$	−0.133	−0.133
$[dp_A^2 / ds]$	−0.047	0.047
$[dp_B^2 / ds]$	−0.001	0.001
Det[π]	13.587	

Under perfect competition the price reaction curves $g_i^k(p_j^k)$ are orthogonal. This is the case when (as given by (4.4b)) e^ks (the own price elasticities of demand) approach infinity. The following limits are possible to derive:

$$\lim_{e^1\to\infty}\left[\frac{dp_A^1}{ds}\right]=\lim_{e^1\to\infty}\left[\frac{dp_B^1}{ds}\right]=\lim_{e^2\to\infty}\left[\frac{dp_A^2}{ds}\right]=\lim_{e^2\to\infty}\left[\frac{dp_B^2}{ds}\right]=0 \qquad (4.16a)$$

Meaning that in a perfectly competitive market no retaliation takes place. Interestingly, except under very implausible parameter values:

$$\left|\lim_{e^1\to\infty}\left[\frac{dp_B^2}{ds}\right]\right|=\left|\frac{e^2}{\hat{c}(e^{2^2}-f^{2^2})}\right|>\left|\left[\frac{dp_B^2}{ds}\right]\right|$$
$$\left|\lim_{e^1\to\infty}\left[\frac{dp_A^2}{ds}\right]\right|=\left|\frac{e^2}{\hat{c}(f^{2^2}-e^{2^2})}\right|=-\lim_{e^1\to\infty}\left[\frac{dp_B^2}{ds}\right] \qquad (4.16b)$$

We see that when a positive cost complementarity prevails and the market 1 approaches the perfectly competitive setting firm B's retaliation in market 2 becomes larger in absolute value. (Under positive cost complementarity the limit ($e^1\to\infty$) $[dp_B^2/ds]$ is negative as long as abs[e^2] > abs[f^2], i.e. the demand is more responsive to the own price change than to the change in rival's price). In other words, the less competitive market 2 is used more intensively by the firm B for retaliation when the market 1 becomes more competitive and the sign of cost complementarity is positive. By contrast, when the market 1 approaches perfect competition firm A's own cross-reaction in market 2 is in fact accommodative.

The main results of our comparative static exercise on the two-market, two-product price setting duopoly model, given our demand and cost assumptions, are summarized below:

Result 4.1. The amount of own and cross-market retaliation depends on the slopes of the reaction functions (as originally shown by Bulow *et.al.* (1985)). More specifically, retaliation is negatively correlated to the degree of price competition in the market in question. In a perfectly competitive market no own or cross-market retaliation takes place.

For example, if the bank loan market is perfectly competitive increases in deposit costs e.g. due to changes in tax rules are not passed-through to lending margins.

Result 4.2. The sign of cross-market retaliation depends on the sign of the cost complementarity between the products produced for the different markets where the oligopolists compete, regardless of the absolute magnitude of the cost complementarity.

Result 4.3. If the other market approaches the perfectly competitive setting and the other is less competitive, retaliatory (accommodative) behaviour on part of competitors becomes stronger in the latter market under positive (negative) cost complementarity.

Result 4.4. We can normally (under plausible values of the underlying demand parameters) expect that a positive cost complementarity leads to cross-market retaliation and a negative cost-complementarity to cross-market accommodation. This means that a positive cost complementarity would result in parallel movements in prices (and quantities) in both markets. This result depends, however, on the values of the demand parameters in generally intractable way.

Regulations (like ceilings on deposit rates or loan rates) can naturally hinder or limit the magnitude of strategic retaliation in certain markets. The effects of regulation are here not explicitly analyzed, however.

4.2.3.3 Equilibrium cross-market profit effects

Whether the initial action of an oligopolist in one market provides costs or benefits through changes in competitors' strategies in the other market depends, as the price reactions, on the degree of price competition in that market, the underlying parameters of the demand function and sign of the cost complementarity. By adding together the respective effects on equilibrium revenues and costs the effect of the change in A's marginal cost in market 1 on A's equilibrium profits that comes from market 2 reduces to the expression (4.17) below:

$$\frac{\partial \pi_A^*}{\partial p_B^{2*}} \frac{\partial p_B^{2*}}{\partial c_A^1} = \frac{f^{2^2}}{4e^2\left(1 - \frac{f^{2^2}}{4e^{2^2}}\right)} \left(p_A^{2*} - c_A^2\right) \frac{dc_A^2}{dc_A^1} \tag{4.17}$$

Hence, the cross-market profit effect from a perfectly competitive market will be zero.

There exist a positive cost complementarity in the production of the two products if:

$$\frac{dc_A^2}{dc_A^1} = \frac{\partial c_A^2}{\partial y_A^1}(-e^1)\frac{\partial p_A^{1*}}{\partial c_A^1} \Rightarrow \text{sign}\left[\frac{\partial c_A^2}{\partial c_A^1}\right] = -\text{sign}[\hat{c}] > 0 \tag{4.18}$$

In case of a positive cost complementarity the sign of (4.17) is positive by the stability condition for market 2 in isolation. This means that:

> *Result 4.5.* Under positive cost complementarity the cross-market profit effect of the favourable shock on A's profits is negative (as long as competition in market 2 is not perfect).

This effect comes through the change in competing firm B's strategy in market 2, which has a negative effect on A's total profit. Under negative cost complementarity this result becomes reversed. We cannot rule out the perverse result that a favourable shock has a negative overall effect on A's equilibrium total profit. This happens under positive cost complementarity if the own market profit effect is smaller than the negative cross-market one.

4.3 Empirical behavioral equations

In this section we derive the behavioral equations that are then estimated from the cross-section data of the Finnish deposit banks. Our analysis is founded on the differentiated goods' oligopolistic price competition model. The differentiated goods' assumption allows banks to retain some market power, since the well know result for homogeneous goods' price competition (with constant and equal marginal costs) is that the only Nash equilibrium involves pricing at marginal cost: The Bertrand equilibrium (see e.g. Shapiro 1989).

The established duality between the parameters of oligopolistic coordination in price and quantity setting models makes the choice between these, sometimes regarded as rival models, principally irrelevant (see e.g. Kamien and Shwartz 1981 for further discussion). Nevertheless, prices, i.e. the interest rates on loans and deposits, can be more readily thought as banks' strategic choice variables, and hence, the price setting model could be regarded as more realistic.

Our empirical price setting model has similar building blocks as the quantity setting models of Gelfand and Spiller (1987), Berg and Kim (1993b) and Suominen (1994). However, the choice to model price competition leads to quite different-looking empirical equations.

Let there be n banks in the industry producing two products, loans and deposit services, indexed by k. A representative bank i chooses prices, p_i^k (k = 1,2) (defined at the end of this section) to maximize its total profits:

$$\max \pi_i = p_i^1 D_i^1(p^1, Z^1) + p_i^2 D_i^2(p^2, Z^2) \\ - C_i(D_i^1(p^1, Z^1), D_i^2(p^2, Z^2), W_i, K_i) \tag{4.19}$$

$$\text{s.t.} \quad y_i^k = D_i^k(p_1^k, \ldots, p_n^k, Z^k) = D_i^k(p^k, Z^k), \; k = 1,2, \; i = 1, \ldots, n,$$

where $D_i^k(.)$ is the firm-specific demand for product k, Z^k the vector of demand shifting variables, W_i the vector of input prices, and K_i the vector of cost shifting variables. The above demand formulation assumes that the two products are not substitutable, and accordingly, the respective demand functions are independent. However, banks' reactions to their competitors' prices in both markets are explicitly modeled recognizing the strategic interdependence between the bank loan and deposit markets. The strategic interdependence between the two markets should be strong on *a priori* grounds, since banks' borrowers are usually tied to keep their deposits with the bank in question. This gives banks strong incentives to follow very closely other banks' deposit rate offerings as favourable deposit rates (and terms) can bring in new borrowers. This strategic link may, naturally, go the other way around, as well, rendering banks' revenues from the deposit market correlated with their success in the loan market competition.

The FOCs necessary to hold in an interior equilibrium equal:

$$\frac{\partial \pi_i}{\partial p_i^k} = y_i^k + p_i^k \frac{\partial y_i^k}{\partial p_i^k} + p_i^k \frac{\partial y_i^k}{\partial p^k} \sum_{j=1, j\neq i}^{n} g_j^{kk}(p_i^k) + p_i^q \frac{\partial y_i^q}{\partial p^q} \sum_{j=1, j\neq i}^{n} g_j^{qk}(p_i^k)$$

$$- \frac{\partial C_i}{\partial y_i^k} \frac{\partial y_i^k}{\partial p_i^k} - \frac{\partial C_i}{\partial y_i^k} \frac{\partial y_i^k}{\partial p^k} \sum_{j=1, j\neq i}^{n} g_j^{kk}(p_i^k) - \frac{\partial C_i}{\partial y_i^q} \frac{\partial y_i^q}{\partial p^q} \sum_{j=1, j\neq i}^{n} g_j^{qk}(p_i^k) = 0; \qquad (4.20)$$

$$k,q = 1,2;\; k \neq q,$$

where $g_j^{qk}(p_i^k)$s are equal to:

$$\sum_{j=1, j\neq i}^{n} g_j^{qk}(p_i^k) = \left[\frac{\partial \sum_{j=1, j\neq i}^{n} p_j^q}{\partial p_i^k} \right]^e \equiv \sum_{j=1, j\neq i}^{n} \upsilon_j^{qk};\; k,q = 1,2,\; k \neq q \qquad (4.21)$$

I.e. the expectations of bank i regarding the pricing of product q by its competitors in response to its change of the price for k. Hence, "expected response" terms are entered in the FOCs to be able to empirically distinguish between the various oligopoly models ranging from monopoly (full collusion) to perfect competition as in similar NEIO studies (see section 1.1.5). This is a convenient way of parametrizing oligopoly behaviour in order to derive testable empirical hypotheses. However, it is basically an *ad hoc* shortcut to study oligopolistic interactions (see e.g. Shapiro 1989), and it does not constitute a *bona fide* theory of oligopolistic interactions (i.e. dynamic responses).[70] To formally study reactions (e.g. price wars and tacit collusion) explicitly dynamic oligopoly models are required.

Multiplying the FOCs with (p_i^k/y_i^k) and rearranging yields:

$$p_i^k + (p_i^k - c_i^k)\left[\varepsilon_i^{kk} + \left(\frac{p_i^k}{\bar{p}^k}\right)\bar{\varepsilon}_i^{kk}\sum_{j=1,j\neq i}^{n}\upsilon_j^{kk}\right] + (p_i^q - c_i^q)\left(\frac{y_i^q}{y_i^k}\right)\left(\frac{p_i^k}{\bar{p}^q}\right)\bar{\varepsilon}_i^{qq}\sum_{j=1,j\neq i}^{n}\upsilon_j^{qk} = 0,\ k,q=1,2,\ k\neq q, \tag{4.22}$$

where the c_i^ks (k=1,2) are the product- and bank-specific marginal costs. The estimates of the marginal costs are obtained from auxiliary cost function estimations (see section 4.5.1). In equation (4.22) $\bar{p}^k$s (k = 1,2) are interpreted as average industry prices weighted by market shares:

$$\bar{p}^k = \sum_{i=1}^{n}\left(\frac{y_i^k}{y^k}\right)p_i^k;\ y^k = \sum_{i=1}^{n} y_i^k, k=1,2 \tag{4.23a}$$

The price elasticities that appear in equation (4.22), and their predicted signs are:

$$\varepsilon_i^{qk} = \frac{\partial y_i^q}{\partial p_i^k}\frac{p_i^k}{y_i^q} < 0,\quad \text{and}\quad \bar{\varepsilon}_i^{qk} = \frac{\partial y_i^q}{\partial \bar{p}^k}\frac{\bar{p}^k}{y_i^q} > 0,\ k,q=1,2,\ k\neq q \tag{4.23b}$$

Allowing conduct to differ by individual banks would not be feasible regarding the degrees of freedom: n–1 conduct parameters to be estimated would result. Following the methodology used by Gollop and Roberts (1979) in a study of the US coffee industry we divide the

---

[70] Especially, the theory of so called consistent conjectural variations (see Laitner 1980 and Bresnahan 1981), which imposes the (rationality) requirement that in the neighbourhood of equilibrium a firm's expectation about a rival's response equal the slope of that rival's reaction curve, is logically flawed. This is since reaction functions are unlikely to represent optimal dynamic responses. They are merely the Nash equilibrium loci corresponding to different output levels in static competition. (See e.g. Dixit 1986).

n banks into s mutually exclusive subsets with r_v (v = 1,..,s) banks in each subset to reduce the number of estimated parameters. The expected response terms (parametrized behavioural terms) take therefore the following form:

$$\sum_{j=1,j\neq i}^{n} \upsilon_j^{qk} = \sum_{v=1\,|j\notin v}^{s} \sum_{j=1}^{r_v} \upsilon_j^{qk} + \sum_{j=1,j\neq i,j\in v}^{r_v} \upsilon_j^{qk}$$

$$\approx \sum_{v=1\,|j\notin v}^{s} r_v \upsilon_v^{qk} + (r_{v\,|j\in v} - 1)\upsilon_v^{qk} \equiv N_v^{qk}, \tag{4.24}$$

$i \in v,\ k,q = 1,2,\ k \neq q,$

where υ_v^{qk} equals the expectations about rival's behaviour held in the subset v (the j subscript is omitted in the approximation in (4.24)).

In addition, the price elasticities are assumed the same for all banks within the same subset v, and further constant valued over time. The respective elasticities are estimated from time series data (see section 4.5.4). The underlying assumption is that customer preferences and other factors affecting the curvature of demand (and market power) are identical within groups.

With the above assumptions inserted in equation (4.22) the system of two behavioural equations becomes:

$$p_i^k + (p_i^k - c_i^k)\left[\varepsilon_v^{kk} + \frac{p_i^k}{\overline{p}^k}\overline{\varepsilon}_v^{kk}\left(\sum_{v=1\,|j\notin v}^{s} r_v \upsilon_v^{kk} + (r_{v\,|j\in v} - 1)\upsilon_v^{kk}\right)\right] +$$

$$(p_i^q - c_i^q)\left[\left(\frac{y_i^q}{y_i^k}\right)\left(\frac{p_i^k}{\overline{p}^q}\right)\overline{\varepsilon}_v^{qq}\left(\sum_{v=1\,|j\neq v}^{s} r_v \upsilon_v^{qk} + (r_{v\,|j\in v} - 1)\upsilon_v^{qk}\right)\right] = 0 \tag{4.25a}$$

$k,q = 1,2;\ k \neq q,\ v = 1,\ldots,s,\ i = 1,\ldots,n$

We assume that banks are price takers in the money market, interest rate r^M, but may have market power in setting loan and deposit rates, r_i^1 and r_i^2, respectively. Hence, the price variables are defined as given in equations (4.25b) and (4.25c) below. These equations represent the empirical behavioural equations for bank loan and deposit markets that are estimated simultaneously from the bank data.

$$
\begin{aligned}
& r_i^1 + (r_i^1 - c_i^1)\left[\varepsilon_v^{11} + \frac{r_i^1}{\bar{r}^1}\bar{\varepsilon}_v^{11} N_v^{11}\right] + \\
& \left[(1-\delta) r^M + \delta r^R - r_i^2 - c_i^2\right]\left[\left(\frac{y_i^2}{y_i^1}\right)\left(\frac{r_i^1}{((1-\delta) r^M + \delta r^R - \bar{r}^2)}\bar{\varepsilon}_v^{22} N_v^{21}\right)\right] = 0
\end{aligned}
\tag{4.25b}
$$

$$
\begin{aligned}
& (1-\delta) r^M + \delta r^R - r_i^2 + \left[(1-\delta) r^M + \delta r^R - r_i^2 - c_i^2\right]\left[\varepsilon_v^{22} + \left(\frac{(1-\delta) r^M + \delta r^R - r_i^2}{(1-\delta) r^M + \delta r^R - \bar{r}^2}\right)\bar{\varepsilon}_v^{22} N_v^{22}\right] + \\
& (r_i^1 - c_i^1)\left[\left(\frac{y_i^1}{y_i^2}\right)\left(\frac{(1-\delta) r^M + \delta r^R - r_i^2}{\bar{r}^1}\right)\bar{\varepsilon}_v^{11} N_v^{12}\right] = 0, \\
& v = 1, \ldots, s, \quad i = 1, \ldots, n
\end{aligned}
\tag{4.25c}
$$

In above equations r^R is the interest rate on mandatory reserves and δ the required level of mandatory reserves as a proportion of total deposits. Note that the definition of p_i^1 to equal r_i^1 differs from the usual specification as a spread over the money market reference rate, r^M.[71] This is since our definition of marginal cost of lending, c_i^1, includes banks' interest costs on deposits and other funds as well as their operating costs (see section 4.5). In (4.25b) and (4.25c) $\bar{r}^k$s equal the average industry lending and deposit rates weighted by market shares:

$$
\bar{r}^k = \sum_{i=1}^{n}\left(\frac{y_i^k}{y^k}\right) r_i^k; \quad y^k = \sum_{i=1}^{n} y_i^k, \quad k = 1,2
\tag{4.25d}
$$

From banks' point of view the proceedings from reinvesting the deposited funds should cover the costs associated with their deposit taking activities including payment and ancillary services provided to depositors. Money market rate represents the most suitable reference for these investments, as well as the opportunity cost for depositors. Therefore, the margin over the money market rate, adjusted for the reserve requirement, is a suitable proxy for the supplier price of deposit services.

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[71] See e.g. Santomero (1984) for a survey of bank modelling.

The resulting estimates of υ_v^{qk}s are the changes in percentages banks in group v expect in rival banks' prices for q in response to one per cent changes in their own prices for k. $\upsilon_v^{kk} = 1$ would correspond to perfect oligopolistic coordination, under which banks implicitly expect their price changes to be followed exactly. Moreover, by perfect coordination banks achieve maximum joint profits which equal monopoly profits. On the other hand $\upsilon_v^{kk} = -1/(n-1)$ would correspond (in the symmetric case) to perfect competition: price equals marginal cost in market k, k=1,2.[72] Hence, estimates of the υ_v^{kk}s represent indices of the degree of competition and the use of market power by banks in the group v in the market k. Finally, the estimated υ_v^{qk}s (k,q = 1,2; k≠q) measure the magnitude of the cross-market price responses.

One way to interpret the expected price reaction terms is that expectations of more aggressive retaliation lead to more collusive equilibrium behaviour. This corresponds to the "topsy-turvy" principle of tacit collusion (see Shapiro 1989), which summarizes most of the relevant features of tacit collusion that appear in the literature on infinitely repeated oligopoly games (see section 1.1.2).

4.4 Data and variable specifications

The accounting and other bank specific data are obtained from Statistics Finland: The Banks, Official Finnish Statistics. The data cover all Finnish deposit banks over the years from 1988 to 1992 excluding some of the smallest commercial banks and the central banks of the local savings and cooperative banks (SKOP and OKO), since their line of business differs markedly from that of the other

72 The duality between υ^{kk} (the price coordination term) and θ^{kk} (k,12) (the quantity coordination term) states that any υ^{kk} implicitly implies a corresponding equivalent θ^{kk} that yields the same symmetric equilibrium price and quantity combination, and vice versa. Kamien and Schwartz (1981) show that for a given number of firms in the industry (n) and the degree of perceived price differentiation, measured by the price differences (p_j^k/p_i^k):s, the relationship between υ^{kk} and θ^{kk} is increasing and concave from $(-1/(n-1), -1/(n-1))$ (in the symmetric case) to (1,1). It is important to note that the price and quantity coordination terms that correspond to the same equilibrium are not the same in absolute value. In fact, the concavity feature implies that the υ^{kk} is always larger than the corresponding θ^{kk}. Moreover, the coordination terms need not always have the same sign. Nevertheless, an increase in either υ^{kk} or θ^{kk} will lead to a reduction in equilibrium quantity, and increase in equilibrium price producing a less competitive outcome. The maximum profit is achieved by perfect coordination when $\upsilon^{kk} = \theta^{kk} = 1$. With these notions its is possible to compare our results to the results of the studies that use quantity setting formulations.

deposit banks in the sample. The allotments to Postal Administration are included in the operating expenses of the Post Bank (PSP), and thus, PSP's cost data are made in line with that of the other commercial banks. The number of banks in the sample falls from 577 in 1988 to 362 in 1992 due to mergers in the sector of local banks, chiefly among savings banks (see table 4.2).

Table 4.2 **Description of the sample**

	1988	1989	1990	1991	1992
Number of banks					
Total (n)	577	538	503	423	362
Commercial banks	5	5	5	5	5
Savings banks	209	176	141	86	39
Cooperative banks	363	357	357	332	317

Note:

Commercial banks exclude SKOP, OKO, Kansallisluottopankki Oy, MB Osakepankki Oy, OP-Kotipankki Oy and foreign owned banks, since their line of business differs markedly from that of the deposit banks in our sample. Postipankki (PSP) is consistently included within commercial banks.

Data source:

Statistics Finland

In the most recent empirical banking literature (see e.g. Humphrey 1993) all services generating substantial value added are specified as banks' output, thus including deposits as well as various types of loans and investments. Since payment and ancillary services associated with banks' deposit taking activities consume a large proportion of banks' resources, and account for a large share of the non-financial, operating expenses, treating deposits as merely inputs would be clearly unsatisfactory.[73] But, in order to capture the whole cost structure of banks, banks' funding costs need to be accounted for by including the unit costs of deposits as well as purchased funds into the vector of input prices (W) in addition to the prices for operating inputs. Hence,

[73] A typical estimate is that the payment and ancillary services account for roughly 50 per cent of banks' all operating expenses. E.g. Berger and Humphrey (1992) report that in the USA the deposit production defined to comprise payment, safekeeping and accounting services has used up around 50 per cent of banks' total labour and physical capital input expenditures. DeBoissieu (1993) obtains a similar figure for the French banking industry by using analytical accounting data published by the French Banking Commission.

deposits are taken to have both output and input characteristics. This approach can be seen as a mixture of the traditional value added (production) and intermediation approaches[74] to specify banks' output and costs in the empirical banking literature. Accordingly, we specify the output variables and inputs in the following manner:

y_i^1 = Output 1 loans: value of current (cheque) account credits, bills and credits to the non-bank public (commercial loans, mortgages and consumer credits)

y_i^2 = Output 2 deposits: value of demand and time deposits by the non-bank public, and current accounts by enterprises

These definitions are also guided by our need to derive reasonable estimates of product specific marginal costs (see section 4.5.1). Stocks of loans and deposits are used here since banks must use resources to the monitoring and administrating of old loans in addition to granting new ones. The amount of (operating) resources spent in producing deposit services is assumed to be related to the value of deposit balances. This is not a fully satisfactory measure of deposit service production, but the best one available. The number of account transactions would be a better measure of the amount of payment and ancillary services produced.

w_i^m = Input prices: Labour (m=1) (labour expenditures per one full time employee), other operating inputs (m=2) (other operating expenses per total assets), deposits (m=3) (interest expenses on deposits per the value of accounts), and purchased funds (m=4) (other interest expenses per the value of other interest bearing liabilities)

Interest rate variables appearing in equations (4.25b) and (4.25c) are obtained from the Bank of Finland, and are defined as follows:

r_i^1 = Average new lending rate. In case of commercial banks bank-specific lending rates are used, but in case of savings and cooperative banks, due to data limitations, average rates

[74] The value added (or production) approach stresses the service production aspect of banking defining all services, i.e. payments, account maintenance, deposit and loan supply, as banks' output. Accordingly, banks' factors of production include only operating inputs. By contrast, the intermediation approach emphasizes the role of banks as financial intermediaries. In this approach only the value of loans and investments measure the magnitude of banks' output, and deposits and purchased funds are regarded as productive inputs only.

charged in the respective bank groups. This is not a too serious limitation, since savings and cooperative banks have operated in largely centralized manner, similar to the large commercial banks, with e.g. centralized marketing and money market operations.

$\bar{r}^1$ = Average new lending rate of all deposit banks (weighted by market shares).

New lending rates are used instead of the rates on banks' entire loan stocks, since they correspond to the choice variables of banks to which banks' customers react in the theoretical model. The rates on entire loan stocks reflect largely past decisions.

r_i^2 = Average deposit rate. Again, bank specific data are used for commercial banks, but for savings and cooperative banks group level data.

