COMPETITION, CONCENTRATION AND THEIR RELATIONSHIP: AN EMPIRICAL ANALYSIS OF THE BANKING INDUSTRY [1]

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J.A. Bikker and K. Haaf

1 INTRODUCTION

The deregulation of financial services in the European Union, the establishment of the Economic and Monetary Union (EMU) and the development of information technology are expected to contribute to drastic changes in European banking markets in the coming years with vast implications for competition and concentration in the banking and financial sector. One of the consequences is already apparent in the recent wave of mergers in the European banking industry. This process of concentration may affect competition in particular on local markets for bank's retail services. Questions may arise such as: Should concentration be slowed down? or: Are additional measures necessarily to ensure sufficient competition in the local retail markets? Besides that, increased concentration and the size of the new global player may cause concerns about financial stability. To judge the implications of those developments, it is necessary to assess the current market structure of the banking industry, to record the degree of competition, and to investigate the impact of consolidation on the market structure and the behaviour of banks. In recent years, however, only a limited number of empirical studies have investigated competition and concentration in European banking markets. This paper seeks to measure the degree of competition in the European banking markets, and to investigate the impact of concentration on competition. Furthermore, it aims at comparing the situation in Europe with that in the US and other countries.

The literature on the measurement of competition can be divided into two major streams. The *structural approach* to model competition embraces the Structure-Conduct-Performance (*SCP*) paradigm and the efficiency hypothesis, as well as a number of formal approaches with roots in Industrial Organisation theory. The *SCP* investigates whether a highly concentrated market causes collusive behaviour among larger banks resulting in superior market performance, whereas the efficiency hypothesis tests whether it is the efficiency of larger banks that enhances their performance. As response to the theoretical and empirical deficiencies of the structural models, *non-structural models* of competitive behaviour have been developed namely the Iwata model, the Bresnahan model, and the Panzar and Rosse (P-R) model.[3] These New Empirical Industrial Organisation approaches test competition and stress the analysis of the competitive conduct of banks without using explicit

[3] See, respectively, Iwata (1974), Bresnahan (1982) and Panzar and Rosse (1987).

information about the structure of the market. In this paper we will use two of these non-structural models, those of Bresnahan and P-R, to assess the degree of competition in a large number of countries. Furthermore, one of the structural approaches, the *SCP* paradigm, provides a theoretical relationship between market structure (concentration) and conduct (competition) which, in the literature, is ignored. This paper fills in this gap by using the P-R model's measure of competition to test this relationship empirically.

Ideally, the evaluation of competitive conditions and the degree of concentration in the banking industry have to depart from the thorough definition of the market under consideration. The relevant market embraces all suppliers of a certain banking service, which are actual or potential competitors, and it has both a product and a geographical dimension. The product definition of a market is based on the substitutability of the products from the point of view of specific consumer wants. The geographical boundaries of a market are delineated from the effective and potential contacts between actual and potential market participants. The geographical boundaries depend on the products involved: the local dimension of a market is relevant for retail banking products and the regional or international dimension is relevant for corporate banking. This desirability to define product and (smaller-scaled) geographical markets complicates the empirical application of competition and concentration models to the banking industry, given the shortage in (European) data with respect to specific banking products or local regions.

This paper tries to solve this problem in the following two ways. The P-R model is applied to samples of banks of various size: small banks which are assumed to operate predominantly on a local scale, large banks which are supposed to compete more than other banks at the international level, whereas medium-sized banks take an intermediate position. Indirectly, banking behaviour on geographical markets of various sizes is observed, which is possible as the P-R model is based on data of individual banks. It is a first step in the right direction: we obtain information about the effect of (size of) geographical markets on competition. Alternatively, the Bresnahan model is applied to two different *products* of banks, actually the most important ones: the provision of deposit facilities and loans. This approach allows us to discern how competition and concentration might vary between these two product types.

