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BANKS AS MULTIOUTPUT OLIGOPOLIES: AN EMPIRICAL EVALUATION OF THE RETAIL AND CORPORATE BANKING MARKETS*

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ABSTRACT

The distinction between retail and corporate banking markets is of much importance in real life banking organizations. The two markets differ with respect to concentration, the importance of informational asymmetries, and the extent of customer mobility. Within a standard conjectural variation model we empirically characterize the strategic behaviour within each of these markets, and also focus on cross market interactions to see whether initial moves in one market affects the equilibrium in the other market.

CONTENTS

1. INTRODUCTION

One of the major interests expressed by researchers who are engaged in empirical banking studies is the assessment of the competitive viability of the industry. For over a decade of research in the area, researchers have tried to address this issue by applying various methods to differing data sets for the purpose of estimating the degree of scale economies. Realizing the multiplicity of products in banking, recent research has also focused on the proper measurement of product mix economies or, what has been termed, economies of scope.[1] This line of research has been centered on the properties of the cost function, and most studies have not incorporated the market influences on the behaviour of banks, and the potential impact of these forces on competitive viability and behaviour of the industry. Very recent literature has been testing for competition and market power in the banking sector.[2] Although market power may be inferred from various concentration ratios such as the Herfindahl index, these measures may not accurately depict the true market power. The purpose of the present paper is to investigate into these market influences, focusing on the degree of market power and on the interactions between different market segments in an oligopolistic market setting.

Multioutput banking firms sell their outputs in a number of different market segments, which are characterized by customers of differing informational gathering and

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[1] See, e.g., the papers by Benston, Hanweck and Humphrey (1982), Murray and White (1983), Clark (1984), Gilligan and Smirlock (1984), Gilligan, Smirlock and Marshall (1984), Kim (1986), Hunter and Timme (1986), Mester (1987), Berger, Hanweck and Humphrey (1987) and many others.

[2] Shaffer (1989, 1993) tests for competition in the US and the Canadian banking industries, but does not consider the multi-output nature of banking. Gelfand and Spiller (1987) do consider multiple outputs, making a distinction between peso and dollar markets in the Uruguyan banking sector.

processing abilities and mobility across product characteristics. These differences are important reasons why banks may develop different strategic behaviour across market segments, perhaps characterised by some kind of retaliation (Porter, 1980, 1981 and, Salop and Scheffman, 1983) or forbearance (due to fear of retaliation).[3] Recent studies of such behaviour in banking markets include Spiller and Favaro (1984), Gelfand and Spiller (1987), Shaffer (1989, 1993), and Berg and Kim (1994). However, only the paper by Gelfand and Spiller includes a cross market analysis of oligopolistic competition.

In this study we attempt to uncover the oligopolistic behaviour of multioutput banks which sell their outputs in two distinct markets common to all banking industries, namely retail and corporate banking markets. That distinction is new to this line of study[4], and its rationale is based on two main observations. First and generally, the distinction between these activities (outputs) is intrinsic to the operation of banks and is of much importance in practice. In fact, banks which are more retail oriented tend to rely more heavily on produced deposits, and thus use more extended branching networks, whereas banks which are more oriented towards corporate customers tend to rely more heavily on the purchase of funds rather than on produced deposits.[5] Second, these activities reflect different types of customers who differ substantially with respect to their ability to gather and process the relevant information in financial markets and therefore

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[3] Feinberg and Sherman (1982).

[4] Hunter, Timme, and Yang (1990) are the only ones, we are aware of, to have used a similar distinction between different loan market segments, albeit for a different purpose, by specifying retail and wholesale outputs in their study of cost subadditivity in large U.S. banks.

[5] Also, larger banks tend to employ a higher proportion of purchased funds.

their mobility across banks differs.[6] In addition, customers cannot substitute retail loans for corporate loans or vice versa, whereas banks can and do divert funds from one market to the other.[7] As a result of these differences among customers, the degree of competition will differ, and the elasticity of demand as perceived by individual banks will be different in these markets.

Since customers can not substitute, demand in the retail and corporate banking markets will be independent. Even so, any shock to either oligopolistic market segment has both a direct and an indirect effect on the profits of a bank, when costs of production across markets for a given bank are interrelated.[8] After the shock the bank's initial allocation of outputs between the two markets is no longer profit maximizing, since the marginal gain from selling a unit in one of the markets has changed and the bank will reoptimize. As has been shown by Bulow, Geanakoplos and Klemperer (1985) this reoptimization or marginal change in strategy can have first-order effects on the bank's profits in oligopolistic markets.[9]

The cross market effect modelled by Bulow, Geanakoplos and Klemperer

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[6] This observation is also made by Klemperer (1987) who examines markets in which consumers' costs of switching between brands of a product makes it easier for a firm to sell to customers who purchased from it in previous period (market).