$\bar{r}^2$ = Average deposit rate of all deposit banks (weighted by market shares).

r^M = Three month money market rate (Helibor).

r^R = Interest rate paid on required cash reserves. (δ = cash reserve requirement on deposits included in the reserve requirement base)

Variables included in vectors K and Z are specified in detail in sections 4.5.1 and 4.5.4, respectively, where the ancillary cost and demand models are specified.

Our grouping of banks into subgroups is the following:

v=1 Commercial banks
v=2 Savings banks
v=3 Cooperative banks

Hence the last two subgroups make up the Finnish local banking sector.

4.5 Auxiliary cost and demand function estimations

4.5.1 Translog cost function model

To be able to estimate the behavioral equations we need estimates of the bank-specific marginal costs. It is not possible to derive the marginal costs from banks' accounting data, since the operating costs cannot be reasonably allocated to the two output categories. For example, its is not possible to say which part of the expenses on bank premises should be allotted to the activities associated with the loan granting and monitoring process and which to deposit taking activities. Our solution is to derive marginal costs from an empirical multiproduct cost function as proposed by Roberts and Samuelson (1988) in a non-banking study, and applied in banking by Berg and Kim (1993b). Using market interest rates as proxies for marginal costs as in Spiller and Favaro (1984) and Gelfand and Spiller (1987) would not be appropriate. Firstly, operating costs would be excluded. And secondly, Finnish local banks that constitute the bulk of our sample do not themselves actively participate in the money market.

We model here the Finnish deposit banks as cost-minimizing, two-product firms, and estimate a system of cost and factor share equations in order to yield efficient estimates of the cost function parameters. We employ a disequilibrium specification by treating physical capital (F) as quasi-fixed. In this formulation the quantity of the capital input replaces the price of capital in the cost function, and enters the cost function as a separate argument. Equilibrium modelling, where all factors are specified variable, is appropriate as long as changes in output demands or input prices are relatively small and smooth, and therefore foreseeable (see Pulley and Humphrey 1993). This situation does not clearly apply to late 1980's and early 1990's as banks began to operate in a liberalized environment, interest rates were highly volatile, and Finland experienced an enormously steep business cycle. Hence, modelling disequilibrium behaviour where costs are minimized subject to the level of physical capital in place seems appropriate.[75]

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[75] Kulatilaka (1987) has shown that the parameter estimates from partial static equilibrium models, such as our cost function model, can be quite sensitive to the exogenity / endogenity assumption of physical capital. In principle, the plausibility of our disequilibrium specification could be tested by specification tests, but there is a difficult measurement problem concerning the price for physical capital. This measurement problem could bias significantly the parameter estimates from an equilibrium model, and hence distort the specification tests.

Cost functions are estimated for each year by using the Full Information Maximum Likelihood (FIML) method simultaneously with factor share equations (S_i^m) (obtained by Shephard's lemma) for all but one variable factors in order to impose theoretical consistency on the parameter estimates and obtain efficient estimates. When physical capital is quasi-fixed the general translog forms (i.e. Taylor series expansions) for the cost function and the factor share equations are the following:

$$\begin{aligned}\ln C(y_i^1, y_i^2, W_i, B_i, F_i) &= \gamma_0 + \sum_{k=1}^{2}\gamma_{1k}\ln y_i^k + \sum_{m=1}^{4}\gamma_{2m}\ln w_i^m + \gamma_3 \ln B_i + \gamma_4 \ln F_i \\ &+ \tfrac{1}{2}\Big(\sum_{k=1}^{2}\sum_{q=1}^{2}\zeta_{kq}\ln y_i^q \ln y_i^k + \sum_{m=1}^{4}\sum_{\tilde{m}=1}^{4}\rho_{m\tilde{m}}\ln w_i^m w_i^{\tilde{m}} + \zeta_{BB}(\ln B)^2 + \zeta_{FF}(\ln F)^2\Big) \\ &+ \sum_{k=1}^{2}\sum_{m=1}^{4}\eta_{km}\ln y_i^k \ln w_i^m + \sum_{k=1}^{2}\eta_{kB}\ln y_i^k \ln B_i + \sum_{k=1}^{2}\eta_{kF}\ln y_i^k \ln F_i \\ &+ \sum_{m=1}^{4}\lambda_{mB}\ln w_i^m \ln B_i + \sum_{m=1}^{4}\lambda_{mF}\ln w_i^m \ln F_i + \xi_{BF}\ln B_i \ln F_i + \varepsilon_i\end{aligned} \tag{4.26}$$

$$\begin{aligned}S_i^m = \frac{\partial \ln C(.)}{\partial \ln w_i^m} &= \gamma_{2m} + \sum_{\tilde{m}=1}^{4}\rho_{m\tilde{m}}\ln w_i^{\tilde{m}} + \sum_{k=1}^{2}\eta_{km}\ln y_i^k \\ &+ \lambda_{mB}\ln B_i + \lambda_{mF}\ln F_i + \mu_i^m, \qquad m = 1,\ldots,3\ (=m-1),\quad i = 1,\ldots,n\end{aligned} \tag{4.27}$$

where the variables not given in section 4.4 are specified as:

C_i= Total interest and operating expenses of the bank i (does not include capital expenses, i.e. depreciation allowances)
B_i= Number of branches
F_i= Physical capital (the book value of premises and other fixed assets)
S_i^m= The cost share of input m

The number of branches is a separate argument in the cost function, and regarded as an alternative way to expand output to the expansion at a given branch capacity. These translog forms have the advantage of not restricting *a priori* the form of the production technology. However, the following homogeneity and symmetry restrictions need to be imposed on (4.26) for it to be consistent with cost minimization and represent a cost function in economic terms:

$$\sum_{m=1}^{4}\gamma_{2m}=1,\quad \zeta_{qk}=\zeta_{kq}\ \forall\ q,k,\quad \rho_{m\tilde{m}}=\rho_{\tilde{m}m}\ \forall\ m,\tilde{m},$$

$$\sum_{\tilde{m}=1}^{4}\zeta_{m\tilde{m}}=0,\quad m=1,..,4,\quad \sum_{m=1}^{4}\eta_{km}=0,\quad k=1,2, \tag{4.28}$$

$$\sum_{m=1}^{4}\lambda_{mB}=0,\quad \text{and}\quad \sum_{m=1}^{4}\lambda_{mF}=0$$

Barten (1969) has shown that the FIML estimators give point estimates for a system of demand equations that are invariant with respect to the choice of the omitted equation. This extends to our case where the cost function is jointly estimated with the expenditure shares. Hence, we need not be concerned about the choice of the omitted equation in (4.27).

Finally, bank-specific predictions of marginal costs are generated by using the following formula:

$$\hat{MC}(y^k)_i=\frac{C_i}{y_i^k}\frac{\partial \ln C(y_i^1,y_i^2,W_i,B_i,F_i)}{\partial \ln y_i^k}$$

$$=\frac{C_i}{y_i^k}(\gamma_{ik}+\sum_{q=1}^{2}\zeta_{kq}\ln y_q+\sum_{m=1}^{4}\eta_{km}\ln w_i^m+\eta_{kB}\ln B_i+\eta_{kF}F_i), \tag{4.29}$$

$k,q=1,2,\ k\neq q$

The estimates of the cost function parameters for each of the cross-sections 1988–1992 are given in Appendix 4.1.[76] OLS estimates from separate regressions were used as starting values for the FIML. Convergence and robustness of the estimates were tested by using zero values as alternatives to the OLS estimates. Parameters were found to be insensitive to this change in the starting values.

[76] Dummy variables were added in equation (4.26) for cooperative banks in 1991, since their data did not fit the overall cost model.

The theoretical parameter restrictions given in (4.28) were imposed on all equations.[77] Estimates of the remaining free parameters are shown in Appendix 4.1. The values of the restricted parameters can be calculated by using the restrictions (4.28). The significance of the parameter estimates is more than satisfactory, and the fit of all equations, except the labour cost share equation, good. The averages of the predicted marginal costs for both loans and deposits and their standard deviations are given in table 4.3 below. Before discussing these estimates a few words on the development of banks' funding and operating costs are in place.

The changes in tax rules since 1989 have increased banks' average funding costs,[78] as the high level of the market interest rates at the end of the 1980's and early 1990's was reflected into banks' average deposit rates (see figure 4.1). After the peak in the market interest rates in August 1992, the Bank of Finland lowered its base rate in February 1993 from 8.5 % to 7.5 %. Since then the base rate has mirrored the fall in the market rates. This has significantly decreased banks' deposit costs as apparent in figure 4.1. The base rate was 5.25 % with the effect from 1 February 1994.

Banks grew very rapidly in Finland over a period from 1987 to 1989 by means of a substantial credit expansion. This diminished the role of deposits in banks' overall funding, and increased the unit cost of funds. Foreign funds' share started to increase significantly since long term credits denominated in foreign currencies were liberated in 1986, first to manufacturing industries and ship yards and later on in 1987 to the other industries, as well. Foreign funds' average share in commercial banks' funding increased from 17 % to 41 % between 1980 and 1992, while that of the domestic deposits' fell from 58 % to 31 %. In local savings and commercial banks the average respective changes were from an insignificant level up to 15 %, and from around 80 % down to 50 %. At the same time, CD:s' and bonds' role in

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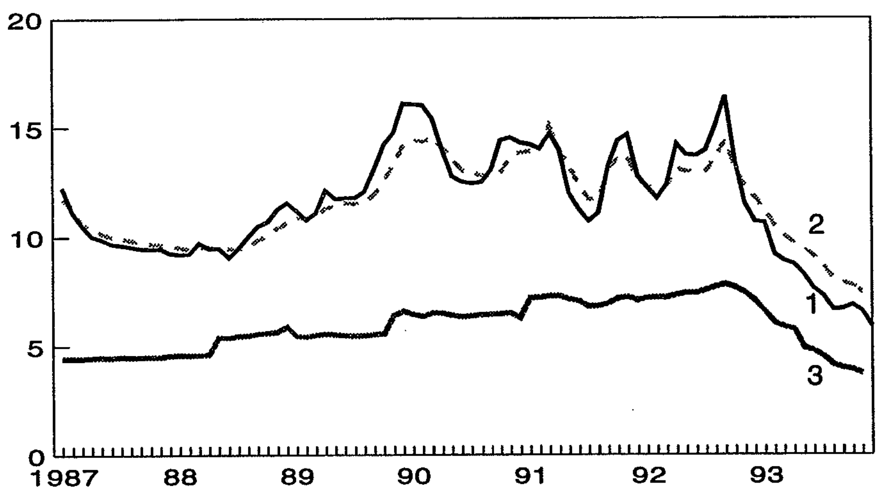
[77] Likelihood ratio tests contrasting the log likelihood values from unrestricted (excluding theoretical restrictions) and restricted (including theoretical restrictions) models were in favour of the former. This denotes that the hypothesis of cost minimization is not fully satisfactory, and cost (productive) inefficiencies exist. This result is consistent with the literature detecting large and highly variable cost inefficiencies among banks (see Vesala 1993 for a review of the international literature, and e.g. Kuussaari (1993) for evidence from a DEA model concerning the Finnish local banking sector). However, the theoretical restrictions need to be imposed in order to make inferences about banks' cost function, although the unrestricted model is statistically preferred.

[78] Revert to table A1.2 in Appendix 1 and section 1.4 for details of the banking deregulation in Finland.

banks' funding rose significantly up to around 10 % (see Jokinen and Solttila 1994). In sum, Finnish banks have been increasingly relying on purchased funds. However, at the beginning of the 1990's banks' credit expansion ceased, and the loan stock even contracted in 1992, easing banks' pressures on the liability side, and restoring some of the balance between loans and deposit funding (see Koskenkylä and Vesala 1994).

The share of operating costs in banks' total costs decreased from 33.5 % in 1988 to 27.5 % in 1992. Hence, banks' reliance on financial inputs has increased reflecting in part the output expansion between 1987 and 1989 without increasing branch capacity. In fact, the overall number of branches has been rather steadily declining since 1987. Banks' labour force increased until the end of 1989, but has since contracted by over one fifth.[79] The development of the unit cost of labour and other operating inputs faced by banks are shown in figure 4.2. We see that unit labour costs rose in real terms by nearly 10 % over the period of study, while simultaneously, the real unit costs of other operating inputs showed roughly an equal relative fall. The latter is mostly due to technical development, which has reduced banks' costs of operating ADP-equipment and network.

Figure 4.1 **Finnish deposit banks' funding costs (%)**



1 Helibor 3 months
2 Deposit banks: average interest rate on purchased funds
3 Deposit banks: average interest rate on deposits

Source: Bank of Finland

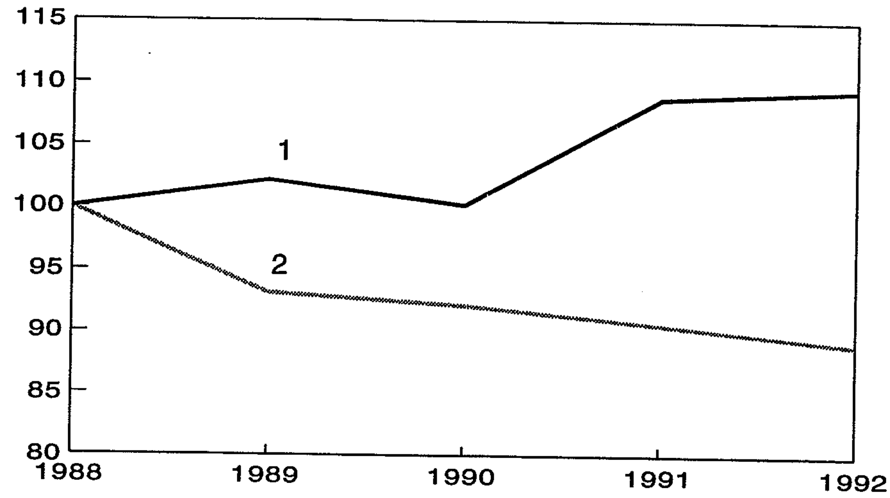
[79] There was an increase of around 10000 in banks' total personnel in the 1980's until 1989 when it topped 53200. Until the end of 1992, the yearly figures were: 50200, 46800 and 42202. (Source: Finnish Bankers' Association)

The marginal costs of loans should include the use of both financial and operating inputs. Associated with lending banks use operating resources to produce evaluation, signalling and monitoring services (see Fama 1985). In case of deposits, the marginal cost should reflect merely the use of operating inputs. The services banks produce in conjunction with their deposit taking activities, called deposit services, include payment and ancillary services, e.g. book keeping and safekeeping services (see Fama 1980). Of these the payment transmission services are the most important, and consume most heavily banks' resources (see e.g. Brand and Duke 1982 and DeBoissieu 1993).

The predicted values of the marginal costs 1988–1991 (see table 4.3) seem very plausible against this ground, as also against the depicted development of the input prices (figures 4.1 and 4.2). The year 1992 constitutes a problem. In real terms banks loan stock decreased by almost 6 per cent during 1992, as the economic conditions had deteriorated and the banks credit losses started to climb (see Koskenkylä and Vesala 1994 tables 2 and 4). As a result, banks' product mix shifted markedly toward deposits. This kind of a product mix shift is not well handled within our cost model producing inappropriate marginal cost predictions for 1992. Due to this, we do not present any estimates for the year 1992.

Our estimates of the marginal cost of lending are presented by ascending bank size (in terms of total assets) in figures A4.1.1–A4.1.4 in Appendix 4.1 for each year 1988–1991. The lending marginal cost curve, when individual banks' assets constitute the output axis, appears to be significantly upward sloping. For a majority of the small local banks the marginal cost of lending appears to have been consistently lower than the money market rate. As noted, at these banks deposits' share in total funding continued to be higher than that at the large commercial banks. Moreover, a significant amount of foreign funds, whose interest cost was lower than the cost of domestic money market funds, was used to finance credit extension, also at the local banks through their central organizations. Seemingly low marginal cost of lending might be one reason for the heavy lending growth in the late 1980s. In fact, the savings bank sector engaged in the fastest lending growth in the late 1980s, while the growth of the large commercial banks was more smooth over the 1980s. The sector of cooperative banks was, however, more cautious than the other bank groups (see Koskenkylä and Vesala 1994). Note that the predicted marginal costs do not include the cost of physical capital due to our disequilibrium specification.

Figure 4.2 **Finnish deposit banks' real operating unit costs (1988=100)**



1 Unit labour cost
2 Unit cost of other operating inputs

Note: see section 4.4 for definitions

Table 4.3 **Predicted marginal costs (equation (4.29)). Averages and standard deviations, 1988–1991**

	Loans Average	Std	Deposits Average	Std
1988	0.076	0.020	0.029	0.012
1989	0.090	0.023	0.032	0.012
1990	0.109	0.035	0.024	0.022
1991	0.089	0.035	0.025	0.020

4.5.2 Empirical measures of production economies

This section presents the employed empirical measures of the production economies, and the following the obtained empirical results.

Overall scale economies are defined as the elasticity of the cost function with respect to a proportionate increase in all outputs. In a multiproduct case Baumol *et.al.* (1982) propose their measurement by Ray Scale Economies (RSCE), which represent the elasticity of the cost function along a ray $t\bar{y}$, which holds the bank specific product mix and the number of branches constant (such as rays OB or OA in figure 4.3):

$$RSCE_i \equiv \frac{\partial \ln C(ty_i^1, ty_i^2, W_i, B_i, F_i)}{\partial \ln t \,|_{t=1}} = \sum_{k=1}^{2} \frac{\partial \ln C(y_i^1, y_i^2, W_i, B_i, F_i)}{\partial \ln y_i^k} \qquad (4.30)$$

$$k=1,2, \; i=1,...,n$$

$RSCE_i < 1$ indicates overall scale economies, and $RSCE_i > 1$ overall scale diseconomies, respectively. Note that RSCE is a local property, which depends on both the parameters of the cost function and bank specific values of the exogenous variables.

Kim and Ben-Zion (1989) note that a distinction must be made between overall economies of scale when output is increased within a given branch network and when both network size and output are expanded. In order to arrive at a proper measure of overall scale economies that accounts for both channels of output expansion RSCE must be augmented by:

$$RSCEB_i \equiv \frac{\partial \ln C(y_i^1, y_i^2, W_i, B_i(\bar{y}_i), F_i)}{\partial \ln B_i} \frac{\partial \ln B_i(\bar{y}_i)}{\partial \ln \bar{y}_i} \qquad (4.31)$$

Thus, $RSCET_i = RSCE_i + RSCEB_i$ measures the scale effects at the banking firm level, and $RSCE_i$ can be regarded as a branch level measure.

A bank that minimizes costs would set $\partial C_i(.)/\partial B_i = 0$ if there was no additional value of branches *per se* to banks' customers (see Berger *et.al.* 1987). But if banks are able to translate some of the possible value of "overbranching" generating convenience and cost savings to customers to higher fees or more favourable rates, optimization would result in more branches than the condition $\partial C_i(.)/\partial B_i = 0$ would stipulate, and RSCEB would be $\neq 0$.

In order to control for the effect of a possible product mix change along with a scale increase, we define Expansion Path Scale Economies (EPSCE) as in Berger *et.al.* (1987) to equal the elasticity of the incremental cost with respect to an incremental output change along a segment representing a product mix change (such as AB in figure 4.3):

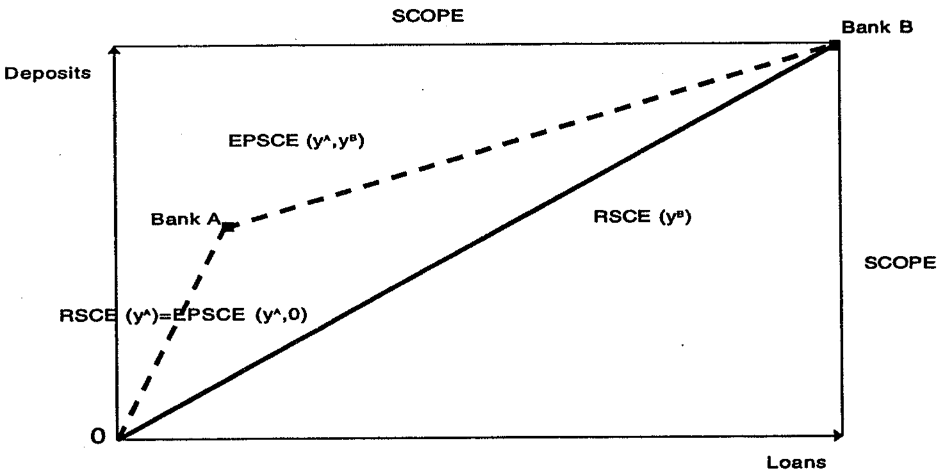
$$EPSCE(y^A,y^B) \equiv \frac{\partial \ln[C(\bar{y}^A + t(\bar{y}^B - \bar{y}^A), W^A, B^A, F^A) - C(\bar{y}^A, W^A, B^A, F^A)]}{\partial \ln t|_{t=1}}$$

$$= \sum_{k=1}^{2} \left[\frac{\dfrac{y^{kB} - y^{kA}}{y^{kB}}}{\dfrac{C(\bar{y}^B, W^B, B^B, F^B) - C(\bar{y}^A, W^A, B^A, F^A)}{C(\bar{y}^B, W^B, B^B, F^B)}} \right] * \qquad (4.32)$$

$$\left[\frac{\partial \ln C(\bar{y}^B, W^B, B^B, F^B)}{\partial \ln y^{kB}} \right]$$

$EPSCE(y^A, y^B) < 1$ indicates scale economies on the segment AB. For banking firms, EPSCE can be regarded as more descriptive than RSCE, since in reality banks rarely have identical output mixes. More specifically, loans tend to get more weight in banks' output mix as they grow in size.[80] In terms of the figure 4.3., expansion path scale economies would thus exist for the small bank A, if it could lower its unit costs by increasing scale and simultaneously becoming more loan intensive (as the large bank B).

Figure 4.3 **Empirical measures of production economies. A two-product case**



Source: Berger *et. al.* (1987)

[80] For example at the end of 1992 the ratio of total loans to total deposits was 0.98 in the smaller half of Finnish local banks, and 1.14 in the bigger half (in terms of total assets). For commercial banks the respective figure was 1.67.

Product-specific economies of scale (PSSCE) are present if a decline in per-unit cost of producing a specific product occurs when the output of that product increases holding the output of the other products constant. Such measure is not, however, meaningful in banking as it is typically impossible to change only the output of one product, say loans in our case. Nevertheless, an approximate measure can be constructed from marginal costs. Namely, declining marginal costs of product k would indicate product specific economies of scale. Marginal costs are decreasing if:

$$PSSCE(y^k)_i \equiv \frac{\partial}{\partial y_i^k}\left[\frac{C_i}{y_i^k}\,\frac{\partial \ln C(y_i^1, y_i^2, W_i, B_i, F_i)}{\partial \ln y_i^k}\right] = \frac{C_i}{y_i^k}\left(\frac{\partial^2 \ln C(.)}{\partial \ln y_i^{k\,2}}\right) - \frac{1}{y_i^k}\left(\frac{\partial \ln C(.)}{\partial \ln y_i^k}\right) \tag{4.33a}$$

is negative. In terms of the translog (4.33a) equals approximately:

$$PSSCE(y^k)_i \approx \left[\frac{C_i}{y_i^k}(\zeta_{kk})\right], \qquad k = 1,2 \tag{4.33b}$$

Clearly this is sufficient, but too strong condition, and therefore some product-specific economies may remain unrevealed.

Generally, economies of scope can arise from two sources: (1) the spreading of fixed costs over an expanded product mix,[81] and/or (2) the cost complementarities between different products when the costs of producing individual products vary positively with the production of other outputs. In banking the former means exploitation of the existing branch network, ADP-equipment and networks and personnel by adopting new services. The latter is associated with (1) information economies, (2) risk reduction, and (3) customer cost savings when all services can be purchased from a same bank (exercise "one stop

[81] Baumol *et.al.* (1982) stress the cost benefits from joint production originating from inputs that can be shared or employed jointly without congestion as a general source of scope economies.

banking").[82] The customer cost savings include reductions in search and information costs, as well as transaction costs due to inter-account fund transfers. These benefits to consumers can not naturally be measured in banks' cost structure analyses, which are thus likely to underestimate the overall benefits of joint production.