The plan of the paper is as follows. Section 2 introduces and explains the P-R approach and applies this model to banks from 23 industrialised countries, where for each country four samples are employed: small, medium-sized and large banks as well as all banks. Section 3 presents the Bresnahan model and adopts this model to nine EU countries and for each country on two market segments: deposits and loans. Section 4 displays various concentration indices and applies them to the (same) 23 industrialised countries. Furthermore, two formal derivations of the competition-concentration

relationship are given, based on, respectively, the Herfindahl index and the k-bank concentration ratio. Finally, this relationship is tested empirically. The last section summarises and draws conclusions.

2 THE PANZAR AND ROSSE APPROACH

The first approach applied in this paper in order to assess the market structure of the banking industry is the approach of Rosse and Panzar (1977) and Panzar and Rosse (1987). They measure competitive behaviour of banks on the basis of the comparative static properties of a reduced-form revenue equation based on cross-section data. Panzar and Rosse (P-R) assume that banks operate in their long-run equilibrium[4] and that the performance of these banks needs to be influenced by the actions of other market participants. Furthermore, the P-R approach supposes a price elasticity of demand, *e*, greater than unity, and a homogenous cost structure. To obtain the equilibrium output and the equilibrium number of banks, profits are maximised at the bank as well as the industry level. That implies, firstly, that bank *i* maximises its profits, where marginal revenue equals marginal cost:

$$R_i'(x_i, n, z_i) - C_i'(x_i, w_i, t_i) = 0 \tag{2.1}$$

R_i refers to revenues and C_i to costs of bank *i* (the accent-marks refer to 'marginal'), x_i is the output of bank *i*, *n* is the number of banks, w_i is a vector of m factor input prices of bank *i*, z_i is vector of exogenous variables that shift the bank's revenue function, t_i is a vector of exogenous variables that shift the bank's cost function. Secondly, it means that, in equilibrium, the zero profit constraint holds at the market level:

$$R_i^*(x^*, n^*, z) - C_i^*(x^*, w, t) = 0 \tag{2.2}$$

Variables marked with an asterisk * represent equilibrium values. Market power is measured by the extent to which a change in factor input prices (dw_{k_i}) is reflected in the equilibrium revenues (dR_i^*) earned by bank *i*. Panzar and Rosse define a measure of competition, the "*H*-statistic" as the sum of the elasticities of the reduced-form revenues with respect to factor prices:[5]

$$H = \sum_{k=1}^{m} \frac{dR_i^*}{dw_{k_i}} \frac{w_{k_i}}{R_i^*} \tag{2.3}$$

Concerning the value of *H*, P-R assert that *H* is zero or negative when the competitive structure is a monopoly, a perfectly colluding oligopoly, or a conjectural variations short-run oligopoly. Under these

4 Note that also the number of banks is endogenous.

5 See Panzar and Rosse (1987) or Vesala (1995) for details of the formal derivation of *H*.

conditions, an increase in input prices will increase marginal costs, reduce equilibrium output and subsequently reduce total revenues. Under perfect competition, the *H* statistic is unity. In this case, an increase in input prices raises both marginal and average costs without - under certain conditions - altering the optimal output of any individual firm. Exit of some firms increases the demand faced by each of the remaining firms, thereby leading to an increase in prices and total revenues by the same amount as the rise in costs. Monopolistic competition models are *a priori* most plausible for characterising the interaction between banks. The monopolistic competition model recognises the existence of product differentiation and is consistent with the observation that banks tend to differ with respect to various product quality variables and advertising, although their core business is fairly homogeneous. Panzar and Rosse prove that, under monopolistic competition, *H* is unity or less. H is a decreasing function of the perceived demand elasticity, so *H* increases with the competitiveness of the banking industry. The testable hypotheses are: the banking industry is characterised by monopoly for $H=0$, monopolistic competition for $0<H<1$ and perfect competition for $H=1$. The empirical application of the P-R approach assumes a log-linear marginal cost function:

$$\ln MC = a_0 + a_1 \ln OUT + \sum_{i=1}^{3} b_i \ln FIP_i + \sum_{j=1}^{m} g_j \ln EX_{COST_j} \tag{2.4}$$