[7] Or engage in cross subsidization practices.

[8] We treat the notion of interrelated costs as jointness in production. This phenomenon may or may not result in scope economies. In our present context jointness is sufficient for the strategic interaction among multioutput oligopolies.

[9] The reason is that small changes in bank i's equilibrium strategy in market 1 will cause small changes in its competitor j's marginal profit schedule and thus induce small changes in j's market 2 strategy. These small changes in j's strategy have first-order effects on i's profits.

depended primarily on interrelated costs. But they also showed that cross market effects observed in practice may depend on the nature of oligopolistic competition occurring in the two segments, and on short-run input-output constraints, such as the banks' ability to fund desired increases in total overall lending to both markets.[10] Cost complementarity, which should perhaps be expected between retail and corporate market outputs, would cet. par. induce parallel movements of bank outputs in the two market segments, as long as short-run constraints are not too severe. However, in a near competitive market segment we would not expect significant effects originating from another market, whereas in a highly non-competitive segment such effects may be significant.

The classification of banking output into retail and corporate market activities seems a natural starting point for providing us with a more coherent picture as to the oligopolistic nature of interaction among banks. By taking account of the process by which output is supplied, the varying price elasticities of demand in each of these markets, and the possible cross markets strategic effects, we hope to gain further insights into the competitive behaviour of banking firms.

The paper is organized in the following manner. Section 2 presents the model. In section 3 we discuss the data used. Section 4 presents estimation and results, and section 5 concludes the paper.

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[10] The limitation on credit lines from money market funding may be a function of the economy's openness, the tightness of regulatory regimes and the state of health of the banking system.

2. THE MODEL

Similar to Gelfand and Spiller (1987), we consider a set of multioutput banks, i=1,...,I, each supplying their output in two credit markets (retail and corporate) at prices P^k (k=1,2). The ith bank chooses output quantities q^k_i, k=1,2, to maximize its profits π_i,

$$\begin{aligned} &\Pi_i = P^1 q_i^1 + P^2 q_i^2 - C_i(q_i^1, q_i^2) \\ &s.t. \\ &(1)\ P^k = P^k(q^k) \qquad k=1,2 \\ &(2)\ \{ R_j^k;\ j \neq i, \quad k=1,2 \ \} \end{aligned} \tag{1}$$

where $P^k(.)$ is the inverse demand function for product k, q^k is the total supply of product k, R^k_j is the expected reaction of bank j in market k (to be explicitly specified below), q^k_i is the quantity of product k produced by bank i and $C_i(.)$ is the multioutput cost function of the ith bank. In the case of imperfectly competitive markets, each bank will recognize that a change in one of its outputs will have an effect on both product prices through all other banks' output reactions. In general there would also have been an effect through the cross price elasticities. However, in our specific case there is no substitutability in demand between the two markets, since these markets are defined by two separate groups of customers and no arbitrage opportunities exist.

The first order conditions for each bank i are,

$$\Pi_i^k = P^k + (q_i^k \frac{\partial P^k}{\partial q^k})(1 + \sum_{j=1, j\neq i}^{I} \frac{\partial q_j^k}{\partial q_i^k}) + (q_i^m \frac{\partial P^m}{\partial q^m})(\sum_{j=1, j\neq i}^{I} \frac{\partial q_j^m}{\partial q_i^k}) - C_i^k = 0 \tag{2}$$

where m,k=1,2, but m≠k; i=1,...,I; and π^k_i, C^k_i are partial derivatives of π_i, C_i with

respect to q^k_i, respectively. The terms $\partial q^k_j/\partial q^k_i$ are bank i's expectations of reactions from bank j in market k to its own output decision in that market. The term $\partial q^m_j/\partial q^k_i$ is the expected reaction from bank j in the other market, $m \neq k$, to the same initiation[11].

The main objective of this paper is to analyse the nature of these conjectures and to determine whether they change through time between and within the markets of retail and corporate banking. To obtain a parsimonious representation of conjectural variations, we shall assume that either the absolute aggregate response or the relative aggregate response expected from other banks are constant across banks in each year:

$$\frac{\partial(\sum_{j \neq i} q_j^m)}{\partial q_i^k} = \theta_{mk} \tag{3}$$

or

$$\frac{\partial \log(\sum_{j \neq i} q_j^m)}{\partial \log q_i^k} = \theta_{mk} \tag{4}$$