Pulley and Humphrey (1993) show that translog forms or their variants are inherently unable to estimate scope economies accurately, given the banking data available.[83] They claim that some considerably large estimates of scope economies that appear in the literature are likely to result from the shortcomings of the translog form.[84] We respect these observations in our own study, and abstain from estimating overall scope economies, but instead attempt to measure cost complementarities between loans and deposits. We use the translog form despite of its shortcomings in the measurement of the scope economies, since it is well suited to the estimation of marginal costs, which constitutes our main task.

At non-zero output levels cost complementarity requires:

$$\frac{\partial^2 C(y_i^1, y_i^2, W_i, B_i, F_i)}{\partial y_i^1 \partial y_i^2} < 0 \iff \tag{4.34a}$$

$$\left[\frac{\partial^2 \ln C(.)}{\partial \ln y_i^1 \partial \ln y_i^2} + \left(\frac{\partial \ln C(.)}{\partial \ln y_i^1}\right)\left(\frac{\partial \ln C(.)}{\partial \ln y_i^2}\right)\right] < 0, y_i^1, y_i^2 \geq 0,$$

which in terms of the translog reduces to:

$$[\zeta_{12} + \gamma_{11}\gamma_{12}] < 0 \tag{4.34b}$$

[82] See e.g. Pulley and Humphrey (1993), Vesala (1993), and Breger *et.al.* (1987) for a more detailed discussion on the sources of potential scope economies in banking.

[83] McAllister and McManus (1993) point out further shortcomings of the translog form due to lack of sufficient flexibility.

[84] This is since zero output levels necessary to obtain the scope economy measures can not be imposed on translog consistently, and the fixed cost component can not be handled appropriately (see Pulley and Humphrey 1993). By using a composite functional form that overcomes some of the limitations of the translog Pulley and Humphrey arrive at overall 4 %–5 % cost savings from joint production of five different types of deposits and loans as compared to specialized production. Their data covers 205 large US banks over a period from 1978–1990.

A necessary (but not sufficient) condition for cost complementarity is:

$$\frac{\partial^2 \ln C(y_i^1, y_i^2, W_i, B_i, F_i)}{\partial \ln y_i^1 \partial \ln y_i^2} = [\zeta_{12}] < 0, \qquad (4.35)$$

since marginal costs are required to be non-negative.

4.5.3 Production economies in Finnish banking – empirical results

Tables A4.2.1–A4.2.4 in Appendix 4.2 present results of the tests given in section 4.5.2 that measure the production economies on Finnish banks' cost function. The tables are organized by ascending bank size so that savings and cooperative banks, i.e. local banks, are divided into three groups by cumulative market share in terms of total assets. Thus for example, the group I consists of the smallest local banks amounting jointly to a third of local banks' assets. Measures for the commercial banks, and at the sample mean are reported separately. The four classes of banks are characterized by asset size and diversification in the last three columns. Prob-values given in parentheses below the production economy measures represent Wald tests[85] on the unrestricted model (including, nevertheless, the theoretical cost function restrictions (4.28)). All measures of production economies are essentially linear restrictions on the parameters and locally valued predictions of the model that can, thus, be tested appropriately. t-values are reported below the tests of the necessary conditions for cost complementarity as they depend on single parameters only.

According to our findings, RSCE:s are consistently statistically indistinguishable from unity. Hence, the Finnish banks' cost function does not appear to exhibit either scale economies or diseconomies when output expansion occurs at a given product mix and number of branches. Thus, on average, Finnish banks seem not to have operated branches below the scale efficient (optimal) size. The absolute

[85] In general, the Wald test tests H_0 of $C(\theta) = q$ (like RSCE = 1) where $C(\theta)$ represents a function of the model parameters. The test statistics $W = (C(\theta) - q)'(Var[C(\theta) - q])^{-1}(C(\theta) - q)$ is chi-squared distributed by degrees of freedom amounting to k, which equals the number of parameters in the unrestricted model minus the number of parameters in the restricted model (see e.g. Greene 1990).

measures of RSCE increase always with bank size, which is consistent with the classical cost theory.[86] It is confirming that these results are basically in line with Kuussaari's (1993) scale efficiency findings.

RSCEB:s are found in almost all cases significantly different from zero, and always negative ranging up to roughly 6 % at maximum.[87] Only for the smallest local banks the measure is insignificant in case of the first three years. Moreover, the "branching effect" grows in absolute terms as the bank size increases. Hence, the hypothesis of a positive "overbranching value" gains support. Further, as the RSCET:s are everywhere below unity in absolute terms slight economies of scale seem to exist at the banking firm level if also branches are regarded as means to increase output.

Our findings of RSCE:s equal to unity and negative RSCEB:s are quite contrary to the common view that banks' should increase output with their given branching capacity to reduce unit costs. On the contrary, banks seem to be able to recapture in the price for the deposit input a part of the "overbranching convenience value" to customers, and this ability seems to increase along with the bank size. The measured effects are, however, small. In terms of the RSCET, which accounts for the both channels of output expansion, the utmost cost savings are around 3.5 %. Our results are also different to those typically obtained in the US, namely, that at the branch level the scale elasticity measures (eg. RSCE) are somewhat lower than at the firm level (e.g. RSCET) (see Vesala 1993).

[86] Our findings are, thus, in line with the typical results presented in the recent literature employing multiproduct cost (and production) functions that at the banking firm level scale economies or diseconomies are fairly small. Estimates of overall Ray Scale Economies vary typically only a few percentage points around unity. These results appear to be considerably robust across different output and cost specifications, as well as across various countries and banking institutions. Most of the studies concern, however, the US banking industry. A partial list of the US studies includes Gilligan *et.al.* (1984), Berger *et.al.* (1987), Buono and Eakin (1990), Ferrier and Lovell (1990) and Berger and Humphrey (1991). (See Vesala 1993 for a review of the literature, and (scarce) European evidence.)

[87] The $(\partial B_i/\partial \bar{y}_i)$:s needed to calculate the RSCEB:s were obtained from auxiliary regressions, and were found significantly different from one. Their values varied between 0.637 and 0.687 when total assets were used to proxy for $\bar{y}_i$. The method of determining the magnitude of the $(\partial B_i/\partial \bar{y}_i)$ is not explicitly treated in most studies analyzing the "branching effects", but we presume that, like in our case, separate regressions have been used. Assuming $(\partial B_i/\partial \bar{y}_i) = 1$ would clearly overestimate the true "branching effects".

Our EPSCE findings[88] are interestingly significantly different from unity at the 5 % level in five cases. Unfortunately, the EPSCE:s do not show a similar regular pattern as the RSCE measures. For the middle sized local banks incremental product mix choices would had first, in 1989 and 1990, been cost increasing (even by 11.85 % in 1990), but already in 1991 cost decreasing (by 8.16 %). The same trend pertains also to the largest local banks. Estimated expansion path diseconomies of 5.81 % in 1990 alter into measured 8.18 % economies in 1991, remembering though that the null hypothesis of EPSCE amounting to unity can not be strongly rejected in the latter case. Among the smallest local banks' incremental product mix changes appear not to bear any significant impact on costs. Presumably, the structural changes in the Finnish local banking sector, chiefly mergers among savings banks, are the main cause for these observations. One could conclude that the 15 and 22 mergers that took place in the savings banks sector in 1990 and 1991, respectively, were cost increasing in nature, while the establishment of Savings Bank Finland in 1992 had prospects to enhance cost performance. One is also inclined to conclude based on the RSCE and EPSCE measures that the cooperative banks that carried out only a few mergers at the end of the 1980s and early 1990's did not, at least, suffer any important cost disadvantage, more plausibly the other way around, relative to the savings banks that pursued a much more active merger policy. These interpretations are, however, only suggestive and very subtle.

For commercial banks the EPSCE:s are larger than unity but significantly so only in 1989. Hence, according to our results, the smaller commercial banks should not have any cost related incentive to mimic larger commercial banks asset – liability structures.

In general, our results indicate that banks may not make the scale and incremental product mix choices exclusively on the basis of cost minimization. Other motives appear be more decisive. The strongest motives for e.g. scale increases by mergers are most plausibly to be desire to strengthen bank's position in the industry, or carry out otherwise difficult reorganizations or capacity reductions.

The marginal costs of producing loans and deposits are found everywhere increasing in a statistically significant manner, except in 1990 in case of loans. Thus, evidence in favour of product-specific scale economies can not be presented. On the other hand, due to the

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[88] To obtain the EPSCE measures, data for the biggest (bank B) and smallest (bank A) bank within the respective groups are inserted in the equation (4.32).

weaknesses of our measure, we can not conclude about product-specific diseconomies of scale either.

Our cost complementarity measures are negative in all cases, but only the necessary conditions are found statistically significant, except in 1990. Thus, the cost of producing deposits and loans are found to vary positively when produced together, but our evidence in this regard, based on the cost function parameters, is statistically weak.

4.5.4 Demand models for bank loans and deposit services

4.5.4.1 Demand for bank loans

The estimates of the demand elasticities facing each of the subsets of banks that are needed in the behavioral equations are obtained by estimating separate demand equations from monthly time series data. The demand for bank loans is set to take the following log-linear form:

$$\ln D^1_{v_t}(r^1_{v_t},\bar{r}^1_t,Z^1_t) = \alpha_0 + \alpha_{SD}SD_t + \tilde{\alpha}_1 \ln\left(\frac{r^1_{v_t}}{r^M}\right) - \alpha_2\left(\ln\left(\frac{r^1_{v_t}}{r^M}\right) - \ln\left(\frac{\bar{r}^1_t}{r^M}\right)\right) + \sum_{j=1}^{J}\beta_j \ln z^1_t + u_t \tag{4.36}$$

$$v = 1,\ldots,s;\ Z^1 = (z^1_1,\ldots,z^1_J);\ \text{and}\ \tilde{\alpha}_1 = (\alpha_1 + \alpha_2)$$

A relative price formulation is used due to strong correlation between own and average lending rates which blurs parameter identification. The own and substitute price elasticities therefore equal: $\varepsilon^{11}_v = \alpha_1 = (\tilde{\alpha}_1 - \alpha_2)$, and $\bar{\varepsilon}^{11}_v = -(-\alpha_2)$. The average rates of banks' new lending are quoted as margins over the money market rate, r^M, as commonly perceived by banks' customers, since banks' customers typically compare banks' lending rates to the money market rate in order to judge the changes in banks' offerings over time. Moreover, the cost of alternative funds (not intermediated through banks) correlates positively with the market interest rate.

Four exogenous demand shifting variables, z_j, are included in (4.36): Real income level (real GDP), asset prices (proxied by the stock market index), rate of inflation, and price for a foreign substitute (proxied by the 3 month DEM interest rate). Seasonal dummies are added to control for the rapid increase in lending at the end of 1988 (see Figure A4.3.2 in Appendix 4.3) due to a heavy increase in property sales due to changes in capital gains taxation rules, and heavy turbulence at the end of 1992.

4.5.4.2 Demand for deposit services

Deposit services (payment and ancillary services) are still extensively cross-subsidized, although direct service charges have been increasingly imposed (see figure A4.3.3 in Appendix 4.3), which means that a large part of the effective price for these services is charged within the interest margin on deposits. The provision of free or underpriced payment and account keeping services compensates the depositor for not being paid the market interest rate. The customer decision to deposit money balances with a bank depends on the effective price for all services the customer by doing that obtains. Moreover, what the customer actually demands are the payment and ancillary services.

We proxy the effective price for the deposit services in the demand equation in the following way which accounts for the interest foregone on deposits as well as the direct service charges:

$$p_{v_t}^{D} = \frac{y_{v_t}^{2}\left(r_t^{M} - r_{v_t}^{2}\right)\frac{1}{12}}{q_{v_t}^{S}} + p_{v_t}^{S}, \quad v = 1,\ldots,s, \tag{4.37}$$

The volume of these services, q^S, is measured in (4.37) by the amount of payment transactions channelled through the Finnish clearing system. This should be a reasonable approximation, since, as we noted earlier, the payment transmissions constitute the most important category of the deposit services. The direct service charges, p_v^Ss, are calculated from bank specific fees on various cheque, giro and payment transactions. The "group-level" average charges are calculated by using the number of deposit accounts as weights (see Appendix 4.3).[89]

The demand equation for the deposit services is specified in the following manner:

[89] Suominen (1994) uses an analogous definition for the aggregate industry level price for deposit services, except that a Statistics Finland price index of payment services is used in place of the actual service charges.

$$\ln q^s_{v_t}(p^D_{v_t}, \bar{p}^D_t, Z^2_t) = \alpha_0 + t + \alpha_{SD}SD_t + \tilde{\alpha}\ln p^D_{v_t} - \alpha_2(\ln p^D_{v_t} - \ln\bar{p}^D_t) + \sum_{j=1}^{J}\ln z^2_t + u_t, \ v = 1,...,s; \ Z^2 = (z^2_1,...z^2_J); \text{ and } \tilde{\alpha}_1 = (\alpha_1 + \alpha_2) \tag{4.38}$$

A linear trend, t, is included in (4.38), since the volume of deposit services, q^s has grown strongly trend-wise over the estimation period (see figure A4.3.6 in Appendix 4.3). Unfortunately, there are two very large shocks that affect the price for deposit services as defined in (4.37) through deposit balances as well as the relative prices for the deposit services at the different subgroups of banks (see figures A4.3.4 and A4.3.5 in Appendix 4.3). Firstly, the change in capital gain taxation in force since the beginning of 1989, and secondly, a bank strike in February 1990. Substantial shifts in the price variables follow these shocks which are very large compared to the remaining variation in the data, and would, therefore cause significant bias in the estimated parameters. This represents an "errors in variables" situation, which is corrected by removing the effect of these shocks by the following instrumental variables method (see Greene 1990, ch. 9.):

$$\ln p^D_{v_t} = a_0 + a_1 t + a_2 CD_t + e_t \tag{4.39a}$$

$$(\ln p^D_{v_t} - \ln\bar{p}^D_t) = b_0 + b_1 t + b_2 CD_t + f_t \tag{4.39b}$$

$$\ln\hat{p}^D_{v_t} = \hat{a}_0 + \hat{a}_1 t + e_t \tag{4.39c}$$

$$\widehat{(\ln p^D_{v_t} - \ln\bar{p}^D_t)} = \hat{b}_0 + \hat{b}_1 t + f_t \tag{4.39d}$$

The fitted values for both of the price variables (4.39c) and (4.39d) represent the original time series for these variables, except that the effects of the shocks controlled by the dummy variable CD are smoothed away. The fitted values are inserted in the equation (4.38) which is then estimated by OLS. This method has the effect of increasing the standard errors of the parameter estimates due to which the t-values become underestimated. Naturally, the bank strike caused also a very large drop in the volume of services produced, q^s (see Figure A4.3.6 in Appendix 4.3). This effect is controlled in (4.38) by a seasonal dummy, SD. The SD is extended also to control for the apparent shift of deposits away from savings banks especially to cooperative banks since the early 1990, when the severe financial difficulties of the savings bank group started to become more apparent (see figure A4.3.7 in Appendix 4.3).

4.5.4.3 Estimation results

Tables A4.3.1 and A4.3.2 in Appendix 4.3 report the results from estimating the demand equations (4.36) and (4.38). Note that all money variables are expressed in real terms. Autocorrelation is a problem in the loan equation which is well expected as the changes in bank lending have followed a strongly cyclical pattern in Finland over the period of study (see figure A4.3.2 in Appendix 4.3). The remaining first-order autocorrelation is corrected by the Hildreth-Lu method (see e.g. Greene 1990, p. 432).

All elasticity estimates have the predicted sign, and the demand for loan funds is consistently more elastic than that for deposit services, as expected. The biggest deviation across bank groups is that the own price elasticity of loans at commercial banks is significantly higher than at the two groups of local banks. This is likely mainly due to the significantly larger share of more competitive corporate loans in commercial banks' asset portfolios (see further discussion in section 4.6.3). The signs of the other exogenous variables are almost universally in line with expectations, except those of real GDP in the deposit demand equation for commercial and savings banks. However, in all cases real GDP has an insignificant effect on the demand for deposit services.

4.6 Behavioral equations: estimation and results

The two behavioural equations for both bank loan and deposit markets (equations (4.25b) and (4.25c)) are estimated simultaneously by FIML for each year 1988–1991. The entire panel data set, in which the yearly cross-sections are pooled together, is also used in order to obtain estimates of average conduct over the period of study, and to test for the significance of the yearly changes in the parameter values by using Wald tests. The Wald tests are performed on an unrestricted model in which yearly dummy variables are attached to all coordination parameters. The Wald tests concern the significance of these yearly dummies.

The estimated oligopolistic price coordination terms (expected price responses), υ_v^{qk}s (k, q = 1,2; k ≠ q), are reported in tables A4.4.1 and A4.4.2 in Appendix 4.4. The estimates given in table A4.4.1 are obtained by assuming equal conduct among banks in the industry by setting the number of subsets in which banks are divided, s, equal to unity. The estimation results given in table A4.4.2 are derived by using our classification of banks according to their type and closeness of their business operations in commercial banks (v = 1), savings banks (v = 2) and cooperative banks (v = 3). The largest group by number, cooperative banks, is taken as the benchmark group in estimating the equations (4.25b) and (4.25c). The estimates for savings and commercial banks are obtained by adding respective dummy variables to all coordination terms. Hence, the t-values given in table A4.4.2 for the estimated υ_1^{qk}s and υ_2^{qk}s refer to a null-hypothesis whether the coefficients of the respective dummy variables equal zero in case of commercial and savings banks.

All own market price responses, υ_v^{kk}s (k = 1,2) are positive indicating that Finnish banks indeed regard rival banks' offerings as strategic complements in both bank loan and deposit markets when they engage in price competition.[90] Positive response terms correspond to a retaliatory situation in both markets. This means that the results derived from the comparative static exercise presented in section 4.2.3 should provide an appropriate setting to evaluate our behavioral results.

Nearly all cross-market price responses are also positive. They have, thus, equal signs as the own market price response terms. This presents further evidence in favour of a positive cost complementarity in the joint production of loans and deposit services, since, under plausible values for the demand parameters, a positive cost complementarity leads to parallel price responses in both markets (see section 4.2.3.2). This, result does not depend on the absolute magnitude of the cost complementarity, only its sign. This is in line with our estimates of the parameters of banks' cost function (see section 4.5.3). For example, with expected retaliation in the loan market a positive cost complementarity leads to expected positive cross-market response in the deposit market (the estimated υ_v^{21}s are positive). However, as we noted in section 4.2.1, multimarket contact can result in strategic cross-market interdependencies in a repeated game situation even when cost linkages are absent.

[90] Note that the estimated positive values of the $\bar{\varepsilon}^{kk}$s imply the same. (See tables A4.3.1 and A4.3.2).

4.6.1 Average own market price coordination terms

The estimated values of the average own market price coordination terms are all highly significant for each of the four years analyzed. These average terms represent largely the behaviour of the relatively small local banks, since they dominate the sample.

The behavioural patterns differ significantly in both markets. The deposit market is characterized by significantly larger strategic interactions than the loan market as the υ_v^{22}s are averagely (the pooled estimates) 1.54 times larger than the υ_v^{11}s. This indicates that the behaviour in the loan market is significantly more competitive than that in the deposit market. Note that the benchmark for perfect competition equals virtually zero as our sample size is large. Thus, our results suggest that averagely roughly 41 per cent of the monopoly power has been used in the Finnish loan market between 1988 and 1991. The corresponding estimate for the deposit market is around 63 per cent.

If the above values of the coordination terms are inserted in the monopoly pricing formula, in addition to the weighted averages of our price elasticity estimates (see tables A4.3.1 and A4.3.2), the price in the loan market has, on average, been approximately 1.35 times the marginal cost of lending, and in the deposit market approximately 2.33 times the marginal cost of deposit services. The spread between price and marginal cost can be calculated also directly by using only the marginal cost estimates (equation (4.29)) without information about the demand elasticities and price coordination terms. Averagely, over the period from 1988 to 1991, the prices in the loan market appear to have been 1.41 times the marginal costs of lending, and in the deposit market 2.15 times the marginal costs of deposit services. These figures correspond fairly well to the above figures calculated by the monopoly pricing formula, and therefore, to our estimates of the demand elasticities and price coordination terms. This increases our trust in our estimates of the price coordination and elasticity terms.

Our results are broadly in line with Suominen's (1994) results of 4–56 per cent use of monopoly power in the loan market and 18–100 per cent in the deposit market.[91] Suominen uses aggregate time series data of the Finnish deposit banks from September 1986 to December 1989, and bases his analyses on a two-product quantity setting model

[91] 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 that affect the OLS estimates. The use of instrumental variables methods seems however questionable, as Suominen recognizes, as his sample size is quite small.

that incorporates linear demand and marginal cost functions. Suominen's model is a two-product extension of Bresnahan's (1982) test of competition.

Significant consumer switching costs (see Klemperer 1987), particularly on the retail side of the market, has been suggested as an economic explanation to banks' market power in the deposit market. Consumer switching costs represent all costs to banks' customers when they transfer the handling of their financial affairs (account keeping, payment management etc.) to another bank. These costs translate into lower customer mobility and greater possibilities for banks to exert market power (see. e.g. Vives 1991).[92] Another factor contributing to greater market power in the deposit market is presumably a greater degree of local differentiation which makes the deposit market (again the retail side) consist of powerful "local monopolies" (see e.g. Neven 1993). In case of loans, people tend to be more willing to "shop over longer distances" and consult the offerings of competing banks.

The regulatory constraints through the tax exemption rules while banks lending rate setting has been free from explicit regulations during the period of study, are, nevertheless, the major reason for the apparently lower level of price competition in the deposit market. Due to the tax exemption rules, changes in the remuneration rates for the demand and transaction accounts that constitute a bulk of banks' deposits have been regulatory induced as the tax exempt deposit rates have been tied to follow the base rate. This represents a situation of full price coordination: The respective deposit rates at all banks move exactly together. The fact that the estimated price coordination term is lower than unity indicates that some price competition in taxable time and savings deposits has, nevertheless, taken place. The change in the tax exemption rules in 1989 had the effect of opening up a larger share of the taxable time and savings accounts to price competition. Once the new tax exemption rules came into force, banks started to develop new types of taxable deposit accounts very actively.

Note that, inferences about market power based merely on the Herfindahl indices of concentration in loan and deposit markets (see Appendix 2.1) would conflict with our findings. The loan market, which is found more competitive, has been more concentrated in Finland than the deposit market. This illustrates the general problem with using only concentration indices in measuring market power: Other influences may be more significant in actual oligopolistic

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[92] It is not clear, however, why switching costs should be higher in the deposit than in the loan market. There are good arguments in favour of either case.

markets like market contestability (barriers to entry) and demand conditions (see section 1.1.3).

Our estimate of the average own market price response in the loan market increases significantly at less than 1 per cent level in 1991 compared to the 1988–1990 value. The estimated υ_v^{11} rises from around 0.34 per cent in 1989, when the lowest value is obtained, up to around 0.43 per cent indicating a 26 per cent rise in the use of market power. Thus, competition in the bank loan market seems to have significantly eased in 1991 when the profitability of the Finnish deposit banks started to deteriorate. Commercial and savings banks have been showing losses since 1991, and cooperative banks since 1993 (see Koskenkylä and Vesala 1994, table 1). The potential explanations to the observed weakening in competition in the loan market are discussed in the concluding chapter 5.

By contrast, the deposit market seems to have exhibited a quite stable degree of competition. The 1988 estimate is even lower than that for 1991. Hence, the introduction of the withholding tax in 1991 on taxable deposits, which had the effect of opening up further competitive possibilities in the deposit market does not show up as an increase in competition in the deposit market, on average. The introduction of new taxable higher-yielding deposit accounts during the latter part of our study period seems, thus, to have been largely coordinated activity. On the other hand, these deposits can be effectively used in competition, and hence represent a reserve for keen competition, which has the effect of deepening tacit collusion. This is the "topsy-turvy" principle of tacit collusion referred to in section 1.1.2 Unfortunately, we do not have estimates for years after 1991 to test properly the effect of the introduction of the withholding tax on competition in the deposit market.