where *OUT* is output of the bank, *FIP* are the factor input prices (regarding *e.g.* funding, personnel expenses and other non-interest expenses) and EX_{COST} are other variables, exogenous to the cost function C_i. Equally, the underlying marginal revenue function has been assumed to be log-linear of the form:

$$\ln MR = d_0 + d_1 \ln OUT + \sum_{k=1}^{p} h_k \ln EX_{REV_k} \tag{2.5}$$

where EX_{REV} are variables related to the bank specific demand function. For a profit-maximising bank, marginal costs equal marginal revenues in equilibrium, yielding the equilibrium value for output:

$$\ln OUT = (a_o - d_0 + \sum_{i=1}^{3} b_i \ln FIP_i + \sum_{j=1}^{k} g_j \ln EX_{COST_j} - \sum_{k=1}^{p} h_k \ln EX_{REV\,k})/(d_1 - a_1) \tag{2.6}$$

Substitution of this equilibrium value of output into the product of the marginal revenue function (2.5) and the inverse-demand equation, $\ln p = x + h \ln OUT$, provides the reduced-form equation for revenues.

2.1 THE EMPIRICAL P-R MODEL

In the empirical analysis, the following operationalisation of the reduced-form equation for revenues is used:

$$\ln INTR = a + (b \ln AFR + g \ln PPE + d \ln PCE) + z \ln BSF + h \ln OI + e \tag{2.7}$$

where *INTR* is the ratio of total interest revenue to the total balance sheet,[6] *AFR* is the ratio of annual interest expenses to total funds, or the Average Funding Rate, *PPE* is the ratio of personnel expenses to the total balance sheet, or the (approximated) Price of Personnel Expenses, *PCE* is the ratio of physical capital expenditure and other expenses to fixed assets, or the (approximated) Price of Capital Expenditure, *BSF* are Bank Specific exogenous Factors (without explicit reference to their origin from the cost or revenue function), *OI* is the ratio of Other Income to the total balance sheet, and e is a stochastic error term. *AFR*, *PPE* and *PCE* are the unit prices of the inputs of the banks: funds, labour and capital, or proxies of these prices. In the notation of equation (2.7), the *H* statistic reads as $b + g + d$. To verify whether the competitive structure has changed over time due to the process of liberalisation and deregulation, we apply model (2.7) to a pooled cross-section (across banks) and time-series analysis over the time span 1988-98. We assume that the market structure shifts *gradually* over time. Ignoring market dynamics may lead to imprecise parameter estimates and biased *H* statistics, which could in turn result in wrong inferences about the competitive nature of the banking industry. Therefore, we multiply the elasticities of *H* by a continuous time-curve model $\exp(e \cdot TIME)$:

$$\ln INTR = a + (b \ln AFR + g \ln PPE + d \ln PCE)\exp(e \cdot TIME) + z \ln BSF + h \ln OI + e \tag{2.8}$$

Note that $\varepsilon = 0$ indicates that *H* is constant over time. Without this assumption of *gradual change*, the results may be implausibly erratic, as found by Molyneux *et al.* (1994), who applied the P-R model for a series of subsequent years.

The dependent variable is 'ratio of total *interest* revenue to the total balance sheet', as in Molyneux *et al.* (1994). The choice for taking only the interest part of the total revenue of banks is consistent with the underlying notion of the P-R model that financial intermediation is the core business of most banks. However, Shaffer (1982) and Nathan and Neaves (1989) have chosen total revenue as dependent variable. Actually, in recent years, the share of non-interest revenues to total income has increased. We also include the ratio of other income to the total balance sheet (*OI*) as explanatory variable to account for the influence of the generation of other income on the model's underlying

[6] Here we follow the specification of the dependent variable of Molyneux *et al.* (1994). Other authors use unscaled revenues. Re-estimation of the equation with unscaled revenues yields similar results, or even exact equal results, when one of the bank specific factors is 'total assets'.

marginal revenue and cost functions. Actually, the P-R model we will apply, equation (2.8), encompasses the model of Molyneux *et al.* (η=0).