Upon substitution of equations (3) or (4) into the first order conditions specified in equation (2) and rearrangement, we arrive at the first order conditions for bank i in market k,

$$p^k[1 - \frac{1}{\varepsilon^k}\frac{q_i^k}{q^k}(1+\theta_{kk})] - p^m\frac{1}{\varepsilon^m}\frac{q_i^m}{q^m}\theta_{mk} = C_i^k \tag{5}$$

or

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[11] The conventional term for these expected reactions is conjectural variation. They determine the observed price-cost margins and depict the degree of competitiveness in the markets.

$$p^k\{1-\frac{1}{\varepsilon^k}[\frac{q_i^k}{q^k}+(1-\frac{q_i^k}{q^k})\theta_{kk}]\} - p^m\frac{1}{\varepsilon^m}\frac{q_i^m}{q_i^k}(1-\frac{q_i^m}{q^m})\theta_{mk} = C_i^k \quad (6)$$

where k,m=1,2 represent market indexes, and $\varepsilon^k=-(\partial q^k/\partial P^k)(P^k/q^k)$ is the price demand elasticity in market k. Equation (5) or (6) above represents a system of two equations (one for each market) to be estimated jointly with the cost function.

3. DATA

The above model is applied to a panel of data from the Norwegian banking sector for the three years 1990-1992, and it contains 453 observations in total[12]. This panel covers the climax of an extensive banking crisis with huge loan losses, and also the start of a recovery period. Most banks were cutting costs during these three years, and systematically reconsidering their market strategies. Due to the ongoing crisis and serious bank failures, the system as a whole was very careful in extending new credit; in fact, through our sampled years, total (sample) bank credit declined by roughly 5% in real terms, which is considered as very unusual. The market interactions may thus well have changed even over this short time interval.

Bank outputs are specified as loans extended to retail and corporate customers. Three variable factors of production are specified; labour, materials, and borrowed

[12] There were 157, 149 and 147 banks in the 1990, 1991, and 1992 sets, respectively. This is the complete set of Norwegian banks, exclusive of seven or eight subsidiaries of foreign banks in each year and one commercial bank that was established in 1992.

money. We further specify two quasi-fixed factors, namely produced deposits and machine capital. Produced deposits are customer deposits obtained from others than financial institutions, and is exclusive of money market funding.

The bank-specific prices of labour are computed as total labour expenditures per man-hour. Borrowed money is defined as the amount borrowed from other financial institutions and from the national and international money markets. Its unit price is the money market rate, assumed equal to all banks.[13] The materials input price is measured by a national price index and thus varies through time, but is constant across banks. The expenditure on materials includes the costs (exclusive of depreciation allowances) of operating machines and transport equipment, external EDP, postage, telephone and telex, and other materials.

Produced deposits are treated as a quasi-fixed factor and therefore appear as quantity (measured as average of start and end of the year balances) in the cost function. This treatment is based on the view (Flannery, 1982) that produced deposits involve transaction specific (set-up) costs to both customers and banks, giving each a strong incentive to continue the relationship in order to amortize these costs. Thus the level of produced deposits is changeable only at increasing costs rendering its quantity quasi-fixed.

The retail output is defined as loans granted to private non-commercial institutions, personal enterprises and individuals. The corporate output is defined as loans granted to

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[13] Price variations due to risk differences among banks have not been important during the years covered in our sample.

other sectors, including governments, financial institutions, limited companies and foreign companies. Investments in bonds and other securities are not included. The retail and corporate outputs are measured by the average of start and end of year loan balances. Their corresponding unit prices are assumed constant across banks, since a number of nation-wide banks compete directly on the most important local markets, and since the loan rates charged tend to be uniform within the entire networks of these banks.

Data on prices of retail and corporate lending are not directly available. But marginal revenues are arrived at by the weighted least square cross section regression of total revenues of individual banks with respect to the loan quantity balances. The intercepts are statistically insignificant, and the R-squares are 0.998 or higher. The coefficient estimates are thus marginal (and average) revenues, and are used as prices in the appropriate equations. The estimated marginal revenues (standard deviations in parentheses) for retail and corporate outputs respectively are: 0.1436 (0.0017) and 0.1194 (0.0015) for 1990; 0.1562 (0.0013) and 0.0834 (0.0010) for 1991; and 0.1384 (0.0008) and 0.0869 (0.0006) for 1992.[14]

The estimation procedure also requires data on the market demand elasticities of the two outputs. These are assumed constant over time, and are derived from aggregate time series data 1988-91, by regressing total retail and corporate lending quantities on the average interest rates charged by banks according to a quarterly survey[15] and on the

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[14] We tried adjusting the lending volumes for non-performing loans, but that did not make a significant difference to the estimates.