4.6.2 Average cross-market price coordination terms

Our comparative static results derived in section 4.2.3.2 indicate that the cross-market effects are the larger the more competitive is the initial market, and the smaller the more competitive is the market where the cross-market retaliation takes place (see equations (4.16a) and (4.16b)). The estimated υ_v^{21}s are always substantially larger (2.8 times larger according to the estimates from the pooled data) than the υ_v^{12}s. These results are well in line with the estimated own market effects. The less competitive deposit market is expected to be used more actively for retaliation against the initial price changes in the loan market than the other way around. Although the demand deposit rates have been subject to significant regulation through the tax exemption rules, banks could have used taxable time deposits in competition over customers. Moreover, deposit terms can be apparently used quite extensively in competition. For example, certain amount of payment transfers can be allowed to be done from higher-yielding time or savings accounts, or better salary account terms can be offered to high-income customers. When demand deposit rates are regulated through the tax rules different types of "fringe" benefits or competition on taxable time deposits can be quite rewarding in terms of market share. Therefore, this part of the deposit market could be used in retaliation, and it seems to have served as a reserve to retaliate against competitors.

When conclusions are made in a reversed manner, larger estimated cross-market responses in the deposit market than in the loan market present additional evidence in favour of more intense price competition in the loan market. Further, the significant decrease in υ_v^{21} in 1991 indicates that competition in the loan market has eased. This can, however, be also interpreted as evidence of more competition in the deposit market. Nevertheless, the estimated own market price responses suggest that the former interpretation is more correct.

The fact that the estimated cross-market price responses are significantly different from zero indicates strong strategic interdependencies between the loan and deposit markets. Given the results presented in section 4.2.2.2, these strategic links provide evidence in favour of significant cost interdependencies in the joint production of loans and deposit services. However, the strategic interdependence of the loan and deposit markets can be due to other motives beyond banks' cost structure (revert to section 4.2.1). An additional motive for strong cross-market retaliation is likely the fact that banks' borrowers are commonly tied to keep their transaction deposit accounts (demand deposits, salary accounts) with the bank in question. The relatively large estimates of the υ_v^{21}s could, therefore, indicate that banks expect favourable deposit rates to bring in new borrowers.

In general, ability to exploit (in part due to regulatory protection) deposit customers is typically given as an explanation for more competitive pricing in the loan market. Our results present support in favour of this kind of a behaviour: Banks' borrowers seem to have benefited at the expense of the depositors.

4.6.3 Bank group – specific price coordination terms

Our division of the sample into three subgroups allows us to make inferences about differences in conduct across these groups of banks. The development and the relative sizes of the estimated own and cross-market price response terms are in line with those obtained from the aggregate version of the model: The loan market is always depicted as more competitive than the deposit market, the cross-market effects are always stronger in the deposit market than in the loan market, and the loan market has turned less competitive in 1991 (see the reported Wald test results in table A4.4.2).

Most strikingly, the results suggest significant differences in conduct across the subgroups of banks. Commercial banks were found to behave most competitively in the loan market. The estimates of the υ_v^{11}s and υ_v^{12}s are clearly lowest for commercial banks (v = 1). The coefficients for the dummies whether the above conduct parameters for commercial banks differ from those for the cooperative banks (v = 3) are almost always significant. Moreover, the estimates obtained by using the pooled data set suggest that, on average, approximately 27 per cent of monopoly power has been used by the commercial banks in lending compared to around 44 per cent by the cooperative banks and 68 per cent by the savings banks (v = 2). These estimates are highly significant. The demand elasticity facing the commercial banks in the loan market was found significantly higher in absolute terms than that facing the local banks (see Table A4.3.1). Thus, by the monopoly pricing formula, the price charged by the commercial banks in the loan market has been only 1.07 times the marginal cost of lending compared to the average figure of 1.35 for the whole sample. As in the case of estimated average conduct, commercial banks were found significantly less competitive in 1991 compared to the earlier years with 37 per cent use of monopoly power and roughly 10 per cent premium over marginal cost. Small number of observations, however, lowers the reliability of the results for commercial banks.

More competitive conduct of the commercial banks in the loan market can be explained by the substantially larger share of corporate or commercial loans in their asset portfolios than in those of the local banks who have traditionally focused more on the retail side of the market.[93] This shows up in the estimated differences in the conduct

[93] The average share of corporate loans (including loans to private and public enterprises, and non-bank financial firms) on Finnish commercial banks' balance sheets was 52 per cent between 1989 and 1993, while the corresponding figures for the savings and cooperative banks were 26 and 25 per cent, respectively. These ratios have been quite stable over time. The bulk of the remainder of banks' lending consist of credits to the household sector. (Data source: Bank of Finland)

parameters, since the supplier price for new loans (marginal revenue) from corporate lending is lower than that from retail lending, and the demand elasticity estimate is higher. This originates from the fact that retail customers are less informed and less likely to switch banks than the corporate customers who have a much larger variety of potential sources of funds. Berg and Kim (1993b) have empirically analyzed the differences between corporate and retail bank lending in Norway and interpret their findings of less competition in the retail market by the informational differences on both the demand and supply side of credit. On the demand side, the corporate customers have in general stronger incentives to gather information and compare price offerings of banks making them much better informed than the retail customers. On the supply side, banks are more likely to have exclusive information about their retail customers granting them an absolute advantage in the evaluation of their creditworthiness (see also Stiglitz and Weiss 1988 and Vale 1993). For example, the information gathered in a prior lending decision can be reused when granting another type of loan to the same customer. By contrast, since most corporate customers must make available their financial statements, this kind of a supply side informational asymmetry is less likely to arise in the corporate market. The informational advantages tend to grant banks market power in the pricing of retail loans.

The behaviour of the commercial banks is found to resemble much closer that of the cooperative banks in the deposit market. The estimates of υ_1^{22}s and υ_1^{21}s are not significantly different from those for the cooperative banks. However, the υ_1^{22} estimate from the pooled sample indicates that the commercial banks have expected significantly more retaliation in the deposit market than the cooperative banks. Moreover, now the estimates for commercial and cooperative banks suggest that deposit market competition has slightly increased in 1991. (This change is significant, however, only in case of the cooperative banks).

The behaviour of the savings banks was found to deviate significantly from that of both cooperative banks and commercial banks. The estimated values of all own and cross-market price response terms are always largest in case of the savings banks.

The Akaike's Information Criteria (AIC) reported in tables A4.4.1 and A4.4.2 indicate that the model where the conduct is allowed to differ within the industry always fits the data better than the model containing only terms of average response. Hence, the estimates presented in table A4.4.2 are statistically preferred.

4.7 Summary and conclusions

In this chapter we have characterized oligopolistic behaviour in Finnish bank loan and deposit markets between 1988 and 1991. Our basic finding is that both markets exhibit significant oligopolistic interdependencies: The Finnish deposit banks were found to regard the offerings of their rivals in both markets as strategic complements in a situation of oligopolistic price competition. However, we find that the loan market is characterized by much weaker strategic interdependencies than the deposit market which indicates that the loan market is significantly more competitive. Certain economic reasons can be advanced to explain the lower level of competition in the deposit market. However, the major reason for this observation is undoubtly the more stringent regulatory control through the tax exemption rules that has prevailed in the deposit market. According to our estimates, approximately 41 per cent of monopoly power has been exercised in the loan market, and around 63 per cent in the deposit market, on average over our period of study. This estimated average conduct represents mainly that of small local banks due to the structure of our sample. These figures translate, given our estimates of the demand elasticities, to average 35 per cent and 133 per cent premiums in pricing in the loan and deposit markets, respectively, as compared to marginal costs. Hence, banks' borrowers seem to have benefited from significantly more favourable prices than the depositors.

Our estimations allowed the competitive bahaviour to vary across commercial, savings and cooperative banks. Our results indicate that the commercial banks have behaved much more competitively in the loan market than the local banks. This is most likely due to the fact that the commercial banks have a much larger share of corporate loans in their portfolios than the local banks. Informational asymmetricies between banks and their customers in the retail side of the loan market tend to grant banks market power in their lending rate setting. The average use of monopoly power by the commercial banks was estimated 27 per cent which, due to a significantly higher demand elasticity, corresponds to only 7 per cent average premium over marginal cost. Commercial banks' conduct was also found significantly less competitive in 1991 compared to the earlier years with 37 per cent use of monopoly power and roughly 10 per cent premium over marginal cost.

In general, expected heavy retaliation may constitute an effective barrier to entry, making the deposit market less lucrative for potential entrants. Berg and Kim (1993b) note that the fear of retaliation can explain, in part, why foreign and domestic entrants have traditionally established presence first in the corporate banking market, and usually ignored the retail market altogether.

Our estimates of the cross-market price response terms indicate strong strategic interdependencies between the loan and deposit markets. This provides evidence in favour of cost interdependencies between loans and deposits in their joint production (see section 4.2.2.2). We found a much stronger strategic link from actions in the loan market to the deposit market than the other way around. This suggests that the strategic interdependence between the loan and the deposit market might also arise because banks regard the deposit rates as powerful means to attract new borrowers. This, in light of our comparative static results presented in section 4.2.3.2, provides additional evidence in favour of keener competition in the loan market. In addition, the fact that the own and cross-market responses are found to have equal positive signs, suggests that the sign of the cost complementarity in the production of loans and deposits is positive (see section 4.2.3.2). This was supported also by our tests using independently estimated cost function parameters. The results of these tests were, however, statistically weak.

One of our main results was that we measured a significant fall in the level of competition in the loan market in 1991 when banks' profitability started to deteriorate. This result is in line with our results presented in chapter 2. We will discuss the potential explanations for this shift in chapter 5 that summarizes our empirical results.

We conducted a simultaneous estimation of banks' translog cost function and factor share equations in order to obtain efficient estimates of the cost function parameters and, hence, generate predicted bank-specific marginal costs needed as inputs to the behavioural equations. We used the estimated cost function parameters to evaluate the existence of certain production economies in the production of banking services, as well. The main results of this departure from our main analysis were the following. Scale economies or diseconomies were not found to exist when the output expansion occurs at a given product mix and branch capacity. We could not establish evidence in favour of product-specific scale economies either. In contrast, the output expansion via branches was discovered to exhibit some scale economies indicating that there exist positive "overbranching value" to banks' customers, which allows banks to reduce the price they pay for deposits. A simultaneous change in scale and product mix was detected to feature first expansion path scale diseconomies among middle sized and large local banks in 1989 and 1990, and then economies in 1991. We discussed some implications of these findings for the cost aspects of the mergers among the Finnish local banks in section 4.5.3. Otherwise, our measures of expansion path scale economies were not significantly different from unity.

Against this background, the scale, and incremental and absolute product mix choices are clearly not made based exclusively on their effects on costs. Hence, it seems that mergers and acquisitions do not decrease costs *per se*, and the main motive for these deals is most plausibly the desire to increase market power instead of cost efficiency. However, mergers can be used as a tool to carry out otherwise difficult capacity reductions. In fact, when scale economies are not present, management needs to take specific actions to cut costs and reduce inefficiencies in order to make mergers result in cost savings.

At the end three caveats are worth mentioning. Firstly, the fact that we have estimated the behavioral model in stages weakens the reliability of the statistical tests taken in the final step of the analysis. A simultaneous estimation was not possible given the data available. However, our parameter estimates are relatively stable, which increases the reliability of our results. Secondly, as pointed out by Parker and Röller (1994), the reliability of the final estimates of the oligopolistic coordination terms depends on the reliability of the marginal cost and demand elasticity estimates. We tend to regard mainly the latter estimates as subject to this criticism. The cross-check of the estimated price marginal cost margins, using first only information on demand elasticities and estimated coordination terms and then only price data and the estimated marginal costs, indicates that these estimates are fairly consistent with each other. This strengthens our confidence in the presented results. Finally, one could argue that the smaller the bank is the larger is likely the demand elasticity it faces in absolute terms. Thus, our assumption of equal sized demand elasticities in respective bank groups would not be appropriate. However, small banks operate in small communities, and are thus, not faced by an infinitely large market and horizontal demand. One could make the demand elasticity contingent on banks' overall market share, but this would not be plausible due to the above reason. Local market share would be the appropriate scale factor, but these type of data have not been available to the author, unfortunately.

5 Summary and joint conclusions

In this volume three independent empirical assessments of competition in the Finnish banking industry and respective results have been reported in chapters 2,3 and 4. Modeling strategies and data are quite different in the three analyses although all studies fall into the realm of the new empirical industrial organization (NEIO) studies testing competition and market power in an industry using industry- or firm-specific data. In the introductory chapter 1 we established a number of theoretical and empirical reasons why the NEIO-approach should outperform the traditional structure-conduct-performance (SCP)-approach in empirical analyses of competition. Moreover, there are sound reasons why the SCP-prediction of less competition in more concentrated markets would not necessarily hold and could, therefore, lead to biased conclusions, and perhaps unjustified competition policy decisions. In fact, our evidence of quite keen competition in the Finnish bank loan market, supported in all three assessments in spite of high market concentration, provides evidence against the SCP-paradigm.

We noted in section 1.3 that fierce banking competition may not be optimal from social perspective as it seems to had increased the financial fragility of the banking sector due to excessive risk taking for example at the US Savings and Loans during the 1980s. Intense competition for market share seems to had led to excessive risk taking in lending in Norway, Sweden and Finland, as well, during the late 1980s, which resulted in acute banking crises in these countries. Finding an appropriate balance between competition and stability constitutes thus one of the most fundamental regulatory problems in the banking sector. Regulators should foster efficient competition as far as banks' prudential buffers to absorb negative shocks, e.g. capital adequacy and asset diversification, are not jeopardized. We have not, nevertheless, examined this regulatory balance in more detail. Our research has focused on analyzing the nature of competition, measuring its level and changes over time since the significant liberalization of the Finnish banking industry around the mid 1980s.

We used a simple spatial model in section 1.2 to demonstrate how banks compete when price competition is suppressed by regulations and how deregulation is likely to affect competition in banking. Deregulation should increase price competition if the regulatory constraints on banks' pricing, foremost rate setting, had been binding. This is exactly what we observe in chapter 2 as a significant increase in price competition in the bank loan market is detected after the lifting of the regulations on banks' lending rate setting in 1986. Some international evidence for the pro-competitive effect of deregulation was given in section 1.2, as well.

The model predicts also that banks are induced to compete in service proximity when price competition is restrained by regulations and regulations guarantee an ample interest margin on deposits. This type of quality competition would result in extensive branch and ATM delivery capacities. Regulation is not decisive by itself, but the breadth of the interest margin on deposits. Nevertheless, regulatory protection tends to result in wider margins than those prevailing in effective price competition. Once price competition is liberalized banks would have less incentives to build up delivery capacity, even the contrary, locate apart from other banks in order to gain local market power. Some international and domestic evidence was found to support both more extensive delivery networks in case of ample deposit margins and tight regulation, as well as the predicted effects of deregulation and narrower deposit margins on banks' delivery capacity.

We have approached the subject of our study using different empirical specifications in order to test different hypotheses and the robustness of our results. The results from the three empirical analyses are quite consistent with each other which increases our confidence in our results.

5.1 Price competition in the bank loan market and its evolution over time

In chapters 2 and 3 banks were treated as single-product firms who use deposits and purchased funds as productive inputs in producing financial intermediation services: bank loans (chapters 2 and 3) as well as other interest bearing assets (chapter 2). Therefore, the conclusions about competition presented in these chapters pertain to the Finnish bank loan market in particular. In chapters 2 and 3 the focus was on the analysis of price competition and its evolution over time: in chapter 2 from 1985 to 1992, and in chapter 3 from 1987 to the end of 1993. The first analysis, based on empirical reduced form revenue equations, discriminated between the hypotheses of the data being generated by (local) monopoly, perfect collusion, monopolistic free entry (Chamberlinian), or perfect competition equilibrium behaviour by using bank-specific accounting and balance sheet data. Significant support in favour of the Chamberlinian equilibrium was established, and monopoly and perfectly collusive behaviour were clearly rejected.

According to the estimation results presented in chapter 2, banks' behaviour in the loan market did not deviate significantly from perfect competition in 1989 and 1990. The level of price competition was found considerably lower in 1985–1988, and a subsequent drop was indicated for years 1991 and 1992. These changes were confirmed statistically significant by using panel data. Even larger changes in competition were indicated for the largest banks in the industry.

In chapter 3 we employed a switching regression model based on repeated oligopolistic competition in order to test for the stability of banks' pricing behaviour, or in other words, stability of collusion in the bank loan market over time. An algorithm proposed by Kiefer (1980) was employed to generate a maximum likelihood (ML) estimate of an indicator variable sequence which characterises the regime classification into more collusive and competitive phases. In chapter 3 we used aggregate industry level time series data. The resulting ML regime classification estimates uncovered a significant reversion to more competitive conduct for a period from late 1989 to mid 1990. Hence, this period exhibits a significant change in banks' competitive behaviour. Exact level of oligopolistic coordination measuring the level of price competition could not be identified due to the structure of our model, but it was evident, based on reasonable assumptions regarding the level of price competition in the reversionary phase, that the level of price competition in the bank loan market had been far below the perfectly collusive (monopoly) level. According to our estimates, a less than 10 per cent average price rise had taken place at times when the industry supply relation shifted from the more competitive phase to the more collusive one.

One of our main results from the analysis of chapter 4 was that we measured a significant fall in the level of competition in the bank loan market in 1991, as well. The analysis of chapter 4 was not extended to a period prior to 1988, since the existence of a well functioning money market is required for its proper implementation.

In sum, our results establish quite convincingly that the level of price competition in the loan market had significantly increased after deregulation and subsequently decreased in 1991 and 1992 when banks' profitability started to deteriorate. It seems, therefore, that profitability constrains effectively banks' ability to compete. Still, various other explanations can be proposed to account for this cyclical pattern.

Firstly, deregulation can be interpreted as a shock to the system inducing a new pattern of behaviour. This denotes a shift in competitive parameters of banks from competition in service quality (e.g. the ease of accessibility and technological level) to price competition, which as demonstrated by our spatial model presented in section 1.2 results in less focus on distribution capacity and leads to increased customer mobility, and thus more competitive environment. Deregulation extended also the market for banks' services as it made possible to meet previously unsatisfied loan demand, and, in general, increased the business opportunities of banks. Banks' loan stock increased drastically after the regulations were lifted. This denotes massive "stock-adjustment" on part of banks characterized by an expansion in balance sheets and a higher risk profile of lending. For example, banks became more active in riskier parts of the credit market. These aggressive growth policies appear to have lifted the level of competition. The fall in competition in 1991 could be interpreted as a reversion to a more cooperative regime after a period of adjustment to a new liberalized environment which was characterized by greater customer mobility and keen competition for market share.

Secondly, during the heavy lending growth market share seems to had been substituted for (short term) profitability as banks' primal business objective. Setting growth and market share above the profitability objective can be explained by management preferences which can conflict with the aims of the owners. In this case banks' owners could be blamed for the neglect of proper monitoring of management. The conflict of interest could be one reason for the heating of competition for market share, but there is a deeper question to raise: How can the growth in market share be a benefit to banks? If a bank can achieve higher profits in the future by increasing its market share, this is in the interest of owners, even if profitability suffers in the short run. Banks' customers do not change banks very easily as they are subject to significant switching costs when changing banks and banks strive to bind their customers by contractual means (see e.g. Vives 1991). This also means that the banks *de facto* have some market power over their customers due to the switching costs and tying and that their future prospects depend on their current market share. Deregulation and economic upswing increased the size of the market, so that the competition for market share can be regarded largely as competition for new clients.

The credit expansion was so massive, however, that it hardly can be fully explained by the above argument. Excessive risk taking (moral hazard), shielded by a publicly provided extensive safety net, seems to had played a significant role. Also pressures to enhance capacity utilization (see discussion in sections 1.2 and 2.4) had probably been an additional motive for credit expansion as the capacity created during the period of regulation constituted a burden in the competitive environment of deregulated loan markets. Our results reported in chapter 2 indicate, in terms of the Chamberlinian monopolistic competition model, that the capacity built up in the regulatory era could be regarded, in fact, as overcapacity.

Thirdly, the fall in the level of competition could be interpreted in terms of the supergame models as a reversion to a more collusive equilibrium after a period in which the equilibrium path of the industry has deviated from collusive behaviour. This behavioural pattern gains support from our analysis in chapter 3. Even taken at face value, the price setting behaviour in the loan market, as indicated by the evolution of the lending margin, seems to conform with this price war hypothesis (see Figure A3.1 in Appendix 3). Hence, high demand for credit, prompted by deregulation and a simultaneous boom in the Finnish economy, seems to have triggered a period of more intense competition. Rotemberg and Saloner's (1986) model predicts that colluding oligopolists are likely to behave more competitively in periods of high demand and economic boom. In Finland, GDP growth was greatest in late 1989, i.e. at the time when a reversion to more competitive behaviour was indicated in chapter 3. However, lending growth was already slowing down in 1989 and 1990. Hence, banks seem to have engaged in keenest price competition in the situation of most rapid economic expansion but slowing demand for credit. When demand for bank loans was growing fast in 1987 and 1988 banks had apparently not to price as aggressively, since all banks were faced with ample demand. Bank of Finland placed in March 1989 a supplementary cash reserve requirement for those banks who did not control their lending growth. Certain banks bore the costs of the extra reserves rather than curtailed their lending. Consequently, it seems that banks engaged in the most aggressive pricing in the loan market when they thought that others would slow down their lending, and, thus, rewards in terms of market share would have been greatest. We could not find evidence in favour of the alternative Green and Porter's (1984) model predicting shifts to more competition at times of unanticipated changes in market shares. In sum, economic conditions seem to have been quite decisive for the level of price competition in the loan market, though individual events, like supplementary reserve requirements, did certainly have an impact on the competitive behaviour of banks.

Fourthly, a significant motive to strengthen price coordination is likely to recoup some of the financial losses that Finnish banks started to accumulate in 1991. The bank loan and deposit markets (more specifically, the retail side of these markets) became more lucrative as the money market started to function less well, and raising international funds became more difficult. These factors seem to have increased the importance of the traditional loan granting and deposit taking activities.

Finally, the increased difficulties of numerous banks' customers to meet their loan servicing obligations following the downturn in economic conditions in the early 1990s seem to had resulted in less competition in the loan market as competing banks' desire to take over these clients had naturally reduced. Furthermore, the fall in collateral values diminished the possibilities of households and enterprises to change banks.

The indicated reduction in competition in the early 1990s is bad news from the social perspective. However, now that Finland has joined the Single Market in Europe and the EU we feel that it is reasonable to assume that foreign (potential) competition will constrain the behaviour of the Finnish banks, and that the contestability of the Finnish banking market should increase in the future. There are already strong sings of increased interest among the large Swedish banks to operate quite extensively in Finland.

5.2 Oligopolistic competition in bank loan and deposit markets

In chapter 4 banks were treated as two-product firms competing simultaneously against their rivals in bank loan and deposit markets (multimarket contact). Loans and deposit services, including payment and ancillary services, constitute two most important outputs of banks. Using a two-product structure represents a significant improvement, since a single-or composite-product formulations arguably lead to empirical misspecification of banks' supply relation and thus potential loss of valuable information. Moreover, treating deposits merely as inputs is unsatisfactory, since they consume a bulk of banks' operating resources. In addition, the two-product structure allowed us to measure the level of price competition in both markets separately, and perhaps more interestingly, examine the strategic interdependencies between the two markets. In chapter 4 bank-specific data was used as in chapter 2, but the period of study had to be constrained to 1988–1991 due to reasons detailed in sections 4.1 and 4.5.1.

To facilitate the interpretation of results and check their theoretical consistency, we presented in chapter 4 a model of duopolists producing simultaneously for two different markets. The key results from our comparative static exercise on the duopoly model, given our assumptions presented in section 4.2, were the following:

(1) The sign of cross-market retaliation, i.e. a competitive response of bank's rivals in a market in response to its initial action in the other market, depends on the sign of the cost complementarity, regardless of its absolute magnitude. Under plausible demand function parameter values positive cost complementarity leads to cross-market retaliation. The signs of the cross-market effects are, however, generally ambiguous.