The 'ratio of personnel expenses to the number of employees (*PENE*)' could be a plausible alternative to the 'ratio of personnel expenses to the total balance sheet' (*PPE*) included in our estimations. However, the former proxy is only available for a small subset of our sample of observations. Apart from that, empirical exercises reveal that results based on *PENE* are rather similar to those based on *PPE*. This is probably due to the large sample used, which makes the results less sensitive to measurement errors. The 'ratio of physical capital and other expenses to fixed assets' is also a proxy.[7] In particular, the balance sheet item 'fixed assets' appears to be unrealistically low for some banks. However, the exclusion of outliers or a correction for fixed assets, such as applied by Resti (1997), did not change the estimation results remarkably.

Bank specific factors (denoted by *BSF*) are other explanatory variables that reflect differences in risks, costs, size and structures of banks, and should, at least theoretically, descend from the marginal revenue and cost functions underlying the empirical P-R equation (2.8). The risk component can be proxied by the ratio of risk capital or equity to total assets (*EQ*), the ratio of loans to total assets (*LO*) and the ratio of non-performing loans to total loans (*NPL*). In principle, more variables for risk are considered, as for some banks not all variables are available. To capture differences in the deposit mix, the ratio of interbank deposits to total customers and short-term funding (*BDEP*) and the ratio of demand deposits from customers to total customer and short-term funding (*DDC*) are used. Divergent correspondent activities are taken into consideration when the ratio of cash and due from depository institutions (or banks) to total deposits (*CDFB*) is included. Total assets (*TA*) are used as a scaling factor.

A positive parameter for *LO* is expected, as more loans reflect more potential interest rate income. The coefficient for *OI* is probably negative as the generation of other income may be at the expense of interest income. Variables which did not have these theoretically expected signs, were consequently deleted from the specifications. Regarding the signs of the coefficients of the other explanatory variables, there are various contradicting theories[8] or no strong *a priori* expectations.

[7] 'Capital expenses' includes the cost of premises, equipment and information technology.

[8] For example, Molyneux *et al*. (1994) expects a negative coefficient for EQ, because less equity implies more leverage and hence more interest income. However, on the other hand, capital requirements are higher, the riskier the loan and investment portfolios, suggesting a positive coefficient.

2.2 EMPIRICAL RESULTS

We apply the P-R model to banks from 23 European and non-European countries, listed in Table 2.1. The data have been obtained from the database of the International Bank Credit Analysis Ltd (Fitch-IBCA), a London-based bank credit rating agency. In principle, individual bank data are used for the years 1988-98, but the actual starting date of the sample varies across countries. For each country, Table 2.1 reports the number of banks and available number of observations.[9] The total number of banks is 5,444 and the total number of observations is almost 29,000. Hence, on average, the sample includes 5.3 observations for each bank, as part of the observations are missing due to non-reporting of (all required) data by banks in their annual report, mergers and new entries in the sample period.

For each country, the model estimations have been adopted to a sample of all banks, as well as to subsamples of, respectively, small banks, medium-sized banks and large banks. This partition in small, medium-sized and large is based on total assets of the banks: the smallest 50% of all banks of the world-wide sample constitute the small-banks sample, the largest 10% of all banks constitute the large-bank sample, whereas the remainder form the medium-sized sample. The large-bank sample is relatively small to ensure that only the really large banks are included. Of course, the size distribution differs across the countries, see Table 2.1. Moreover, the final numbers are affected by the availability of the data, which actually appears to be greater, the larger the banks are.

Appendix 1 presents 23 tables, one for each country considered, with the estimation results of the various bank-size categories. For New Zealand and South Korea, the number of small banks is too low to estimate the model. In principle, we started for each country and bank-size combination with a model, which includes all selected Bank specific factors. Actually, for some countries, data are not available for part of these variables, or only available for a limited number of banks. In the latter case, we only accepted a small reduction in the sample and otherwise dropped the variable involved.[10] We also excluded the variables Loans or Other income if their coefficients obtained the wrong sign, which, as a matter of fact, only happened very rarely. Finally, for the sake of parsimony, *BSF* were deleted, if their coefficients were not significant. The latter also holds for the time-trend variable.