[15] Since quarterly data are required, the retail and corporate output prices estimated above can not be used.

inflation rate. There are 16 quarterly observations, and a logarithmic functional form is imposed. The demand elasticities are estimated as -0.9017 (0.2728) in the retail market and -0.8619 (0.3256) in the corporate market.[16] Notice that these are market demand elasticities, and that the demand elasticities perceived by individual banks may differ more between the two markets, due to different degrees of market imperfections.

4. ESTIMATION AND RESULTS

4.1. Empirical Specifications

To assess the marginal costs of different outputs, two alternative procedures are used in previous studies of oligopolistic markets. Spiller and Favaro (1984) and Gelfand and Spiller (1987) in studies of banking industries used the money market rate as their estimate of marginal costs. Roberts and Samuelson (1988) in a non-banking study derived the marginal costs from an estimated multioutput cost function. We adopt the latter more general approach, but unlike Roberts and Samuelson's study, our conjectural variation parameters will be estimated simultaneously with the cost function parameters, thus allowing for the conduct parameters to be consistent with the short-run constraints on total lending imposed by the technology (variable cost function). Generating marginal costs from an auxiliary cost function and then using them as data in the estimation of the behavioural equations (conjectural variation parameters) disregards constraints posed by technology (cost function) and introduces inaccuracies and various biases in the

[16] Our conclusions with respect to banks' strategic behaviour will be robust to significant deviations from these point estimates. We tested this assertion by reestimating our model with demand elasticities (ϵ_1, ϵ_2) equal to (-0.5,-0.5), (-0.5,-2.0), (-2.0,-0.5) and (-2.0,-2.0), respectively. Our qualitative conclusions in section 4 were not changed in any way.

econometric testing.

As discussed earlier we estimate a multi-output variable cost function with produced deposits and machine capital specified as quasi-fixed factors. Thus, the variable cost function is,

$$VC=g(\ w,\ y,\ BR,\ Z\ ) \tag{7}$$

where VC is variable cost, **w** is a vector of variable input prices, **y** is the two-output vector, BR is the number of branches, and Z is a vector representing the quasi-fixed inputs. The empirical cost function is taken to be a second-order translog approximation to a twice differentiable arbitrary cost function:

$$\begin{aligned}\log VC=&\alpha_0+\sum_i^m \alpha_i \log y_i+\sum_j^n \beta_j \log w_j+\gamma_B \log BR+\sum_k^l \delta_k \log Z_k\\&+\frac{1}{2}\left(\sum_i^m \sum_j^m A_{ij} \log y_i \log y_j+\sum_j^n \sum_k^n B_{jk} \log w_j \log w_k\right)\\&+\sum_i^m \sum_j^n \Gamma_{ij} \log y_i \log w_j+\sum_i^m \Delta_i \log y_i \log BR\\&+\sum_i^m \sum_k^l E_{ik} \log y_i \log Z_k+\sum_j^n H_j \log w_j \log BR+\sum_k^l K_k \log BR \log Z_k\\&+\sum_j^n \sum_k^l M_{jk} \log w_j \log Z_k+\frac{1}{2}\left(N_{BB}(\log BR)^2+\sum_k^l \sum_h^l P_{kh} \log Z_k \log Z_h\right)\end{aligned} \tag{8}$$

This cost function will be assumed equal for all years, except for the first order parameters and the intercept where different values for different years will be allowed for. This limits the number of parameters to be estimated, and thus allows the pooling of observations from several years.[17]

[17] We have introduced time dummies into the intercept and first order coefficients. Bank specific dummies could not be introduced due to the strong dominance of the cross section observations in the panel. However, estimating each year seperately has produced no appreciable change in results, thus pointing to the robust nature of our estimation results.

We follow standard practice by estimating cost share equations jointly with the cost function:

$$S_j=\beta_j+\sum_k^n B_{jk}\log w_k+\sum_i^m \Gamma_{ij}\log y_i+H_j\log BR+\sum_k^l M_{jk}\log Z_k \qquad (9)$$

where S_j is the cost share of input j.