(2) Limit results: (i) In a perfectly competitive market no own or cross-market retaliation takes place (no oligopolistic coordination). (ii) If the other market approaches the perfectly competitive setting and the other is less competitive, retaliatory (accommodative) behaviour on part of competitors becomes stronger in the latter market under positive (negative) cost complementarity. I.e. the less competitive market is used more intensively for retaliation. For example, if the loan market is perfectly competitive increases in deposit costs due to changes in tax rules, for example, will not be passed-through to lending margins.

Our empirical results reported in section 4.6 are well in line with the comparative static predictions of our two-product duopoly model. Both bank loan and deposit markets were found to exhibit significant oligopolistic interdependencies: The Finnish deposit banks were found to regard the offerings of their rivals in both markets as strategic complements in a situation of oligopolistic price competition. However, the strategic interdependencies were found weaker in the loan market than in the deposit market which indicates that the loan market had been significantly more competitive. The major reason for this observation is most plausibly the quite stringent regulatory control that prevailed in the deposit market through the tax exemption rules at the same time when the loan rate setting was free from explicit regulations.

Averagely, over the period of study, the use of monopoly power was estimated 41 per cent in the loan market, and around 63 per cent in the deposit market. These figures translate, given our estimates of the demand elasticities, to average 35 per cent and 133 per cent premiums in pricing in the loan and deposit markets, respectively, as compared to marginal costs. Hence, banks' borrowers seem to have benefited from significantly more favourable prices than the depositors. Commercial banks were found to behave significantly more competitively than the local cooperative and savings banks in the loan market throughout the period of study. This is mainly due to the larger share of more competitively priced corporate loans in commercial banks' loan portfolios.

Our estimates of the cross-market price response terms indicate strong strategic interdependencies between the loan and deposit markets. In light of our comparative static results, the cross-market price response estimates support higher level of price competition in the loan market. Moreover, the regulation-free part of the deposit market (taxable deposits) seems to be the part of the banking market where the most intensive retaliation is expected to take place. I.e. keen competition in this market niche seems to be reserved as a threat to punish competitors' aggressive actions elsewhere. Finally, our cross-market estimates provide evidence in favour of significant cost interdependencies between loans and deposits in their joint production. This was also supported by our tests using independently estimated cost function parameters. The results of these tests were, however, statistically weak.

By-products of our analyses in chapter 4 were the estimates of certain measures of production economies for the Finnish banking industry:

(1) Scale economies or diseconomies were not found to exist when the output expansion occurs at a given product mix and branch capacity. We could not establish evidence in favour of product-specific scale economies either. In contrast, the output expansion via branches was discovered to exhibit some scale economies indicating that there exist a positive "overbranching value" to banks' customers, which allows banks to reduce the price they pay for deposits.

(2) A simultaneous change in scale and product mix was detected to feature first expansion path scale diseconomies among middle sized and large local banks in 1989 and 1990, and then expansion path scale economies in 1991. Otherwise, our measures of expansion path scale economies were not significantly different from unity.

Against this background, the scale, and incremental and absolute product mix choices are clearly not made based on their effects on costs exclusively. Hence, it seems that mergers and acquisitions do not decrease costs *per se*, and the main motive for these deals is most plausibly the desire to increase market power instead of cost efficiency.

To conclude, our research has produced a quite considerable amount of econometric evidence and results on a subject which has been very little studied: the competitive conditions in the Finnish banking industry. What have not been thoroughly addressed are the determinants of the local competitive conditions. Our analyses have been conducted either at the industry-level, or they examine average behaviour within the banking industry, although some separate evidence for the largest banks or different types of banks have been presented in chapters 2 and 4, respectively. We feel that the results presented should provide a good basis for further analyses addressing, for example, the expected changes in the competitive conduct in the Finnish banking industry now that Finland has become a part of the Single Financial Market in Europe.

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Appendix 1

Table A1.1 Income structure: average ratios, per cent of ABST

	Net interest income (Intermediation margin)			Net non-interest income			Net banking income (Overall gross margin)			Net non-interest income/net interest income (%)		
	80–84	85–89	90–92	80–84	85–89	90–92	80–84	85–89	90–92	80–84	85–89	90–92
Belgium	2.82	2.66	2.38	0.64	0.82	0.70	3.46	3.48	3.08	22.79	30.93	29.25
France	4.49	4.16	2.84	0.82	0.76	1.00	5.30	4.92	3.84	18.18	18.42	36.09
Germany	2.94	2.85	2.57	0.66	0.76	0.85	3.61	3.61	3.42	22.61	26.81	33.22
Italy	3.43	3.74	3.98	1.29	1.44	1.28	4.71	5.18	5.26	37.66	38.52	32.25
Netherlands	3.16	3.00	2.27	1.03	1.08	0.92	4.20	4.08	3.18	32.68	36.00	40.43
United Kingdom	4.30	3.83	3.41	1.97	2.19	2.32	6.27	6.02	5.72	46.51	57.44	68.13
EU-6	3.52	3.42	2.94	1.00	1.11	1.15	4.52	4.53	4.09	28.39	32.68	39.21
Finland	2.36	1.89	1.66	2.1-	2.19	1.82	4.51	4.08	3.48	94.14	115.98	114.52
Norway	3.89	3.36	3.29	50.99	1.13	1.09	4.89	4.49	4.38	25.54	33.58	34.04
Sweden	2.64	3.28	3.01	0.92	1.28	1.66	3.56	4.56	4.67	35.07	38.84	56.52
SCANDINAVIA	2.84	2.83	2.58	1.24	1.54	1.38	4.08	4.37	3.95	43.77	54.31	53.53

Notes: ABST = balance sheet total – interbank assets – assets held with central banks
The figures for EU-6 and SCANDINAVIA are obtained by adding together country-specific base information first converted into ECUs.

Data source: OECD Bank Profitability Statistics (see for institutional coverage). The largest possible part of the banking sector in each country has been included.

Table A1.2 Timetable of banking deregulation in Finland

June 1982	Authorized banks were allowed to take part in lending consortia with foreign banks. The share of the financing was limited to 50 per cent for domestic firms and 20 per cent for foreign firms.
September 1985	The Bank of Finland issued new guidelines on the granting of personal loans. Housing loans remained unaffected: first-time buyers were required to provide 25 per cent prior savings, homeowners lest one-third.
January 1986	The Bank of Finland revised its regulations on the banks' average lending rate with effect from the beginning of 1986. The bank lending rate was permitted to exceed the Bank of Finland's base rate by maximum of 1.75 percentage points. The dual interest rate system was introduced in the call money market. A lower rate was paid on deposits than was charged on call money credits.
May 1986	Regulation of bank lending rates was relaxed by raising the upper limit on average interest rate by 0.25 percentage point, i.e. from 9.75 to 9 per cent. Upper limits were placed on the amount of foreign credit intermediated by banks for financing imports.
August 1986	**The Bank of Finland totally abolished the regulation of banks' average lending rates.** **Manufacturing and shipping companies were allowed to raise foreign credits with a maturity of at least five years for financing their own operations either through an authorized bank or a special credit institution or directly from a foreign lender with no quantitative restrictions.**
November 1986	Lending rates applied to short and medium-term loan agreements could be linked to a reference rate reflecting the cost of unregulated short-term funding. Banks were still required to link lending rates on housing loans and other long-term loans (over five years) to the base rate of to charge fixed rates of interest on such loans.
March 1987	The Bank of Finland complemented its system of monetary control by introducing trade with banks in certificates of deposit on an experimental basis, along with term credits and term assets.
May 1987	**The Bank of Finland eased restrictions on the use of money market rates as reference rates.** The Bank began to publish daily 1, 2, 3, 6, 9 and 12-month Helibor money market rates.

August 1987	**The right to raise foreign credits with a maturity of at least five years was extended to include other companies and co-operative societies engaged in business activities, with the exception of financial and insurance institutions and housing and real estate companies.**
October 1987	The savings and cooperative banks were allowed to deal in certificates of deposit with the Bank of Finland, provided the banks met the requirements for trading. The Bank of Finland ceased issuing precise guidelines to the banks concerning prior savings required for housing loans and other personal loans.
January 1988	The Bank of Finland commenced to calculate and publish 3- and 5-year long-term market rates on a monthly basis. Banks were allowed to use these rates as reference rates in their lending (incl. housing loans). The long-term reference rates are based on market rates for taxable, fixed-rate bonds. Banks could use these long-term market rates as reference rates for their new long-term housing loans.
January 1989	The Bank of Finland abolished the financing arrangements for domestic suppliers' credits, new-export credits and short-term export credits.
March 1989	An agreement supplementing the cash reserve agreement between the Bank of Finland and the banks was signed on March 13. It enabled the Bank of Finland to raise the cash reserve requirement to a maximum of 12 per cent. The application of this additional requirement was linked to developments in bank lending.
September 1989	**The minimum credit period for foreign financial credits raised by companies engaged in business was shortened from five yeras to one year.**
January 1990	**The Bank of Finland allowed banks to use their own prime interest rates in borrowing and lending.** The central bank allowed banks to emit their own certificates of deposit, which were tradeable with those emitted by the Bank of Finland.
February 1990	A credit tax of 0.5 % was placed on currency loans.
July 1990	Foreign investments were allowed for households. Local Communities were allowed to raise long-term currency loans for the financing of expenses.

January 1991	**The Bank of Finland abolished the remaining regulation on currency loans, except for loans to households.**
	Repurchase agreements were taken into operation between the central bank and deposit banks. Banks could not use their own certificates of deposit or bonds in these agreements.
September 1991	Bank of Finland decided to take control of Skopbank so as to restore confidence in the bank's activities.
October 1991	Private households were allowed to raise currency-denominated loans.
April 1992	The interest payable on the banks' cash reserve deposits at the Bank of Finland was raised by one percentage point with effect from 1 April. The new rate was the 3-month Helibor less two percentage points, but not less than 8 per cent.
	The law establishing the Government Guarantee Fund was approved by Parliament on 30 April. The purpose of the Fund is to help ensure the stability of deposit banking and secure depositors' claims.
May 1992	The base rate was raised by one percentage point to 9.5 per cent with effect from 1 May. As a result of this decision, the banks are allowed to raise the rate of interest on loans that are tied to the base rate by one percentage point, but the Bank of Finland recommended that the rise should not be applied to rates that are already 12 per cent or more. Owing to an amendment to the law on the tax relief of deposits and bonds, the base-rate rise did not apply to interest rates on tax-exempt deposits.
January 1993	The Bank of Finland raised the banks' cash reserve requirement from 5.0 per cent to 5.5 per cent of the cash reserve base at end-December. The Bank of Finland decided to lower the rate of interest paid on cash reserve deposits as from 1 January. The new interest rate were percentage points below three-month Helibor, however not less than 8 per cent.
February 1993	The base rate was lowered from 8.5 per cent to 7.5 per cent with effect from 15 February. On 23 February, Parliament unanimously approves a resolution requiring the Finnish State to guarantee that Finnish banks meet their commitments under all circumstances. At the same time, Parliament undertook to grant the Government whatever funds and powers might be necessary for this purpose.
March 1993	The internal organization of the Government Guarantee Funds was changed on 11 March. The changes were designed to improve the Fund's prerequisites for providing bank support.

May 1993	The base rate was lowered from 7.5 per cent to 7.0 per cent with effect from 17 May. The maximum annual rate of interest payable on tax-exempt transaction accounts was lowered from 4.5 per cent to 2.5 per cent with effect from 6 May.
June 1993	The Bank of Finland lowered the banks' cash reserve requirement from 4.5 per cent to zero (0) per cent of the cash reserve base at end-May and returned the banks' cash reserve deposits on 1 June 1993.
July 1993	In June, an amendment to the Regulations for the Bank of Finland entered into force providing for a mandatory minimum reserve system. On 30 June, the Bank decided to terminate the existing cash reserve agreement with the banks and replace it by the minimum reserve system. Deposit banks and branches of foreign credit institutions are required to hold 2.0 per cent of their liquid deposits, 1.5 per cent of their other deposits and 1.0 per cent of their other domestic liabilities as non-interest-bearing minimum reserves at the Bank of Finland.
August 1993	The base rate was lowered from 6.5 per cent to 6.0 per cent with effect from 16 August.
December 1993	The base rate was lowered from 6.0 per cent to 5.5 per cent with the effect from 1 December.
February 1994	The base rate was lowered from 5.5 per cent to 5.25 per cent with the effect from 1 February.

Sources: Bank of Finland, Brunila and Takala (1993)

Appendix 2.1

Table A2.1.1 **Finnish deposit banks, 1985–1992. Description of the sample**

	1985	1986	1987	1988	1989	1990	1991	1992
Number of banks								
Total (n)	631	617	605	585	546	496	423	366
Commercial banks[1]	7	6	6	7	8	8	8	7
Savings banks	254	241	230	211	178	150	86	41
Cooperative banks	370	370	369	367	360	338	329	318
3 quartiles[2]	26	21	20	14	16	16	16	6
8 deciles[3]	53	41	38	26	27	25	22	7
9 deciles	184	161	150	108	95	85	67	24
Market shares								
Total deposits								
Savings banks	0.27	0.28	0.28	0.28	0.29	0.26	0.25	0.24
Cooperative banks	0.23	0.23	0.24	0.24	0.24	0.25	0.26	0.27
Commercial banks	0.50	0.49	0.48	0.48	0.47	0.49	0.49	0.49
KOP	0.17	0.18	0.18	0.18	0.17	0.17	0.15	0.17
SYP	0.16	0.18	0.18	0.18	0.18	0.17	0.17	0.17
PSP[4]	0.12	0.11	0.11	0.10	0.10	0.11	0.11	0.11
Total loans								
Savings banks	0.21	0.21	0.23	0.21	0.22	0.20	0.19	0.18
Cooperative banks	0.20	0.21	0.22	0.20	0.18	0.18	0.18	0.19
Commercial banks	0.59	0.58	0.55	0.59	0.60	0.62	0.63	0.63
KOP	0.20	0.20	0.21	0.21	0.21	0.20	0.20	0.20
SYP	0.18	0.21	0.20	0.20	0.19	0.17	0.18	0.19
PSP	0.11	0.11	0.11	0.10	0.09	0.10	0.11	0.12
Herfindahl indices, total assets								
HI_n (all banks)	**0.1195**	**0.1435**	**0.1372**	**0.1118**	**0.1025**	**0.0993**	**0.0941**	**0.1213**
HI_{8d}	0.1860	0.2233	0.2138	0.1743	0.1589	0.1539	0.1456	0.1838
HI_{-8d}	0.0028	0.0031	0.0033	0.0045	0.0052	0.0059	0.0082	0.1076
Herfindahl index, total deposits, HID_n	0.0772	0.0842	0.0826	0.0774	0.0744	0.0699	0.0681	0.1076
Herfindahl index, total loans, HIL_n	0.0992	0.1065	0.1127	0.0995	0.0936	0.0894	0.0915	0.1185
Average market shares, total assets (%)								
All banks	0.16	0.16	0.17	0.17	0.18	0.19	0.23	0.27
8d	1.89	2.44	2.63	3.85	3.70	4.00	4.55	14.28
-8d	0.17	0.17	0.18	0.18	0.19	0.20	0.25	0.27

Notes:
[1] Commercial banks exclude Kansallisluottopankki Oy, MB Osakepankki Oy, OP-Kotipankki Oy and foreign owned banks, since their line of business differs markedly from that of the other deposit banks in our sample.
[2] Number of banks making 75 % of the market with respect to total assets.
[3] Number of banks making 80 % of the market with respect to total assets.
[4] Postipankki (PSP) is consistently included within commercial banks.

Appendix 2.2

Table A2.2.1 Equation (2.25a) for total annual interest revenues (TIR), all banks 1985–1992

Coeff	1985	1986	1987	1988	1989	1990	1991	1992
cnst	3.421**	4.566**	4.771**	2.443**	5.839**	6.779**	4.478**	4.729**
	(3.283)	(4.431)	(4.301)	(2.067)	(4.749)	(5.216)	(3.416)	(3.772)
WAGE	–0.043	–0.148	–0.077	0.039	-0.108	-0.041	-0.088	-0.046
	(–0.272)	(–0.972)	(–0.446)	(0.236)	(-0.594)	(-0.242)	(-0.448)	(-0.225)
DEP	0.059	0.107	0.328	0.001	0.930**	1.237**	0.396	0.519
	(0.223)	(0.444)	(1.432)	(0.001)	(3.513)	(4.026)	(1.414)	(1.786)
FUND	0.165**	0.245**	0.268**	0.154*	0.176*	0.185**	0.268**	0.147*
	(3.820)	(4.769)	(4.304)	(2.126)	(2.336)	(3.309)	(4.218)	(2.527)
H	**0.182**	**0.204**	**0.519**	**0.194**	**0.998****	**1.381****	**0.576**	**0.620**
	(0.575)	(0.709)	(1.850)	(0.611)	(3.185)	(4.140)	(1.712)	(1.670)
F-tests[2]	F^3_{595}	F^3_{580}	F^3_{556}	F^3_{522}	F^3_{532}	F^3_{477}	F^3_{409}	F^3_{403}
	4.906**	7.904**	7.100**	1.554	6.206**	10.16**	7.027**	3.420*
	(0.002)	(0.000)	(0.000)	(0.200)	(0.000)	(0.000)	(0.000)	(0.018)
EQUITY	0.053**	0.048**	0.044**	0.053**	0.041**	0.032**	0.009	0.062**
	(8.632)	(7.841)	(7.068)	(7.762)	(6.054)	(4.149)	(0.856)	(4.903)
FIXA	0.604**	0.612**	0.613**	0.598**	0.604**	0.611**	0.612**	0.555**
	(40.57)	(41.41)	(40.95)	(38.23)	(37.51)	(37.20)	(37.01)	(29.21)
CDUE	0.058	0.209**	0.141	0.056	0.135	0.187*	0.163*	0.200**
	(0.705)	(2.625)	(1.661)	(0.652)	(1.715)	(2.100)	(2.294)	(2.840)
COMML	–0.035	–0.044	–0.016	0.023	–0.049	–0.064	–0.118*	–0.128*
	(–0.806)	(–1.017)	(–0.381)	(0.501)	(–1.019)	(–1.259)	(–2.046)	(–2.151)
BSIZE	-0.117**	-0.099**	–0.123**	–0.180**	–0.188**	–0.152**	–0.178**	–0.160**
	(-3.758)	(–3.126)	(–3.738)	(–5.197)	(–5.158)	(–3.927)	(–4.280)	(–3.993)
DCB	1.110**	0.805**	1.097**	1.252**	1.235**	1.267**	1.286**	1.436**
	(4.557)	(3.058)	(3.662)	(4.697)	(4.582)	(5.614)	(6.180)	(6.671)
Centered R^2	0.873	0.873	0.879	0.882	0.880	0.900	0.906	0.901
Adj. R^2	0.871	0.871	0.877	0.880	0.878	0.888	0.904	0.898
Breusch-Pagan[3]	$\chi^2(3)$	$\chi^2(3)$	$\chi^2(3)$	$\chi^2(3)$	$\chi^2(3)$	$\chi^2(3)$	$\chi^2(3)$	$\chi^2(3)$
	2.005	2.698	1.042	1.037	0.114	0.513	1.257	1.740
	(0.571)	(0.441)	(0.791)	(0.792)	(0.990)	(0.916)	(0.739)	(0.628)
SEE	0.401	0.402	0.407	0.427	0.454	0.434	0.440	0.417
Number of obs	630	616	604	583	545	504	427	366

Notes: t-statistics of the parameter estimates are given in parentheses. * denotes a coefficient estimate significant at 5 %, and ** 1 % level respectively

[2] H_0: the coefficients of the factor price variables are zero. Significance levels in parentheses.

[3] Breusch-Pagan tests H_0 of homoscedastic error terms. Significance levels in parentheses.

Table A2.2.2 **Equation (2.25a) for total annual interest revenues from outstanding loans to public (TIRL), all banks 1985–1992**

Coeff	1985	1986	1987	1988	1989	1990	1991	1992
cnst	2.685* (2.555)	3.847** (3.680)	4.119** (3.676)	2.025 (1.698)	6.674** (5.149)	6.476** (4.924)	3.064* (2.257)	2.929* (2.263)
WAGE	–0.032 (–0.202)	–0.156 (–0.965)	–0.095 (–0.546)	0.033 (0.196)	–0.063 (–0.330)	–0.071 (–0.412)	–0.035 (–0.172)	0.028 (0.135)
DEP	0.034 (0.127)	0.055 (0.225)	0.261 (1.126)	–0.020 (–0.078)	1.318** (4.723)	1.232** (3.960)	0.167 (0.575)	0.133 (0.444)
FUND	0.188** (4.308)	0.272** (5.219)	0.302** (4.795)	0.190** (2.603)	0.205* (2.573)	0.244** (4.306)	0.310** (4.721)	0.202** (3.365)
H	**0.190** (0.595)	**0.171** (0.586)	**0.468** (1.647)	**0.203** (0.633)	**1.460**** (4.419)	**1.405**** (4.160)	**0.442** (1.269)	**0.363** (0.948)
F-tests[2]	F^3_{595} 6.272** (0.000)	F^3_{580} 9.315** (0.000)	F^3_{556} 8.322** (0.000)	F^3_{522} 2.324 (0.074)	F^3_{532} 10.06** (0.000)	F^3_{477} 12.81** (0.000)	F^3_{409} 7.749** (0.000)	F^3_{403} 3.893** (0.009)
EQUITY	0.057** (9.222)	0.055** (8.804)	0.049** (7.671)	0.055** (8.004)	0.045** (6.263)	0.036** (4.657)	0.014 (1.351)	0.070** (5.393)
FIXA	0.603** (40.18)	0.610** (40.70)	0.616** (40.64)	0.598** (37.86)	0.602** (35.42)	0.612** (36.84)	0.636** (36.62)	0.572** (29.16)
CDUE	–0.215* (–2.559)	–0.090 (–1.110)	–0.112 (–1.305)	–0.157 (–1.833)	–0.025 (–0.297)	0.004 (0.040)	0.002 (0.029)	0.021 (0.287)
COMML	–0.011 (–0.255)	–0.016 (–0.357)	0.005 (0.115)	0.048 (1.055)	0.002 (0.043)	–0.030 (–0.581)	–0.109 (–1.821)	–0.086 (–1.400)
BSIZE	–0.125** (–3.991)	–0.103** (–3.221)	–0.126** (–3.825)	–0.180** (–5.284)	–0.181** (–4.690)	–0.166** (–4.231)	–0.181** (–4.201)	–0.156** (–3.774)
DCB	1.103** (4.491)	0.829** (3.104)	1.093** (3.606)	1.060** (3.939)	1.004** (3.533)	1.104** (4.833)	0.691** (3.208)	0.774** (3.483)
Centered R^2	0.872	0.871	0.877	0.878	0.866	0.888	0.899	0.894
Adj. R^2	0.870	0.869	0.875	0.876	0.864	0.886	0.897	0.891
Breusch-Pagan[3]	$\chi^2(3)$ 2.896 (0.408)	$\chi^2(3)$ 2.446 (0.485)	$\chi^2(3)$ 0.218 (0.974)	$\chi^2(3)$ 0.742 (0.863)	$\chi^2(3)$ 0.356 (0.949)	$\chi^2(3)$ 1.004 (0.800)	$\chi^2(3)$ 0.124 (0.989)	$\chi^2(3)$ 0.514 (0.916)
SEE	0.404	0.408	0.412	0.431	0.479	0.439	0.456	0.431
Number of obs	630	616	604	583	545	504	427	366

Notes: t-statistics of the parameter estimates are given in parentheses. * denotes a coefficient estimate significant at 5 %, and ** 1 % level respectively
[2] H_0: the coefficients of the factor price variables are zero. Significance levels in parentheses.
[3] Breusch-Pagan tests H_0 of homoscedastic error terms. Significance levels in parentheses.

Appendix 2.3

Aggregation of individual cross-sections

A2.3.1 Pooled data of all banks 1985–1992

The pooling procedure presumes constant parameter values across different cross-sections. In order to test for the validity of pooling and to find an appropriate pattern of aggregation we conducted a two step aggregation test procedure. First we estimated the following revenue equation that includes both intercept and multiplicative dummies for each of the regressors for each of the yearly cross-sections:

$$\begin{aligned} \ln R_i^*(W_i, A_i, K_i) &= j_0 + \sum_{yr=1}^{7} D_{yr} + \sum_{k=1}^{m} h_k \ln w_{k_i} + \sum_{yr=1}^{7}\sum_{k=1}^{m} D_{yr} h_k \ln w_{k_i} + \\ &+ \sum_{j=1} j_{2_j} \ln a_i + \sum_{yr=1}^{7}\sum_{j=1} D_{yr} j_{2_j} \ln a_i + \sum_{p=1} j_{3_p} \ln k_i + \sum_{yr=1}^{7}\sum_{p=1} D_{yr} j_{3_p} \ln k_k + \varepsilon_i, \end{aligned} \qquad \text{(A2.3.1)}$$

where the values of yr from 1 to 7 represent years from 1986 to 1992 respectively. The estimation results admit first-level aggregation: Aggregation of a particular regressor in the pooling procedure is allowed if significant breaks in parameter estimates are not indicated for none of the individual cross-sections by t-values, or by F-statistics in case of joint estimates of factor price elasticities. We do not report the specific results from estimating the equation (A2.3.1) (it contains 71 regressors).[1] In stead, the equation (A2.3.2) depicts the functional form that passed the above first-level aggregation test in terms of the actual regressors used in our estimations. The resulting form turned out to be the same for both revenue specifications, TIR and TIRL.

[1] The fit of the equation (A2.3.1) for both of the revenue specifications, TIR and TIRL, was good in terms of the adjusted R^2, 0.890 and 0.885, respectively. Neither of them suffered from heteroscedasticity: The significance levels of the Breusch-Pagan test statistics were 0.991 and 0.344, respectively. Number of observations was 4295.

$$
\begin{aligned}
TIR_i\ (TIRL_i) = & \ cnst + h_1 WAGE_i + h_2 DEP_i + h_3 FUND_i \\
& + \sum_{yr=1}^{7} D_{yr} h_1 WAGE_i + \sum_{yr=1}^{7} D_{yr} h_2 DEP_i \\
& + \sum_{yr=1}^{7} D_{yr} h_3 FUND_i + j_1 EQUITY_i \\
& + \sum_{yr=1}^{7} D_{yr} j_1 EQUITY_i + j_2 FIXA_i + j_3 CDUE_i \\
& + j_4 COMML_i + \sum_{yr=1}^{7} D_{yr} j_4 COMML_i \\
& + j_5 BSIZE_i + j_6 DCB + \varepsilon_i
\end{aligned}
\qquad (A2.3.2)
$$

The second-level aggregation test consists of estimating first the equation (A2.3.2) and then imposing step-wise increasing aggregation and continuing as far as is allowed by test statistics indicating the significance of a break in parameter values as compared to the benchmark period. We pertained to contrasting years in sequence, which has the greatest economic meaning. I.e. we traced out the path of the parameter estimates over time. Thus, we tested only a small fraction of possible combinations of benchmark cross-sections and aggregation patterns if one allows any arbitrary combination.[2] Tables A2.3.1a and b below present the results of the second-level aggregation test procedure. The first sets of rows in the tables represent the equation (A2.3.2) and the last the largest amount of aggregation allowed. The framed rows constitute the most preferred models applied in estimations using the pooled data set.

A2.3.2 Pooled data of the largest banks, 1985–1992

We conducted an identical aggregation test procedure also for the subsample of the largest banks that make 80 % of the market in terms of total assets. Equation (A2.3.3) represents the functional form that passed the first level aggregation test.

[2] Even if we require that the benchmarks contain 1–8 successive individual cross-sections $(1+2^2+3^2+4^2+5^2+6^2+7^2+8) + 4*2! + 13*3! + 4*4! + 10*5! + 6*6! = 5790$ different combinations to be tested result. If we drop the requirement of aggregating only neighbouring cross-sections the number of possible combinations increases sky high.

$$
\begin{aligned}
TIR_i\ (TIRL_i) = {} & cnst + h_1 WAGE_i + h_2 DEP_i + h_3 FUND_i \\
& + \sum_{yr=1}^{7} D_{yr} h_1 WAGE_i + \sum_{yr=1}^{7} D_{yr} h_2 DEP_i \\
& + \sum_{yr=1}^{7} D_{yr} h_3 FUND_i + j_1 EQUITY_i \\
& + \sum_{yr=1}^{7} D_{yr} j_1 EQUITY_i + j_2 FIXA_i \\
& + j_3 CDUE_i + \sum_{yr=1}^{7} D_{yr} j_3 CDUE_i \\
& + j_4 COMML_i + j_5 BSIZE_i + j_6 DCB + \varepsilon_i
\end{aligned}
\qquad (A2.3.3)
$$

The resulted model is otherwise the same as that for the whole sample, but the coefficient of COMML was found stable across the individual cross-sections while significant breaks in the parameter estimates of CDUE were detected. (In case of the whole sample this was the other way around).

Tables A2.3.2a and A2.3.2b report the results of the second-level aggregation test procedure in the way explained above.

Table A2.3.1a **Second-level aggregation tests.**
TIR specification for all banks.
(Benchmark year(s) shaded)

coeff	test[1]	1985	1986	1987	1988	1989	1990	1991	1992
$D_{yr}W$	F(3, 4234)	12.59** (0.00)	0.31 (0.82)	0.92 (0.43)	1.17 (0.32)	1.98 (0.11)	3.71* (0.01)	2.28 (0.08)	1.18 (0.32)
$D_{yr}EQUITY$ $D_{yr}COMML$	t t	8.02** −0.49	−0.51 −0.20	−0.63 0.26	0.17 0.79	−0.49 0.42	−1.54 −0.53	−3.14** −1.53	−0.47 −2.04*
			A[2]	A	A	A	D	D	D
$D_{yr}W$	F(3, 4239)		24.1** (0.00)	0.95 (0.42)	1.55 (0.20)	2.96* (0.03)	5.68** (0.00)	2.69* (0.04)	1.48 (0.22)
$D_{yr}EQUITY$ $D_{yr}COMML$	t t		10.9** −0.86	−0.47 0.42	0.47 0.97	−0.32 −0.39	−1.50 −0.52	−3.21** −1.62	0.70 −2.17*
				A	A	D	D	D	D
$D_{yr}W$	F(3, 4244)			32.2** (0.00)	1.23 (0.30)	2.81* (0.04)	5.48** (0.00)	2.29 (0.08)	1.97 (0.12)
$D_{yr}EQUITY$ $D_{yr}COMML$	t t			13.0** −0.82	0.64 0.89	−0.18 −0.55	−1.45 −0.68	−3.22** −1.82	0.79 −2.38*
					A	D	D	D	D
$D_{yr}W$	F(3, 4249)				36.7** (0.00)	1.79 (0.15)	3.94** (0.01)	1.44 (0.23)	2.28 (0.08)
$D_{yr}EQUITY$ $D_{yr}COMML$	t t				15.42** −2.01*	−0.42 −0.13	−1.69 −0.27	−3.46** −1.49	0.65 −2.11*
						(D)	D	D	D
$D_{yr}W$	F(3, 4249)		1.79 (0.15)			15.4** (0.00)	0.32 (0.81)	0.87 (0.45)	3.26* (0.02)
$D_{yr}EQUITY$ $D_{yr}COMML$	t t		0.42 0.12			7.10** −1.10	−1.03 −0.12	−2.68** −1.16	0.82 −1.71
			(D)				A	D	D
$D_{yr}W$	F(3, 4254)		3.95** (0.01)				33.9** (0.00)	0.96 (0.40)	4.84** (0.00)
$D_{yr}EQUITY$ $D_{yr}COMML$	t t		1.44 0.24				8.64** −1.60	−2.44* −1.24	1.31 −1.85
			D[3]					D	D
$D_{yr}W$	F(3, 4254)		1.45 (0.23)			0.96 (0.41)		18.9** (0.00)	3.96** (0.01)
$D_{yr}EQUITY$ $D_{yr}COMML$	t t		3.46** 1.50			2.44** 1.24		2.44* −2.36*	2.85** −0.54
			D[3]			D[4]			D

Table A2.3.1b **Second-level aggregation tests.**
TIRL specification for all banks.
(Benchmark year(s) shaded)

coeff	test[1]	1985	1986	1987	1988	1989	1990	1991	1992
$D_{yr}W$	F(3, 4234)	13.2** (0.00)	0.49 (0.69)	0.98 (0.40)	1.16 (0.32)	3.19* (0.02)	3.17* (0.02)	2.06 (0.10)	0.48 (0.70)
$D_{yr}EQUITY$ $D_{yr}COMML$	t t	8.81** 0.18	−0.45 −0.15	−0.77 0.13	−0.18 0.57	−0.69 −0.23	−1.68 −0.43	−3.30** −1.65	0.39 −1.45
			A[2]	A	A	D	D	D	A
$D_{yr}W$	F(3, 4239)		26.0** (0.00)	1.00 (0.39)	1.59 (0.19)	5.30** (0.00)	5.14** (0.00)	2.33 (0.07)	0.69 (0.56)
$D_{yr}EQUITY$ $D_{yr}COMML$	t t		11.1** 0.15	−0.66 0.25	0.03 0.75	−0.58 −0.19	−1.70 −0.43	−3.41** −1.79	0.60 −1.54
				A	A	D	D	D	A
$D_{yr}W$	F(3, 4244)			33.8** (0.00)	1.38 (0.25)	5.64** (0.00)	5.25** (0.00)	2.10 (0.10)	0.96 (0.41)
$D_{yr}EQUITY$ $D_{yr}COMML$	t t			14.9** 0.21	0.23 0.64	−0.38 −0.19	−1.47 −0.39	−2.78** −1.73	0.60 −1.48
					A	D	D	D	A
$D_{yr}W$	F(3, 4249)				40.3** (0.00)	4.09** (0.01)	3.53* (0.01)	1.23 (0.30)	1.46 (0.22)
$D_{yr}EQUITY$ $D_{yr}COMML$	t t				16.69** −1.20	−0.55 0.38	−1.76 0.12	−3.57** −1.41	0.62 −1.21
						D	D	D	A
$D_{yr}W$			4.09* (0.01)			15.3** (0.00)	0.31 (0.82)	2.51 (0.06)	4.97** (0.00)
$_{yr}EQUITY$ $D_{yr}COMML$	t t		0.55 −0.40			7.58** −0.14	−0.98 −0.20	−2.69** −1.45	0.87 −1.29
			D[3]				A	A	A
$D_{yr}W$	F(3, 4254)		4.14* (0.01)				31.0** (0.00)	1.61 (0.19)	4.92** (0.00)
$D_{yr}EQUITY$ $D_{yr}COMML$	t t		1.64 −0.40				9.22** −0.29	−2.42* −1.56	1.38 −1.39
			D[3]					D	D
$D_{yr}W$	F(3, 4254)		1.27 (0.28)			1.61 (0.19)		18.7** (0.00)	3.08* (0.03)
$D_{yr}EQUITY$ $D_{yr}COMML$	t t		3.56** 1.42			2.42* 1.56		2.24* −1.96*	2.90** 0.09
			D[3]			D[4]			D

Notes (tables A2.3.1.a and b): All money variables are given in fixed 1985 prices.

[1] H_0: The coefficients of the D_{yr} times the respective regressors are zero. Significance levels in parentheses.

[2] A = aggregation with the benchmark year(s) accepted. D = aggregation rejected

[3] Years 1985–1988 aggregated (as allowed by the test statistics).

[4] Years 1989–1990 aggregated (as allowed by the test statistics).

Table A2.3.2a **Second-level aggregation tests. TIR specification for the largest banks.**

(Benchmark year(s) shaded)

coeff	test[1]	1985	1986	1987	1988	1989	1990	1991	1992
$D_{yr}W$	F(3, 197)	1.49 (0.22)	0.70 (0.55)	0.64 (0.59)	1.57 (0.20)	3.48* (0.02)	7.61** (0.00)	7.11** (0.00)	0.99 (0.40)
$D_{yr}EQUITY$	t	2.11*	–0.93	0.17	–0.32	–1.70	–2.65**	–2.55*	0.74
$D_{yr}CDUE$	t	–1.38	0.88	0.99	1.75	2.63**	3.05**	3.41**	2.60*
			A[2]	A	A	D	D	D	D
$D_{yr}W$	F(3, 202)		1.74 (0.16)	0.34 (0.79)	1.42 (0.24)	3.49* (0.02)	10.12** (0.00)	9.70** (0.00)	1.41 (0.24)
$D_{yr}EQUITY$	t		1.99*	0.55	–0.03	–1.55	–2.56*	–2.44*	1.00
$D_{yr}CDUE$	t		–1.31	0.67	1.70	2.81**	3.43**	3.83**	2.78**
				A	A	D	D	D	D
$D_{yr}W$	F(3, 207)			1.00 (0.39)	0.99 (0.40)	3.15* (0.03)	10.17** (0.00)	9.94** (0.00)	1.36 (0.25)
$D_{yr}EQUITY$	t			2.51*	–0.09	–1.56	–2.66**	–2.55*	0.99
$D_{yr}CDUE$	t			–0.80	1.22	2.51*	3.18**	3.64**	2.39*
					A	D	D	D	D
$D_{yr}W$	F(3, 212)				0.34 (0.80)	2.38 (0.07)	8.65** (0.00)	8.48** (0.00)	0.98 (0.40)
$D_{yr}EQUITY$	t				2.62**	–1.47	–2.63**	–2.57*	0.95
$D_{yr}CDUE$	t				–0.50	2.02*	2.67**	3.16**	1.76
						D	D	D	A
$D_{yr}W$	F(3, 212)		2.38 (0.07)			1.44 (0.23)	0.75 (0.52)	0.78 (0.51)	1.27 (0.28)
$D_{yr}EQUITY$	t		1.47			–0.79	–0.01	–0.22	1.82
$D_{yr}CDUE$	t		–2.02*			1.58	0.432	0.99	–0.09
			D[3]				A	A	A
$D_{yr}W$	F(3, 217)		9.43** (0.00)				1.88 (0.13)	0.31 (0.82)	1.67 (0.17)
$D_{yr}EQUITY$	t		2.64**				–1.31	–0.61	2.28
$D_{yr}CDUE$	t		–2.95**				2.32*	1.02	–0.25
			D[3]					A	A
$D_{yr}W$	F(3, 222)		13.3** (0.00)					2.77* (0.04)	1.94 (0.12)
$D_{yr}EQUITY$	t		3.29**					–1.79	2.50*
$D_{yr}CDUE$	t		–3.79**					–3.11**	–0.53
			D[3]						D

Table A2.3.2b **Second-level aggregation tests.**
TIRL specification for the largest banks.
(Benchmark year(s) shaded)

coeff	test[1]	1985	1986	1987	1988	1989	1990	1991	1992
$D_{yr}W$	F(3, 197)	0.83 (0.48)	0.88 (0.45)	0.31 (0.82)	0.86 (0.45)	2.03 (0.11)	6.48^{**} (0.00)	5.79^{**} (0.00)	2.34 (0.12)
$D_{yr}EQUITY$ $D_{yr}CDUE$	t t	2.39^{*} −1.89	−0.55 0.67	0.55 0.60	−0.04 1.12	−1.26 1.93	-2.20^{*} 2.64^{**}	-2.37^{*} 3.28^{**}	0.28 2.34^{*}
			A[2]	A	A	A	D	D	D
$D_{yr}W$	F(3, 202)		0.57 (0.64)	0.25 (0.86)	1.25 (0.29)	2.68^{*} (0.05)	10.19^{**} (0.00)	9.04^{**} (0.00)	3.22^{*} (0.02)
$D_{yr}EQUITY$ $D_{yr}CDUE$	t t		2.72^{**} -2.65^{**}	0.71 0.74	0.05. 1.49	−1.26 2.51^{*}	-2.35^{*} 3.54^{**}	-2.46^{*} 4.27^{**}	0.33 3.12^{**}
				A	A	D	D	D	D
$D_{yr}W$	F(3, 207)			0.21 (0.89)	0.91 (0.44)	2.47 (0.06)	10.47^{**} (0.00)	9.51^{**} (0.00)	2.99^{*} (0.03)
$D_{yr}EQUITY$ $D_{yr}CDUE$	t t			3.45^{**} -2.36^{*}	−0.04 1.00	−1.30 2.15^{*}	-2.47^{*} 3.33^{**}	-2.56^{*} 4.16^{**}	0.31 2.82^{**}
					A	D	D	D	D
$D_{yr}W$	F(3, 212)				0.61 (0.61)	1.94 (0.12)	9.36^{**} (0.00)	8.50^{**} (0.00)	2.46 (0.06)
$D_{yr}EQUITY$ $D_{yr}CDUE$	t t				3.67^{**} -2.34^{*}	−1.22 1.76	-2.46^{*} 2.95^{**}	-2.59^{*} 3.83^{**}	0.27 2.34^{*}
						(D)	D	D	A
$D_{yr}W$	F(3, 212)		1.94 (0.12)			1.63 (0.18)	0.69 (0.56)	0.76 (0.52)	0.55 (0.65)
$D_{yr}EQUITY$ $D_{yr}CDUE$	t t		1.21 −1.76			−0.26 0.06	−0.15 0.87	−0.45 1.74	1.15 0.58
			(D[3])				A	A	A
$D_{yr}W$	F(3, 217)		9.73^{**} (0.00)				2.41 (0.07)	0.53 (0.66)	1.56 (0.20)
$D_{yr}EQUITY$ $D_{yr}CDUE$	t t		2.46^{**} -2.93^{**}				−0.53 0.47	−0.75 1.68	1.53 0.31
			D[3]					A	A

coeff	test[1]	1985	1986	1987	1988	1989	1990	1991	1992
$D_{yr}W$	F(3, 222)		13.5** (0.00)					2.86* (0.04)	1.43 (0.23)
$D_{yr}EQUITY$ $D_{yr}CDUE$	t t		3.15** −4.16**					−0.96 1.42	1.76 −0.95
			D[3]						A
$D_{yr}W$	F(3, 222)		15.1** (0.00)						2.77* (0.04)
$D_{yr}EQUITY$ $D_{yr}CDUE$	t t		3.49** −4.97**						−1.23 1.73
			D[3]						D

Notes (tables A2.3.2a and b): All money variables are given in fixed 1985 prices.

[1] H_0: The coefficients of the D_{yr} times the respective regressors are zero. Significance levels in parentheses.

[2] A = aggregation with the benchmark year(s) accepted. D = aggregation rejected

[3] Years 1985–1988 aggregated (as allowed by the test statistics).

Table A2.3.3 **Equation (2.25b) for pooled cross-sections. All banks 1985–1992**

Coefficient	TIR	TIRL
constant	4.198** (14.09)	3.362** (10.99)
WAGE	0.194* (2.502)	0.252** (3.152)
DEP	0.679** (6.293)	0.618** (5.571)
FUND	0.205** (5.225)	0.228** (5.652)
H	**1.079**** (6.820)	**1.097**** (6.753)
F-tests (H_0: exclude W, signif. level)	F^3_{4254} 33.876** (0.000)	F^3_{4254} 30.98** (0.000)
D_1 x WAGE	–0.251** (–3.400)	–0.253** (–3.331)
D_1 x DEP	–0.356** (–2.912)	–0.342** (–2.721)
D_1 x FUND	0.004 (0.085)	0.015 (0.032)
H_1	**0.476**** (4.332)	**0.518**** (4.591)
F-tests (H_0: exclude D_1 x W, signif. level)	F^3_{4254} 3.948** (0.008)	F^3_{4254} 4.144** (0.006)
D_2 x WAGE	–0.132 (–1.158)	–0.175 (–1.494)
D_2 x DEP	–0.277 (–1.285)	–0.323 (–1.508)
D_2 x FUND	0.092 (1.386)	0.115 (1.681)
H_2	**0.772**** (2.893)	**0.715**** (2.609)
F-tests (H_0: exclude D_2 x W, signif. level)	F^3_{4254} 0.964 (0.409)	F^3_{4254} 1.607 (0.185)
D_3 x WAGE	–0.340* (–2.485)	–0.437** (–3.111)
D_3 x DEP	–0.283 (–1.203)	–0.496* (–2.052)
D_3 x FUND	–0.097 (–1.430)	–0.054 (–0.772)
H_3	**0.359** (1.088)	**0.110** (0.326)
F-tests (H_0: exclude D_3 x W, signif. level)	F^3_{4254} 4.837** (0.002)	F^3_{4254} 4.921** (0.002)

Table A2.3.3 (cont'd)

Coefficient	TIR	TIRL
EQUITY	0.379**	0.041**
	(8.644)	(9.220)
D_1 x EQUITY	0.007	0.009
	(1.437)	(1.643)
D_2 x EQUITY	−0.022*	−0.023*
	(−2.439)	(−2.419)
D_3 x EQUITY	0.014	0.015
	(1.300)	(1.376)
FIXA	0.603**	0.610
	(111.20)	(109.59)
CDUE	0.173**	−0.004
	(6.670)	(−0.143)
COMML	−0.051	−0.009
	(−1.602)	(−0.290)
D_1 x COMML	0.009	−0.156
	(0.240)	(−0.405)
D_2 x COMML	−0.078	−0.101
	(−1.244)	(−1.558)
D_3 x COMML	−0.122	−0.093
	(−1.874)	(−1.387)
BSIZE	−0.155**	−0.159**
	(−12.71)	(−12.69)
DCB	1.144**	0.767**
	(13.906)	(9.072)
Centered R^2	0.890	0.884
Adj. R^2	0.889	0.883
Breusch-Pagan (signif. level)	$\chi^2(3)$ 6.782 (0.079)	$\chi^2(3)$ 11.659 (0.010)
SEE	0.425	0.436
Number of observations	4290	4290

Notes: All money variables given by fixed 1985 prices.

D_1 = 1 for 1985–1988
= 0 otherwise
D_2 = 1 for 1991
= 0 otherwise
D_3 = 1 for 1992
= 0 otherwise

Table A2.3.4 **Equation (2.25c) for pooled cross-sections. Largest banks 1985–1992**

Coefficient	TIR	TIRL
constant	2.426* (2.098)	0.604 (0.502)
WAGE	0.325* (1.475)	0.541* (2.447)
DEP	–0.116 (–0.363)	–0.311 (–1.115)
FUND	0.583* (2.094)	0.414 (1.688)
H	**0.792*** (2.234)	**0.644*** (1.956)
F-tests (H_0: exclude W, signif. level)	F^3_{222} 2.767* (0.043)	F^3_{222} 3.260* (0.022)
D_1 x WAGE	–0.405* (–2.329)	–0.287* (–1.651)
D_1 x DEP	0.067 (0.189)	0.221 (0.676)
D_1 x FUND	–0.474 (–1.593)	–0.390 (–1.748)
$\mathbf{H_1}$	**–0.021** (–0.061)	**0.187** (0.528)
F-tests (H_0: exclude D_1 x W, signif. level)	F^3_{222} 13.35** (0.000)	F^3_{222} 15.06** (0.000)
D_2 x WAGE	–0.011 (–0.033)	
D_2 x DEP	0.234 (0.385)	
D_2 x FUND	0.048 (0.100)	
$\mathbf{H_2}$	**1.062** (1.247)	
F-tests (H_0: exclude D_2 x W, signif. level)	F^3_{222} 1.940 (0.124)	

Table A2.3.4 (cont'd)

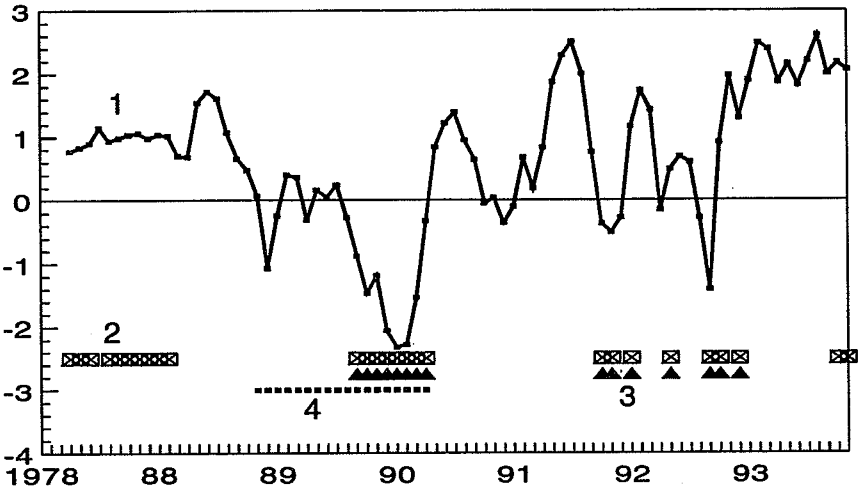
Coefficient	TIR	TIRL
EQUITY	−0.022 (−1.786)	−0.014 (−0.970)
D_1 x EQUITY	0.044** (3.286)	0.045** (3.494)
D_2 x EQUITY	0.070* (2.503)	
FIXA	0.686** (35.95)	0.738** (37.94)
CDUE	0.169** (3.115)	0.096 (1.734)
D_1 x CDUE	−0.204** (−3.793)	−0.257** (−4.977)
D_2 x CDUE	−0.036 (−0.533)	
COMML	−0.182** (−3.339)	−0.097 (−1.748)
BSIZE	−0.109** (−3.085)	−0.036 (−0.970)
DCB	0.954** (9.709)	0.631** (6.157)
Centered R^2	0.963	0.948
Adj. R^2	0.959	0.945
Breusch-Pagan (signif. level)	$\chi^2(3)$ 1.940 (0.124)	$\chi^2(3)$ 0.734 (0.865)
SEE	0.303	0.321
Number of observations	259	259

Notes: All money variables given by fixed 1985 prices. Largest banks are those making 80% of the market in terms of total assets.