Restrictions ensuring homogeneity of degree one in factor prices and symmetry are imposed according to:

$$\begin{aligned}
&A_{ij}=A_{ji},\ \forall j,i\\
&B_{jk}=B_{kj},\ \forall k,j;\\
&P_{hk}=P_{kh},\ \forall k,h;\\
&\textstyle\sum_j \beta_j=1;\\
&\textstyle\sum_k^n B_{jk}=0,\quad j=1,\ldots,n;\\
&\textstyle\sum_j^n \Gamma_{ij}=0,\quad i=1,\ldots,m;\\
&\textstyle\sum_j^n H_j=0;\\
&\textstyle\sum_k^n M_{jk}=0,\quad j=1,\ldots,n;
\end{aligned}$$

The expressions for the marginal cost of retail and corporate loans for each observation are:

$$\begin{aligned}
MC_i &\equiv \frac{VC}{y_i}\frac{\partial \log VC}{\partial \log y_i}\\
&=\frac{VC}{y_i}(\alpha_i+\sum_j^m A_{ij}\log y_j+\sum_j^n \Gamma_{ij}\log w_j+\Delta_i\log BR+\sum_j^n E_{ij}\log Z_i)
\end{aligned} \qquad (10)$$

These expressions depend on the bank's level of retail and corporate loans as well as its input prices, number of branches, and quasi-fixed inputs. Thus, the marginal costs of the two outputs will vary across banks and over time.

The marginal cost expressions (10) are inserted into the first order conditions (5)

or (6), which together with the cost function (8) and two of the three share equations (9) form the system of equations to be estimated. We shall employ the method of maximum likelihood, using the Davidon-Fletcher-Powell algorithm.

The first order conditions were derived in the two alternative forms (5) and (6), depending on whether we choose to model absolute or relative expected responses. However, we always find, by Akaike's Information Criterion[18], that the logarithmic form (6) fits the data much better than the absolute response alternative. The constant absolute response model also exhibits strong indications of misspecification, with negative R^2s frequently appearing. In what follows we shall therefore only report results from the relative response specification (6).

4.2. The Cost Function

The estimates of the year specific first order terms of the cost function (8), along with the conjectural variation parameters from equations (6), are presented in table 1[19]. The large number of second order cost function parameters are assumed equal across years and will not be presented. We have checked the concavity condition with respect to

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[18] Akaike's Information Criterion (AIC) is defined as: AIC = -2log L(f) + 2n, where L(f) is the likelihood function and n is the number of observations.

[19] The measure of short-run (overall) scale economies is $(1-\Sigma\delta_k)/(\Sigma\alpha_i+\gamma_B)$ at the sample mean (the point of approximation). Note that we include the term γ_B to insure that we do indeed measure returns to scale (the variation in unit costs with respect to proportional change in both network size, as measured by the number of branches, and the provision of banking services) rather than returns to network density (the variation in unit costs caused by changing banking service levels within a network of a given size). See Kim and Ben-Zion (1989). The unweighted means (over all banks) of the returns to scale for each of the years are: 0.973, 0.976, and 0.968 for 1990, 1991, and 1992 respectively. These estimates point to short-run increasing returns to scale, and we could statistically reject (at the 1% significance level) constant returns at the sample mean.

variable input prices, which should be met by any well behaved variable cost function. Concavity was found at nearly all observation points.[20] The estimated marginal costs of retail and corporate lending were on average across banks 0.0472 and 0.1111 in 1990, 0.0457 and 0.1203 in 1991, and 0.0422 and 0.1324 in 1992. The marginal costs of corporate lending were thus on average higher than for retail lending.

As has been discussed above, strategic behaviour of multioutput banks may emanate from jointness in production, e.g. cost complementarities. A proper test for the existence of jointness in production is a test of $\alpha_i\alpha_j + A_{ij} \leq 0$.[21] This test was performed using the log likelihood ratio statistic.[22] The computed χ^2 value was 1235.0, which far exceeds the critical χ^2 value for any reasonable significance level. Thus, non-jointness in production of retail and corporate outputs was decisively rejected. Since these two outputs are not substitutable in demand, implying that cross price elasticities are vanishing, production jointness may be one of the major driving forces behind the strategic interaction in this sector.

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[20] There were 21 violations among the 453 observations.

[21] This is a test of $\partial^2 VC/\partial y_1 \partial y_2 \leq 0$, with subscripts indexing the retail and corporate outputs. Note that this test, performed at the point of approximation (the sample mean), is a proper test for jointness, but may not be a proper test for economies of scope because a rejection of the restricted form might imply $\partial^2 VC/\partial y_1 \partial y_2 > 0$ somewhere in the data. However, in the present context jointness is sufficient for a change in equilibrium strategy regarding the level of one output to affect the optimized level of the other output. For tests using approximation analysis see Denny and Fuss (1977) and Denny and Pinto (1978).

[22] The likelihood ratio test statistic is computed as $-2\log(L_r/L_u)$ which is distributed as a χ^2 variate with degrees of freedom equal to the number of independent restrictions, in this case one. L_r and L_u are the likelihood function values of the restricted and unrestricted models, respectively.

4.3. Behavioural Equations

The two first order conditions in the preferred logarithmic form (6) contain four conjectural variation parameters, describing the expected relative responses to initial changes in output. Positive own market reactions ($\theta_{11}>0$, $\theta_{22}>0$) represent expected retaliation, and imply that the market is oligopolistic and characterized by significant strategic interaction. Negative own market reactions ($\theta_{11}<0$, $\theta_{22}<0$) represent expected accommodation (or forbearance), and thus depict a market approaching the competitive structure.[23]

The cross market reactions, given by θ_{12} and θ_{21}, should be interpreted in conjunction with the own market conjectures. Equal signs of own and cross market reactions may be explained by the existence of jointness in production, as established above. For instance, with a retaliatory situation in the first market, jointness may lead us to expect a postive cross market reaction. Opposite signs may also be given reasonable explanations. For instance, a positive own market reaction may be consistent with a negative cross market reaction, since funds may be withdrawn from one market to make possible an expansion of lending in the other market.

The estimated values of the conjectural parameters are reported in table 1. The parameter estimates (standard errors) for own retail market interaction θ_{11} = 0.611 (0.011), 0.641 (0.009) and 0.632 (0.011) for 1990, 1991, and 1992 respectively are

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[23] Note that Cournot conduct would imply θ_{ij} =0, $\forall$i,j. Had the absolute response form been selected by the data (equation 3), then θ_{kk}=-1 would represent a perfectly competitive market.

strongly positive, implying that banks expect an increase in their retail lending to be met with retaliation from other banks in the retail market. The parameter estimates (standard errors) for own corporate market interaction $\theta_{22} = 0.105$ (0.049) for 1990, but it is negative in 1991 and 1992, namely -0.264 (0.069) and -0.343 (0.073), respectively. This implies that banks expect a weak response, or an accommodating response, in the corporate market to an initial increase in their corporate lending. The behavioural patterns are thus very different in the two markets. The retail market is characterized by significant strategic interactions, whereas the corporate banking market appears to be much closer to a competitive type of market structure, with accommodating expected responses in 1991 and 1992. We have tested whether the oligopolistic nature of bank's behaviour is significantly different from a Cournot conduct, which is represented by all the conjectural variation parameters (θ_{ij}) equalling zero. To carry out this task we have performed six sequential (likelihood-ratio) tests, one for each market in each year. Results shown in table 2 point to the rejection of Cournot conduct in both markets for all years.

Notice that the estimated difference between the two markets originates from the much lower marginal revenues obtained from corporate lending than from retail lending, confer section 3 above. The estimated marginal costs are, however, on average higher for corporate lending than for retail lending, confer section 4.2. The mark up over costs is thus much more modest, and in some cases negative, in the corporate market. This corresponds well to the conventional views on these two market segments.

However, it does not correspond well to inferences made about market power based on concentration ratios such as the Herfindahl index. Specifically, we have

computed the Herfindahl index for the retail and corporate markets in 1990-92, as summarised in table 3. The entries in that table depict a non-concentrated retail market, and a highly concentrated corporate banking market.[24] On that basis one would have expected the retail market to be the more competitive. Thus, our analysis shows that concentration indices may be unreliable as a tool for measuring market power. Other influences may in practice be more important determinants.[25]

The oligopolistic structure identified in the retail banking market corresponds to a situation where, for reasons of forbearance (fear of retaliation), banks are not very actively competing for customers. This is consistent with our notion of retail customers as being less informed and less likely to switch from one bank to another than are corporate customers. It is also consistent with informational asymmetry on the supply side, with each bank possessing some exclusive information about its current retail customers, and thus an absolute advantage in the evaluation of their creditworthiness, confer e.g. Stiglitz and Weiss (1988), Sharpe (1990), Vale (1993).

Furthermore, the more competitive structure of the corporate market is consistent with the observation that corporate customers in general have a stronger incentive to gather information and seek price offers from several banks. Since most corporate

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[24] Note that the numbers in table 3 may somewhat exaggerate the true concentration ratios in both markets, since non-banks do also supply retail and corporate loans. This bias may be more important in the market for corporate loans. On the other hand, retail banking and to some extent corporate banking takes place in local markets, and hence our concentration measures may tend to underestimate true concentration. These combined facts are, however, unlikely to affect the qualitative conclusion drawn.

[25] Nathan and Neave (1989), Shaffer (1993), and Shaffer and diSalvo (1994) also report high degrees of competition in structurally concentrated banking markets.

customers must file publicly available financial statements, the informational asymmetry on the supply side might also be less important in that market.