D_1 = 1 for 1985–1988
= 0 otherwise
D_2 = 1 for 1992
= 0 otherwise

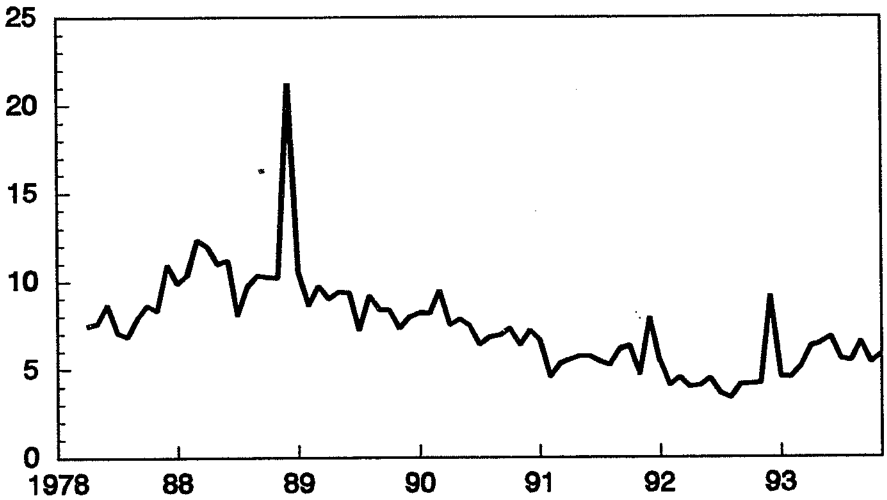
Appendix 3

Figure A3.1 **Finnish deposit banks: Interest margin on new lending, %**



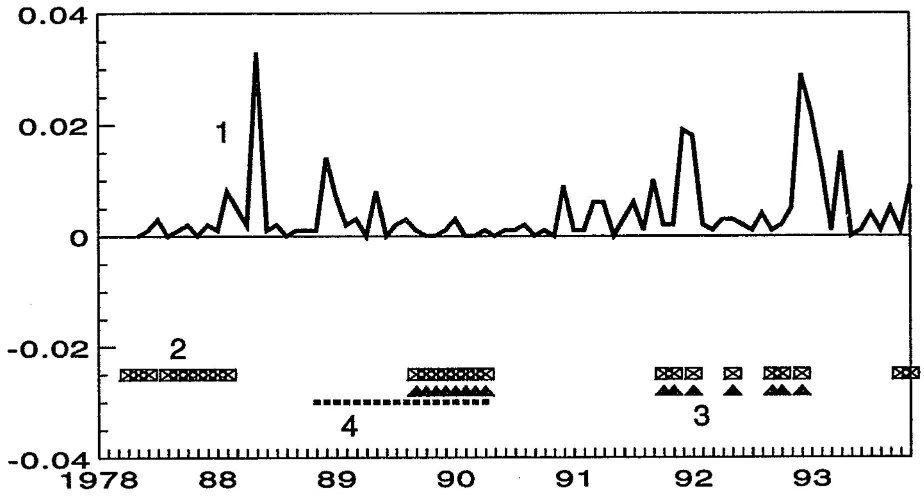
1 Average new lending rate – Helibor 3 months, %
2 CE
3 CER
4 CA

Figure A3.2 **Finnish deposit banks: Real new lending, FIM billions (1985 = 100)**



Data source: Bank of Finland

Figure A3.3 **Finnish deposit banks: Sums of squared market share changes**



1 Sums of squared market share changes
2 CE
3 CER
4 CA

Data source: Bank of Finland

Appendix 4.1

Cost function estimations (FIML)

Table A4.1.1 **1988**

Parameter		Estimate	Standard Error	t-stat
0.	(γ_0)	2.925**	.512	5.712
1.	(γ_{11})	.985**	.184	5.366
2.	(γ_{12})	–.353E–03	.218	–.162E–02
3.	(γ_{21})	1.674**	.042	–15.930
4.	(γ_{22})	.780**	.021	36.367
5.	(γ_{23})	.773**	.032	24.043
6.	(γ_3)	–.052	.079	–.662
7.	(γ_4)	.268**	.059	4.548
8.	(ζ_{11})	.065	.046	1.420
9.	(ζ_{12})	–.267**	.061	–4.401
10.	(ζ_{22})	.272**	.074	3.693
11.	(ρ_{11})	.115**	.410E–02	28.029
12.	(ρ_{12})	–.052**	.221E–02	–23.448
13.	(ρ_{13})	–.047**	.295E–02	–15.991
14.	(ρ_{22})	.185**	.192E–02	96.113
15.	(ρ_{23})	–.106**	.158E–02	–67.117
16	(ρ_{33})	.176**	.337E–02	52.312
17.	(ζ_{BB})	–.015	.941E–02	–1.561
18.	(ζ_{FF})	–.228E–02	.418E–02	–.546
19.	(η_{11})	–.073**	.666E–02	–10.977
20.	(η_{12})	.381E–02	.288E–02	1.324
21.	(η_{13})	–.289**	.723E–02	–39.941
22.	(η_{21})	.066**	.766E–02	8.640
23.	(η_{22})	.329E–03	.325E–02	.101
24.	(η_{23})	.293**	.809E–02	36.249
25.	(η_{1B})	–.609E–02	.017	–.348
26.	(η_{2B})	.605E–02	.020	.306
27.	(η_{1F})	.026*	.012	2.113
28.	(η_{2F})	–.027	.014	–1.945
29.	(λ_{1B})	.251E–02	.168E–02	1.497
30.	(λ_{2B})	–.111E–02	.830E–03	–1.344
31.	(λ_{3B})	.012	.614E–02	1.940
32.	(λ_{1F})	–.239E–03	.174E–02	–.137
33.	(λ_{2F})	–.152E–02	.813E–03	–1.874
34.	(λ_{3F})	–.014**	.191E–02	–7.143
35.	(ξ_{BF})	.516E–02	.398E–02	1.297

* denotes a coefficient estimate significant at 5 %, and ** 1 % level, respectively

Equation C	Std. error of regression = .055 R-squared = .998
Equation S^1	Std. error of regression = .025 R-squared = .163
Equation S^2	Std. error of regression = .011 R-squared = .937
Equation S^3	Std. error of regression = .026 R-squared = .884

Number of observations = 577
Log of likelihood function = 5863.18

Table A4.1.2 **1989**

Parameter	Estimate	Standard Error	t-stat
0.	2.071**	.552	3.754
1.	.724**	.203	3.572
2.	.241	.253	.952
3.	–.450**	.049	–9.241
4.	.523**	.048	10.922
5.	.928**	.048	19.303
6.	–.114	.083	–1.371
7.	.058	.047	1.245
8.	.362**	.038	9.558
9.	–.336**	.041	–8.294
10.	.320**	.059	5.445
11.	.092**	.509E–02	18.157
12.	–.0288**	.451E–02	–6.377
13.	–.052**	.421E–02	–12.352
14.	.143**	.334E–02	42.824
15.	–.071**	.387E–02	–18.317
16	.148**	.689E–02	21.508
17.	–.020*	.989E–02	–1.978
18.	–.257E–03	.441E–02	–.058
19.	–.059**	.599E–02	–9.793
20.	–.356E–02	.010	–.343
21.	–.264**	.012	–21.231
22.	.048**	.722E–02	6.645
23.	.0117	.011	1.024
24.	.261**	.013	19.358
25.	–.021	.018	–1.130
26.	.019	.022	.901
27.	.484E–02	.012	.390
28.	–.542E–02	.014	–.375
29.	.965E–02**	.225E–02	4.294
30.	–.785E–02*	.375E–02	–2.097
31.	.014	.781E–02	1.806
32.	–.195E–02	.165E–02	–1.178
33.	–.413E–03	.284E–02	–.145
34.	–.015**	.329E–02	–4.564
35.	.527E–02	.438E–02	1.203

Equation C	Std. error of regression = .087 R-squared = .995
Equation S^1	Std. error of regression = .021 R-squared = .381
Equation S^2	Std. error of regression = .022 R-squared = .815
Equation S^3	Std. error of regression = .041 R-squared = .765

Number of observations = 538
Log of likelihood function = 4732.41

Table A4.1.3 **1990**

Parameter	Estimate	Standard Error	t-stat
0.	1.615*	.801	2.018
1.	1.271**	.262	4.855
2.	–.422	.355	–1.189
3.	–.316**	.038	–8.392
4.	.556**	.022	25.576
5.	.768**	.041	18.841
6.	–.092	.146	–.628
7.	.172*	.072	2.388
8.	.055	.066	.834
9.	–.116	.076	–1.544
10.	.210*	.103	2.046
11.	.071**	.388E–02	18.339
12.	–.027**	.190E–02	–14.117
13.	–.041**	.356E–02	–11.633
14.	.159**	.168E–02	94.465
15.	–.108**	.156E–02	–69.404
16	.165**	.469E–02	35.218
17.	–.025	.017	–1.523
18.	.705E–02	.649E–02	1.085
19.	–.059**	.540E–02	–10.994
20.	–.022**	.273E–02	–8.112
21.	–.335**	.993E–02	–33.773
22.	.051**	.650E–02	7.770
23.	.029**	.330E–02	8.814
24.	.342**	.012	29.536
25.	.626E–02	.025	.252
26.	–.710E–02	.032	–.225
27.	.061**	.016	3.871
28.	–.077**	.020	–3.944
29.	.771E–02**	.161E–02	4.780
30.	–.247E–02**	.884E–03	–2.797
31.	.013	.727E–02	1.780
32.	–.274E–02*	.132E–02	–2.075
33.	–.372E–02**	.797E–03	–4.676
34.	–.023	.243E–02	–8.987
35.	.625E–02	.653E–02	.957

Equation C — Std. error of regression = .067
R-squared = .997

Equation S^1 — Std. error of regression = .018
R-squared = .458

Equation S^2 — Std. error of regression = .010
R-squared = .950

Equation S^3 — Std. error of regression = .035
R-squared = .860

Number of observations = 503
Log of likelihood function = 4858.33

Table A4.1.4 **1991**

Parameter	Estimate	Standard Error	t-stat
0.	2.891**	1.282	2.255
1.	1.222**	.400	3.055
2.	–.559	.559	–1.000
3.	–.415**	.059	–7.039
4.	.441**	.035	12.753
5.	.792**	.066	12.025
6.	–.045	.205	–.218
7.	.189	.135	1.397
8.	.372**	.130	2.869
9.	–.466**	.142	–3.281
10.	.605**	.179	3.384
11.	.086**	.543E–02	15.919
12.	–.014**	.354E–02	–4.039
13.	–.039**	.515E–02	–7.597
14.	.137**	.251E–02	54.503
15.	–.098**	.286E–02	–34.344
16	.200**	.762E–02	26.196
17.	–.023	.021	–1.109
18.	.297E–02	.962E–02	.309
19.	–.016	.011	–1.451
20.	–.805E–02	.511E–02	–1.576
21.	–.226**	.017	–13.341
22.	.581E–02	.013	.457
23.	.015**	.574E–02	2.636
24.	.235**	.020	11.926
25.	.083*	.034	2.552
26.	–.094*	.427	–2.194
27.	.055	.028	1.948
28.	–.069	.035	–1.955
29.	.012**	.349E–02	3.393
30.	–.310E–02	.184E–02	–1.684
31.	–.012	.011	–1.111
32.	–.209E–02	.243E–02	–.860
33.	–.370E–02**	.135E–02	–2.733
34.	–.026**	.455E–02	–5.656
35.	.771E–02	.959E–02	.804

Equation C — Std. error of regression = .080
R-squared = .997

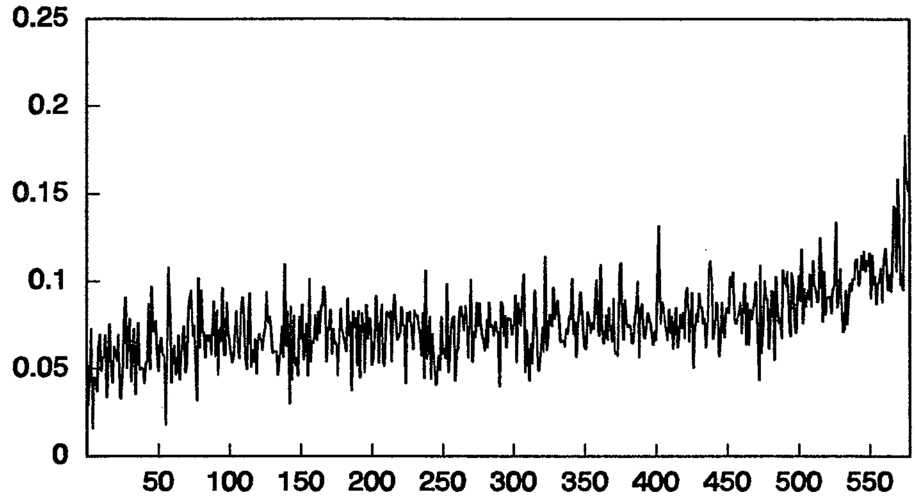
Equation S^1 — Std. error of regression = .026
R-squared = .338

Equation S^2 — Std. error of regression = .014
R-squared = .902

Equation S^3 — Std. error of regression = .047
R-squared = .766

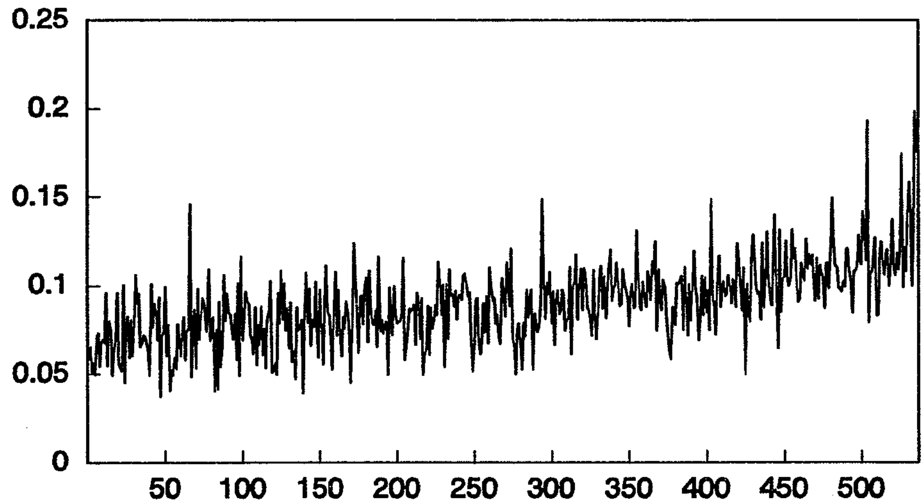
Number of observations = 423
Log of likelihood function = 3636.27

Figure A4.1.1 **Finnish deposit banks: Predicted MC(y¹).**
Sorted banks according to ascending total assets, 1988



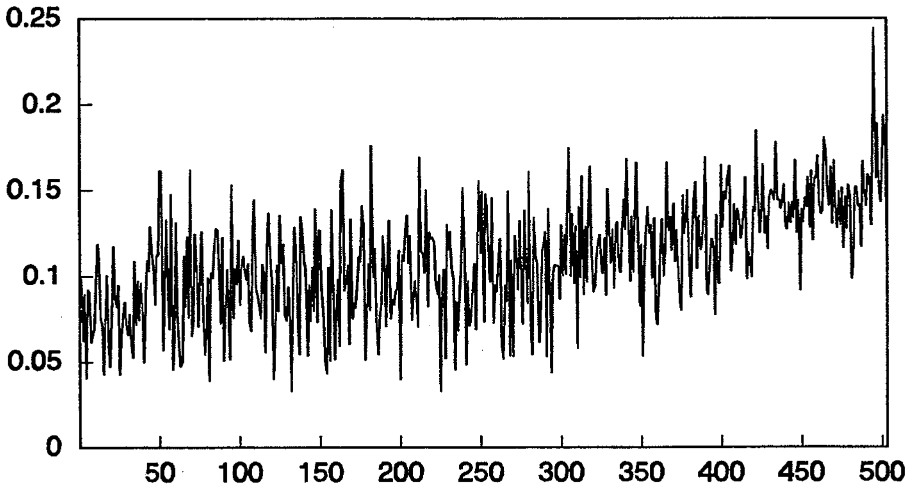
Predicted MC(y¹) average 0.076

Figure A4.1.2 **Finnish deposit banks: Predicted MC(y¹).**
Sorted banks according to ascending total assets, 1989



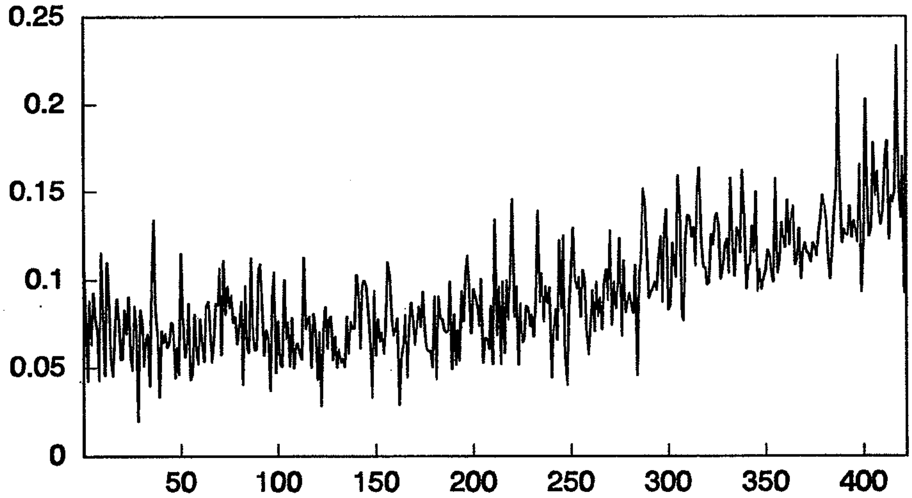
Predicted MC(y¹) average 0.090

Figure A4.1.3 **Finnish deposit banks: Predicted MC(y^1). Sorted banks according to ascending total assets, 1990**



Predicted MC(y^1) average 0.109

Figure A4.1.4 **Finnish deposit banks: Predicted MC(y^1). Sorted banks according to ascending total assets, 1991**



Predicted MC(y^1) average 0.089

Appendix 4.2

Empirical measures of the production economies in Finnish banking

Table A4.2.1 Production economies. Finnish deposit banks, 1988

	RSCE	RSCEB	RSCET	EPSCE	PSSCE(y1)	PSSCE(y2)	Cost Compl.	Necessary Condition of Cost Compl.	Number of Banks	Asset Range (FIM Millions)	Asset Mean (FIM Millions)	Std. Error of Assets (FiM Millions)
Local banks												
I	0.9880	−0.0019	0.9862	0.9951	0.0279**	0.0294**			478	5.32–340.50	122.93	75.88
	(0.9857)	(0.5962)		(0.8264)	(0.0000)	(0.0002)						
II	0.9957	−0.0107*	0.9850	0.9983	0.0306**	0.0335**			79	341.03–2,019.69	754.37	405.8
	(0.9956)	(0.0187)		(0.9426)	(0.0000)	(0.0002)						
III	1.0026	−0.0181*	0.9845	0.9832	0.0330**	0.0369**			15	2,058.49–10,891.02	3,779.28	2,072.26
	(0.9976)	(0.0147)		(0.5249)	(0.0000)	(0.0002)						
Commercial banks	1.0081	−0.0286**	0.9795	1.0082	0.0378**	0.0584**			5	2,590.74–126,816.71	77,217.36	48,662.02
	(0.9935)	(0.0082)		(0.7857)	(0.0000)	(0.0002)						
Sample average	0.9898	−0.0037	0.9860	****	0.0285**	0.0305**	−0.2676	−0.2673**	577		845.23	7,594.01
	(0.9882)	(0.2810)			(0.0000)	(0.002)	(0.2712)	(−4.4009)				

Notes:
1) * denotes a coefficient estimate significant at 5%, and ** 1% level, respectively.
2) Prob-values of the Wald tests on the unrestricted model are in parentheses, except that in the case of the Necesary Condition of Cost Complementarity t-test is reported. H_0 is that the imposed restrictions, e.g. RSCE = 1, are valid.

Table A4.2.2 **Production economies. Finnish deposit banks, 1989**

	RSCE	RSCEB	RSCET	EPSCE	PSSCE(y1)	PSSCE(y2)	Cost Compl.	Necessary Condition of Cost Compl.	Number of Banks	Asset Range (FIM Millions)	Asset Mean (FIM Millions)	Std. Error of Assets (FIM Millions)
Local banks												
I	1.0024	–0.0175	0.9849	1.0188	0.0436**	0.0390**			455	5.69–519.78	153.67	107.85
	(0.9956)	(0.0638)		(0.4377)	(0.0000)	(0.0000)						
II	1.0270	–0.0361**	0.9909	1.0743**	0.0487**	0.0518**			64	541.11–2,851.25	1,103.47	570.04
	(0.9575)	(0.0005)		(0.0076)	(0.0000)	(0.0000)						
III	1.0403	–0.0468**	0.9935	0.9939	0.0523**	0.0610**			14	2,902.71–12,708.23	4,713.31	2,325.93
	(0.9426)	(0.0001)		(0.8327)	(0.0000)	(0.0000)						
Commercial banks	1.0588	–0.0606**	0.9982	1.0638*	0.0582**	0.0843**			5	3,637.05–132,520.29	84,389.09	52,281.20
	(0.9266)	(0.0000)		(0.0383)	(0.0000)	(0.0000)						
Sample average	1.0089	–0.0208*	0.9881	****	0.0445**	0.0415	–0.1612	–0.3355**	538		1,021.40	8,542.49
	(0.9840)	(0.0272)			(0.0000)	(0.0000)	(0.3279)	(–8.2944)				

Table A4.2.3 Production economies. Finnish deposit banks, 1990

	RSCE	RSCEB	RSCET	EPSCE	PSSCE(y1)	PSSCE(y2)	Cost Compl.	Necessary Condition of Cost Compl.	Number of Banks	Asset Range (FIM Millions)	Asset Mean (FIM Millions)	Std. Error of Assets (FIM Millions)
Local banks												
I	1.0037	–0.0075	0.9962	1.0098	0.0071	0.0274*			422	7.81–540.45	160.6	109.79
	(0.9962)	(0.1140)		(0.6047)	(0.4042)	(0.0408)						
II	1.0074	–0.0267**	0.9807	1.1185**	0.0084	0.0390*			61	553.08–2,561.23	1,125.83	513.67
	(0.9935)	(0.0000)		(0.0000)	(0.4042)	(0.0408)						
III	1.0190	–0.0424**	0.9765	1.0581*	0.0089	0.0438*			15	2,784.39–7,674.82	4,443.45	2,325.93
	(0.9849)	(0.0001)		(0.0476)	(0.4042)	(0.0408)						
Commercial banks	1.0248	–0.0549**	0.9698	1.0196	0.0091	0.0574*			5	3,295.41–144,257.55	75,151.75	56,934.90
	(0.9826)	(0.0006)		(0.5964)	(0.4042)	(0.0408)						
Sample average	1.0040	–0.0114**	0.9927	****	0.0074	0.0296*	–0.6529	–0.1164	503		1,150.81	9,376.01
	(0.9960)	(0.0006)			(0.4042)	(0.0408)	(0.2699)	(–1.5439)				

Table A4.2.4 **Production economies. Finnish deposit banks, 1991**

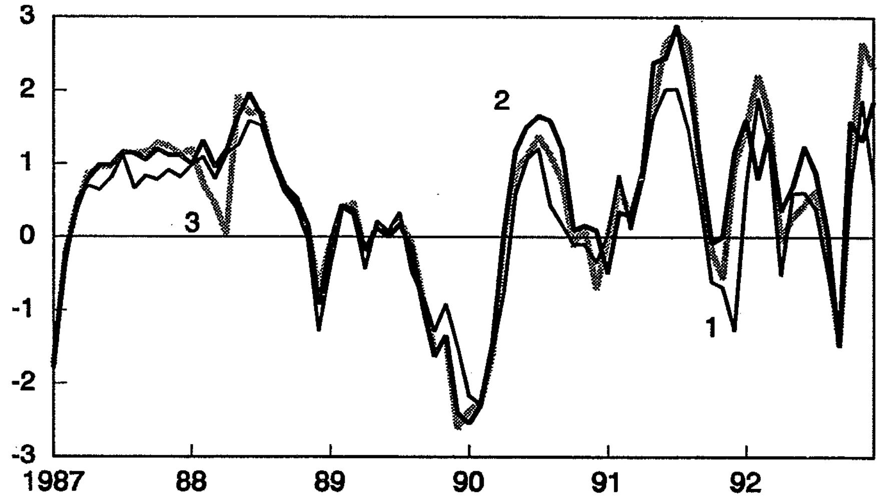
	RSCE	RSCEB	RSCET	EPSCE	PSSCE(y1)	PSSCE(y2)	Cost Compl.	Necessary Condition of Cost Compl.	Number of Banks	Asset Range (FIM Millions)	Asset Mean (FIM Millions)	Std. Error of Assets (FIM Millions)
Local banks												
I	0.9922	−0.0210**	0.9711	0.9639	0.0514*	0.0808**			362	8.83–917.97	205.35	181.2
	(0.9960)	(0.0001)		(0.4369)	(0.0041)	(0.0007)						
II	1.0121	−0.0395**	0.9726	0.9194*	0.0597*	0.1152**			41	951.65–3,515.44	1,768.89	774.85
	(0.9949)	(0.0000)		(0.0348)	(0.0041)	(0.0007)						
III	1.0269	−0.0521**	0.9747	0.9192	0.0687*	0.1397**			15	3,678.55–8,864.21	5,374.99	1,428.72
	(0.9895)	(0.0000)		(0.0689)	(0.0041)	(0.0007)						
Commercial banks	1.0223	−0.0588**	0.9635	1.0075	0.0564*	0.1455**			5	3,677.46–136,933.02	78,130.25	57,252.47
	(0.9922)	(0.0002)		(0.8937)	(0.0041)	(0.0007)						
Sample average	0.9959	−0.0244**	0.9715	****	0.0529*	0.0870**	−1.1494	−0.4661**	423		1,461.32	10,501.79
	(0.9925)	(0.0000)			(0.0041)	(0.0007)	(0.2273)	(−3.2810)				

Appendix 4.3

Demand analyses

Figure A4.3.1

Finnish deposit banks: Average new lending rate – Helibor 3 months, %

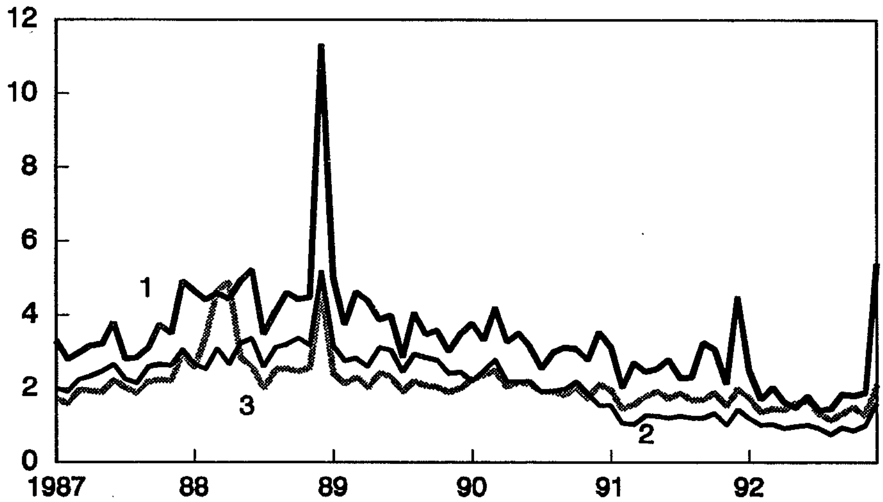


1 = Commercial Banks,
2 = Savings Banks, and
3 = Cooperative Banks

Data source: Bank of Finland

Figure A4.3.2

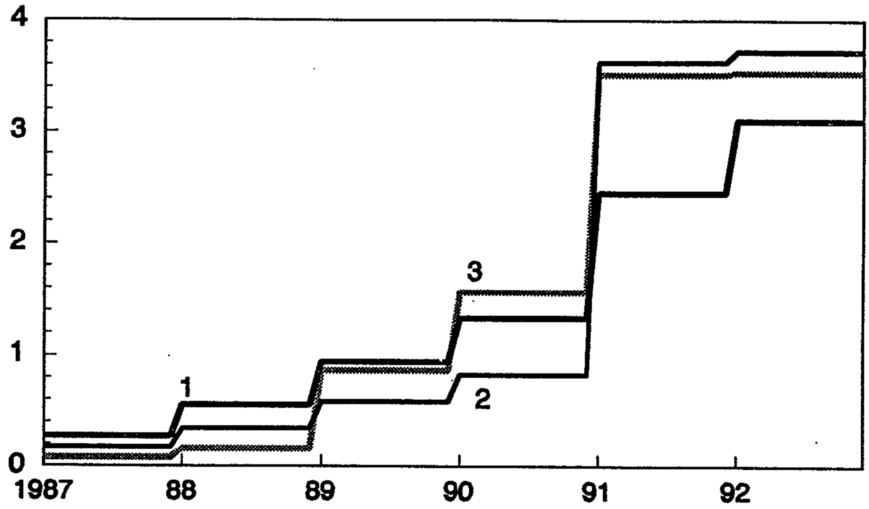
Finnish deposit banks: Real new lending, FIM billions (1985 = 100)



1 = Commercial Banks,
2 = Savings Banks, and
3 = Cooperative Banks

Data source: Statistics Finland, The Banks, Official Finnish Statistics

Figure A4.3.3 **Finnish deposit banks: Direct service charges (p^s), FIM per transaction**

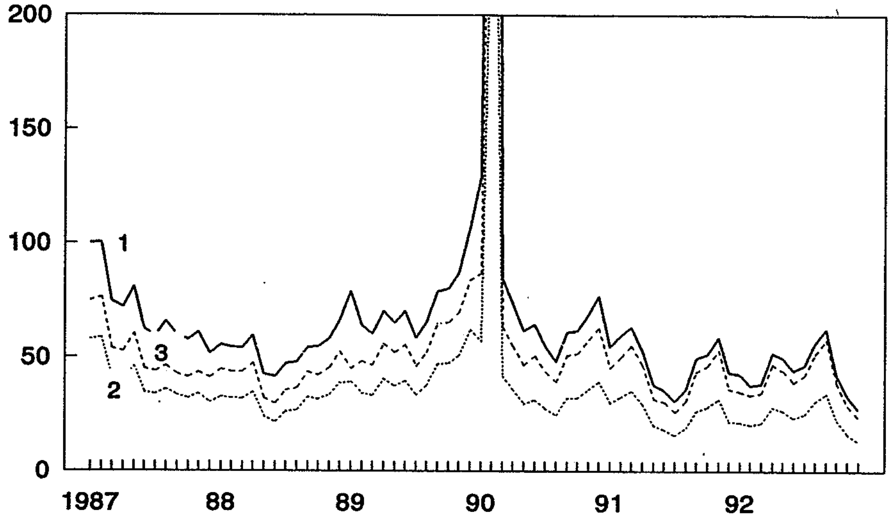


1 = Commercial Banks,
2 = Savings Banks, and
3 = Cooperative Banks

Note: The direct service charge includes an average fee for cheques (including a price for the form), ATM transactions (FIM 0 at all banks), and bank giro transactions. These charges are weighted by respective transaction volumes to obtain the average direct deposit service charges (p_v^Ss). The figures for commercial banks are obtained as weighted average of the deposit service charges at KOP, SYP and PSP using the number of deposit accounts as proxy weights (transaction volumes were not available by banks).

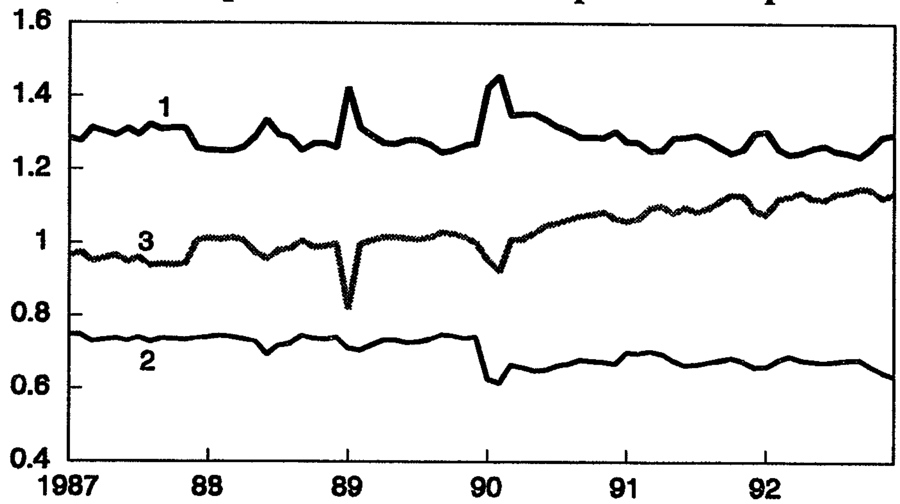
Data sources: Finnish Bankers' Association's survey: Kotitalouksien yleisimmät pankkipalvelumaksut (various issues); Bank charge surveys by Suomen Kuluttajaliitto Oy (various issues); Statistics Finland, The Banks, Official Finnish Statistics (account numbers); and Bank of Finland (transaction data).

Figure A4.3.4 **Finnish deposit banks: Real deposit service prices (p^D) (commercial banks 1987:1 = 100)**



1 = Commercial Banks,
2 = Savings Banks, and
3 = Cooperative Banks

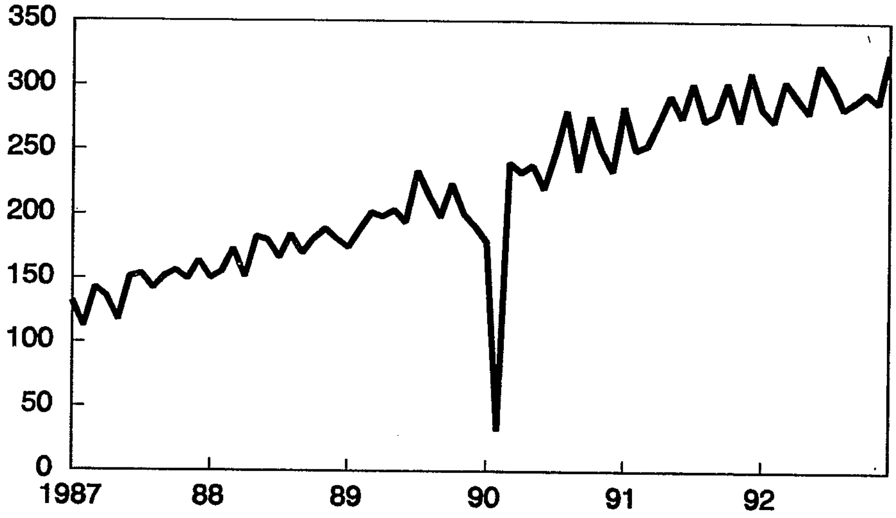
Figure A4.3.5 **Finnish deposit banks: Relative deposit service prices**



1 = Commercial Banks,
2 = Savings Banks, and
3 = Cooperative Banks

Figure A4.3.6

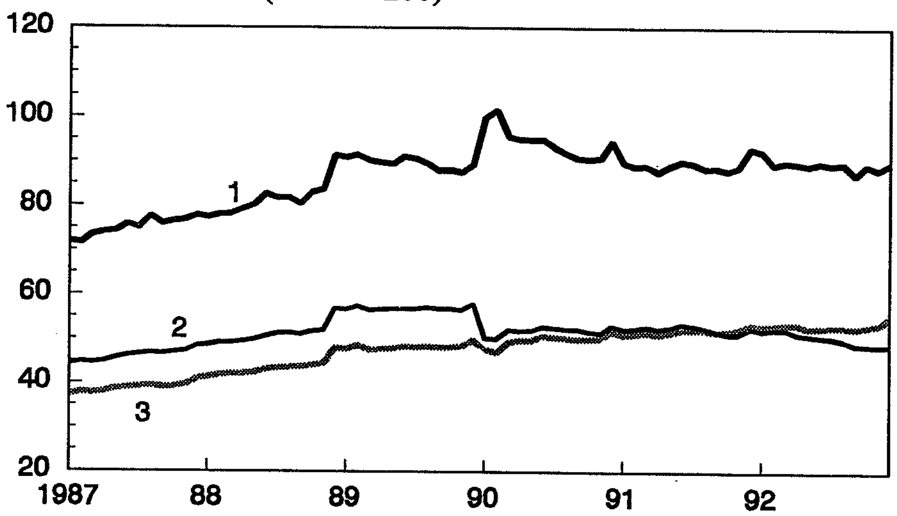
Finnish deposit banks: Total clearing transactions (q^s), millions



Data source: Bank of Finland

Figure A4.3.7

Finnish deposit banks: Real deposit balances, FIM billions (1985 = 100)



1 = Commercial Banks,
2 = Savings Banks, and
3 = Cooperative Banks

Data source: Statistics Finland, The Banks, Official Finnish Statistics

Table A4.3.1 **Demand for bank loans (equation (4.36)) 1987:5–1992:12. Hildreth-Lu estimates**

		Commercial banks (v=1)		Savings banks (v=2)		Cooperative banks (v=3)		All banks	
variable	param.	D^1 (real new loans)	t-value	D^1 (real new loans)	t-value	D^1 (real new loans)	t-value	D^1 (real new loans)	t-value
Constant	α_0	0.460	0.245	−2.578	−1.879	4.589**	2.687	2.059	1.493
SD		0.763**	5.249	0.418**	3.550	0.639**	5.186	0.645**	5.730
r_v^1/r^M	$\bar{\alpha}_1$	−0.975**	−2.688	−0.612*	−2.515	−0.383	−1.176	−0.549*	−1.997
$\bar{r}^1/r^M$	$(-\alpha_2)$	−3.162**	−2.842	−0.836	−1.258	−1.244	−1.388		
ε_v^{11}		**−4.137****		**−1.448***		**−1.627***		**−0.549***	−1.997
F-test		(8.737)	0.000[1]	(3.271)	0.045	(3.653)	0.032		
ε_v^{-11}		**3.162****	2.842	**0.836**	1.258	**1.244**	1.388		
Z^1 (real GDP)	β_1	1.272**	3.347	1.060**	3.499	0.631	1.990	0.976**	3.278
Z^2 (infl. rate)	β_2	2.896	0.635	−3.471	−1.045	1.195	0.029	6.227	1.590
Z^3 (DEM 3 mth interest rate)	β_3	−0.520**	−4.419	−0.495**	−6.889	−0.471**	−4.083	−0.458**	−5.425
Z^4 (Stock prices)	β_4	0.387*	2.899	0.886**	10.31	0.169	1.339	0.454**	5.061
	rho	0.448**	3.468	0.252	1.963	0.532**	4.578	0.419**	3.435
R^2		0.854		0.944		0.810		0.897	
Adj. R^2		0.834		0.936		0.784		0.885	
DW		2.158		2.013		2.026		2.158	
Ljung-Box		50.14		16.11		13.69		31.049	
Q(16−1)		(0.000)[1]		(0.374)		(0.549)		(0.013)	
Breusch-Pagan(2)		4.779		3.696		2.170		4.810	
		(0.092)[1]		(0.158)		(0.338)		(0.090)	
SEE		0.151		0.116		0.130		0.117	
No. of obs.		67		67		67		67	

Notes: Seasonal dummies (SD) 1988:12 and 1992:12. [1] (significance level)

Table A4.3.2 **Demand for deposit services (equation (4.38)) 1988:1–1992:12. Instrumental variables: errors in variables correction (equations (4.39a) – (4.39d))**

		Commercial banks (v=1)		Savings banks (v=2)		Cooperative banks (v=3)		All banks	
variable	param.	$D^2 = q^s$	t-value	$D^2 = q^s$	t-value	$D^2 = q^s$	t-value	$D^2 = q^s$	t-value
Constant	α_0	9.835^{**}	4.444	9.322^{**}	4.176	8.623^{**}	11.61	9.019^{**}	12.78
t		0.009^{**}	5.320	0.010^{**}	5.425	0.009^{**}	6.03	0.011^{**}	19.42
SD		-1.016^{**}	-7.209	-0.997^{**}	-7.034	-1.878^{**}	-22.49	-1.917^{**}	-30.77
p_v^D	$\tilde{\alpha}_1$	−0.080	−0.700	−0.102	−0.899	-0.088^{*}	−2.023	-0.167^{**}	-4.552
p_v^{-D}	$(-\alpha_2)$	−0.329	−0.320	−0.178	−0.190	−0.523	−1.014		
ε_v^{22}		**−0.409**		**−0.279**		**-0.611^{**}**		**-0.167^{**}**	-4.552
F-test		(0.339)	0.714[1]	(0.432)	0.766	(10.19)	0.000		
ε_v^{-22}		**0.328**	0.320	**0.178**	0.190	**0.523**	1.014		
Z^1 (real GDP)	β_1	−0.142	−0.276	−0.051	−0.099	0.029	0.172	0.292	1.788
Z^2 (Stock prices)	β_2	−0.656	−1.633	−0.737	−1.802	-0.327^{*}	-2.555	-0.486^{**}	-3.782
R^2		0.701		0.709		0.971		0.969	
Adj. R^2		0.666		0.675		0.967		0.966	
DW		2.017		1.931		2.266		1.769	
Ljung-Box Q(16–1)		22.22		24.04		16.35		19.56	
		(0.074)[1]		(0.045)		(0.292)		(0.145)	
Breusch-Pagan(2)		0.232		4.402		0.958		0.022	
		(0.890)[1]		(0.111)		(0.619)		(0.989)	
SEE		0.192		0.061		0.111		0.061	
No. of obs.		60		60		60		60	

Notes: Seasonal dummies 1989:1 and 1990:2 (bank strike), and 1990:3–1992:12 savings and cooperative banks. [1] (significance level)

Appendix 4.4

Behavioral equations (FIML)

Table A4.4.1 **Estimates of the expected price responses (oligopolistic coordination terms). Average responses, s=1. (Equations (4.25b) and (4.25c))**

υ^{qk}	1988, % (t-stat)	1989, % (t-stat)	1990, % (t-stat)	1991, % (t-stat)	Pooled 1988–1991, % (t-stat)
Own market effects					
Loans υ^{11}	0.381** (30.07)	0.335** (27.58)	0.394** (47.85)	0.428** (39.34)	0.410** (108.91)
Deposits υ^{22}	0.599** (20.33)	0.577** (17.25)	0.644** (20.42)	0.650** (16.83)	0.631** (61.36)
Cross-market effects					
Loans -> Deposits υ^{21}	0.398** (12.11)	0.340** (9.82)	0.422** (13.35)	0.337** (7.95)	0.372** (33.19)
Deposits -> Loans υ^{12}	0.132** (13.51)	0.089** (9.98)	0.129** (16.68)	0.111** (12.95)	0.133** (49.24)
Log of likelihood function	3034.30	2548.70	2328.91	1977.36	9390.87
AIC	–6060.60	–5089.40	–4649.82	–3946.72	–18773.74
Sample size	577	538	503	423	2041

Note: The Prob-values for the Wald tests, whether the price response terms for 1991 differ from those for the period 1988–1990 are all less than 0.000 indicating that all parameters for 1991 are significantly different, e.g. υ^{11} significantly higher. The null hypothesis is that the parameters are the same (their difference equals zero). The Wald tests are based on the unrestricted version of the model where all parameters are allowed to change over time.
The Akaike Information Criterion for model "fit", AIC, equals –2 times the value of the log likelihood function for the given vector of parameters plus 2 times the number of estimated parameters. The smaller the value AIC obtains the better the model fits the data.

Table A4.4.2 **Estimates of the expected price responses (oligopolistic coordination terms). Bank group-specific responses, s=3. (Equations (4.25b) and (4.25c))**

υ_v^{qk}	1988, % (t-stat)	1989, % (t-stat)	1990, % (t-stat)	1991, % (t-stat)	Pooled 1988–1991, % (t-stat)	Wald-tests[1] I,Prob-values	II,Prob-values
Own market effects							
Loans[2]							
υ_1^{11}	0.188* (–2.18)	0.339 (–0.237)	0.240** (–3.38)	0.372** (–3.93)	0.271** (–11.37)	0.380	0.000
υ_2^{11}	0.697** (23.19)	0.535** (4.64)	0.547** (5.67)	0.984** (20.63)	0.683** (32.00)	0.015	0.631
υ_3^{11}	0.476** (85.96)	0.409** (37.02)	0.437** (64.94)	0.485** (24.13)	0.438** (101.58)	0.000	0.000
Deposits							
υ_1^{22}	0.837 (0.471)	1.268 (0.579)	0.958 (0.81)	0.933 (1.12)	0.919** (4.30)	0.904	0.082
υ_2^{22}	1.399** (20.43)	1.716** (23.80)	1.441** (23.79)	2.409** (22.01)	1.522** (47.67)	0.201	0.003
υ_3^{22}	0.581** (44.84)	0.646** (57.79)	0.633** (54.88)	0.619** (20.46)	0.600** (98.22)	0.000	0.000
Cross-market effects							
Loans -> Deposits							
υ_1^{21}	0.844 (0.299)	1.588 (0.479)	1.069 (1.48)	1.160 (1.57)	1.057** (4.79)	0.974	0.169
υ_2^{21}	1.239** (28.24)	1.587** (16.80)	1.124** (24.90)	2.249** (23.78)	1.224** (39.04)	0.129	0.647
υ_3^{21}	0.405** (43.26)	0.441** (31.22)	0.417** (36.91)	0.359** (12.67)	0.363** (51.72)	0.000	0.000
Deposits -> Loans							
υ_1^{12}	–0.021** (–4.39)	0.064 (–0.744)	–0.002** (–3.18)	0.037** (–6.83)	0.011** (–21.77)	0.001	0.000
υ_2^{12}	0.401** (16.04)	0.276** (6.83)	0.234** (3.33)	0.587** (14.54)	0.354** (27.35)	0.001	0.000
υ_3^{12}	0.229** (48.76)	0.176** (32.18)	0.188** (43.41)	0.196** (9.96)	0.185** (62.31)	0.000	0.000
Log of likelihood function	3452.87	2847.36	2626.76	2204.05	10495.0		
AIC	–6893.74	–5692.72	–5241.52	–4396.10	–20978.0		
Sample size	577	538	503	423	2041		

Notes: 1) Wald tests test, whether the parameter values for 1991 differ significantly, I from values for pooled 1988–1990, and II from values for 1988. The null hypothesis is that the parameters are the same (their difference equals zero).
2) v=1 denotes commercial banks, v=2 savings banks, and v=3 cooperative banks.

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