The parameters θ_{21} and θ_{12} represent expected cross market responses, and are both found to be negative for all three years as shown in table 1. Banks do not expect their competitors to retaliate in another market than where the initial change in lending took place. The estimated negative response in the corporate banking market, following an increase in retail lending, may mainly reflect the rivals' expected diversion of funds from the corporate to the retail market, to generate the expected retaliation in the retail market. Given the presence of cost complementarity (section 4.2), this aggregate cross market effect may seem unreasonable at first glance, but may be explained by the fact that the few large banks[26] dominating this aggregate were during the sample years limited in their access to funding in the money market where additional funding must be obtained.[27] Thus most banks had reason to expect that their rivals' retaliatory capacity would be limited.

The estimated negative response in the retail market, following an increase in corporate lending, is numerically very small. However, it combines with an expected negative or close to zero own market response in the corporate market, and may be due to perceived cost complementarity between the two outputs. We note that $\theta_{12} < \theta_{21}$ (in absolute values), i.e. the expected response is more accomodating in the corporate

[26] The three largest banks in the sample had in 1992 56% of total retail and corporate lending.

[27] The bank crisis particularly hit the largest banks and impaired their funding possibilities. This was not true to the same extent of the majority of small banks.

market (to a change in the other market) than it is in the retail market. This is consistent with the corporate market being the more competitive.

The preceding analysis can be enhanced by paying attention to the change in the parameter estimates through time. Thus, we performed tests of conjectural variation parameters equality through the three years of our sample, using likelihood ratio tests. These tests, along with the restricted model resulting from them, are presented in tables 4 and 5. We could not reject equality of the own retail market responses through the three sampled years; $\theta_{11}(90) = \theta_{11}(91) = \theta_{11}(92) = 0.627$. The cross market effects θ_{12} are also equal, but significantly negative at -0.007, across the three sample years. The other cross market effect θ_{21} was found to be equal for 1990 and 1991 (-0.026), but relatively much stronger in the year 1992 (-0.089). The own corporate market effect was found to be equal for the 1991 and 1992 years ($\theta_{22} = -0.304$) but not equal to that of 1990 ($\theta_{22} = 0.162$). We note that the strategic behaviour identified in the corporate banking market became systematically more forbearing, indicating an increasing degree of competition in that market. Similar trends are not apparent in the retail banking market.

The above results are in accordance with the prevalent views on how the Norwegian banking markets have developed during and after the general crisis that peaked in 1991. The degree of competition has been perceived to be increasing, in particular in the corporate market where a number of new entrants have tried to gain foothold since the mid 1980s. New entrants have been far less important in the retail banking market.

5. CONCLUSIONS

We have characterized oligopolistic behaviour in the retail and corporate banking markets, within a conjectural variation model. We have found evidence of strong differences between the two markets, with expectations of retaliatory behaviour in the retail market and accomodating behaviour in the corporate market. These differences are contrary to what an inspection of the Herfindahl indices of supply side concentration would lead us to expect.

Banks are found to have substantial market power in the retail market, most likely because retail customers often do not have the resources to search for the best offer in the market, and because of important informational asymmetries on the supply side of the market. Both factors contribute to impede the mobility of customers in the retail market.

The customers in the corporate market have a much stronger incentive and ability to search for the best offer among a number of banks. The informational advantages of each bank towards its current customers may also be less important in this market, and the banks are seen to possess less market power. The mobility of customers within the corporate market is potentially much more important than in the retail market, and entry is thus less costly in this market segment.

Cross market effects are found both from the retail to the corporate market and vice versa. In particular, while the direct response to an initial increase in retail lending is expected to be retaliatory, the indirect response in the corporate market is expected to be

non-retaliatory. And while a weak or accommodative direct response is expected to an initial increase in corporate lending, the indirect response in the retail market is always expected to be non-retaliatory. Our findings of significantly negative cross market effects, combined with a positive own market effect in the retail market, indicate that although jointness in costs is present in our data, it may not be the main influence behind bank strategic behaviour. The negative cross market effects may instead be explained by the near competitive nature of the corporate market, and the restrictions on money market funding which may have applied to a relatively small number of large banks.

The experiences from the European banking markets of the past decade indicate that new entrants will most often try to establish some initial presence in the corporate banking market, and may frequently choose to ignore the retail market altogether. This is what we would expect from the estimated own market effects above, where we find that retaliation is expected in the retail market, but not in the corporate market. The priority given of incumbent banks to defending market shares in retail banking is also emphasized by the stronger negative cross market effect in the corporate market. This may mean that incumbent banks perceive their competitive viability as being mainly dependent on their ability to maintain their retail customer relationships.

Table 1: Parameter estimates from the simultaneous estimation of the cost function* and conjectural variation equations, standard errors in parentheses.**

Parameter	1990	1991	1992
α_0 (intercept)	12.130 (0.030)	12.230 (0.033)	12.243 (0.034)
α_1 (retail)	0.415 (0.019)	0.417 (0.019)	0.409 (0.018)
α_2 (corporate)	0.380 (0.020)	0.390 (0.020)	0.431 (0.023)
β_1 (labour)	0.262 (0.009)	0.265 (0.009)	0.290 (0.010)
β_2 (materials)	0.186 (0.010)	0.197 (0.009)	0.234 (0.011)
γ_B (branches)	0.191 (0.018)	0.193 (0.018)	0.185 (0.019)
γ_1 (deposits)	-0.049 (0.033)	-0.072 (0.033)	-0.081 (0.034)
γ_2 (machines)	0.096 (0.026)	0.106 (0.028)	0.100 (0.030)
θ_{11} (retail, retail)	0.611 (0.011)	0.641 (0.009)	0.632 (0.011)
θ_{12} (retail, corporate)	-0.008 (0.002)	-0.008 (0.002)	-0.005 (0.002)
θ_{21} (corporate, retail)	-0.025 (0.014)	-0.054 (0.024)	-0.094 (0.023)
θ_{22} (corporate, corporate)	0.105 (0.049)	-0.264 (0.069)	-0.343 (0.073)
Sample size	157	149	147

* For the sake of brevity the second order terms of the cost function are not shown here. Full details can be made available upon request.

** θ_{ij} indicates the expected response in market i to an initial change in market j. Subscript 1 represents the retail and subscript 2 the corporate banking markets respectively.

Table 2: Testing for Cournot behaviour.

Hypothesis	Computed Chi-Squared	Critical Chi-Squared (2); (0.005)*	Accept / Reject
$\theta_{11}(1990) = \theta_{21}(1990) = 0$	795.06	10.6	Reject
$\theta_{11}(1991) = \theta_{21}(1991) = 0$	988.0	10.6	Reject
$\theta_{11}(1992) = \theta_{21}(1992) = 0$	768.2	10.6	Reject
$\theta_{22}(1990) = \theta_{12}(1990) = 0$	12.18	10.6	Reject
$\theta_{22}(1991) = \theta_{12}(1991) = 0$	25.56	10.6	Reject
$\theta_{22}(1992) = \theta_{12}(1992) = 0$	26.84	10.6	Reject

* The total significance level of 0.05 was allocated across the 6 stages with approximately 0.005 level for each stage, according to the Benferoni principle.

Table 3: The Herfindahl index of market concentration.*

Year	Retail market	Corporate market
1990	886.4	2168.8
1991	870.6	2135.3
1992	842.2	2160.2

* The Herfindahl index (H) is the sum of squared market shares in percentages. The US Department of Justice guidelines consider H $<$ 1000 as an unconcentrated market, and H $>$ 1800 as a highly concentrated one (Salop, 1987).

Table 4: Testing time equality of conjectural variation parameters.

Hypothesis	Computed Chi-Squared	Critical Chi-Squared (1); (0.005)*	Accept / Reject
$\theta_{11}(1990) = \theta_{11}(1991)$	6.00	7.88	Accept
$\theta_{11}(1990) = \theta_{11}(1991) = \theta_{11}(1992)$	0.20	7.88	Accept
$\theta_{21}(1990) = \theta_{21}(1991)$	1.32	7.88	Accept
$\theta_{21}(1990) = \theta_{21}(1991) = \theta_{21}(1992)$	9.44	7.88	Reject
$\theta_{22}(1990) = \theta_{22}(1991)$	60.8	7.88	Reject
$\theta_{22}(1991) = \theta_{22}(1992)$	0.68	7.88	Accept
$\theta_{12}(1990) = \theta_{12}(1991)$	0.52	7.88	Accept
$\theta_{12}(1990) = \theta_{12}(1991) = \theta_{12}(1992)$	2.38	7.88	Accept

* The total significance level of 0.05 was allocated across the 8 stages with approximately 0.005 level for each stage, according to the Benferoni principle.

Table 5: Expected (constrained) relative responses, standard errors in parentheses.

Parameter*	1990	1991	1992
θ_{11} (retail, retail)	0.627 (0.010)	0.627 (0.010)	0.627 (0.010)
θ_{21} (corporate, retail)	-0.026 (0.014)	-0.026 (0.014)	-0.089 (0.024)
θ_{12} (retail, corporate)	-0.007 (0.002)	-0.007 (0.002)	-0.007 (0.002)
θ_{22} (corporate, corporate)	0.162 (0.043)	-0.304 (0.070)	-0.304 (0.070)
Sample size	157	149	147

* θ_{ij} indicates the expected response in market i to an initial change in market j. Subscript 1 represents the retail and subscript 2 the corporate banking markets respectively.

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