[9] Note that ignoring observations of non-financial institutions, which also provide financial intermediation on some subdivision of the banking market, does not distort the current analysis, as the actual (overall) competitive conditions are observed directly, irrespective of the providers of intermediation services.

[10] For this reason, the number of observations of smaller, medium-sized and larger banks of a country do not necessarily add up to the number of all banks. This would hold only, when the model specification would be equal for all bank-size types.

Table 2.1 Sample period and number of observations per country

Country	Sample period	No. of years	No. of banks	No of observation per bank type: All	Small	Medium	Large
Australia	1991-98	8	39	185	13	115	57
Austria	1989-98	10	95	434	226	176	32
Belgium	1989-98	10	85	479	217	194	68
Canada	1988-98	11	60	363	158	140	65
Denmark	1990-98	9	96	578	466	79	33
Finland	1990-98	9	14	77	10	32	35
France	1988-98	11	393	2,489	812	1,334	343
Germany	1988-98	11	2,219	10,987	6,765	3,764	458
Greece	1990-98	9	22	102	46	37	19
Ireland	1992-98	7	35	143	15	112	16
Italy	1988-98	11	365	1,943	813	897	233
Japan	1989-98	10	148	1,081	17	432	632
Korea	1992-98	7	21	63	1	34	28
Luxembourg	1990-98	9	128	825	333	395	97
Netherlands	1991-98	8	57	307	99	145	63
New Zealand	1990-98	9	10	52	9	23	20
Norway	1989-98	10	39	220	74	120	26
Portugal	1991-98	8	41	268	70	144	54
Spain	1990-98	9	154	831	204	458	169
Sweden	1989-98	10	26	145	18	52	75
Switzerland	1988-98	11	385	1,976	1,414	485	77
UK	1989-98	10	213	1,220	518	491	211
US	1991-98	8	799	4,190	1,383	2,326	481
Total			*5,444*	*28,958*	*13,681*	*11,985*	*3,292*

The crucial variable H is equal to $(b + g + d)\exp(e \cdot TIME)$ and, hence, depends on *TIME*, at least when $\varepsilon \neq 0$. In the latter cases, H has been calculated for 1991 and 1997. The coefficient of the average funding rate, b, appears to be the most significant coefficient and positive in almost all cases and, hence, the main contributor to H. The coefficient of the price of personal expenses, g, is also significant and positive in most cases, but commonly smaller than b. The coefficient of the price of capital expenses, d, varies in size, sign and level of significance, and is probably the least important component of H. The elasticity d may also be small due to the lower quality of the data of Capital expenses and Fixed assets, the data which constitute the price of capital expenses. Finally, the coefficient of *TIME*, e, also varies in size, sign and level of significance. Actually e is zero (because not significant) in 53% of all cases, indicating no change in the competitive conditions. Where ε is non-zero, e is positive in 34 out of the 43 cases, which indicates that competition tends to increase over time (see Table 2.2, where H is shown for both 1991 and 1997 when $e \neq 0$). The observation of a rise in competition is more often observed for medium-sized and large banks than for small banks. Loans appear to be the most important *BSF*, both in terms of occurrence and level of significance. Apparently, the ratio of loans and total assets, as proxy of risk, is an important factor of the total interest income ratio. In general, the regression results are very satisfactory, in part due to the large samples: the

estimation of *H* appears to be very robust. Its value is hardly affected by specification choices, such as regarding the *BSF*'s. Furthermore, the goodness of fit of the regression equations is satisfactory.

The tables in Appendix 1 also present the estimated values for *H* and test results for the hypothesis *H*=0 and *H*=1. Table 2.2 reports these values for *H* for various bank-size samples and - where applicable (ε ? 0) - for various years. The superscripts refer to the test results in the footnotes of the tables in the Appendix 1. Values of *H* for which the hypothesis *H*=0 is not rejected at the level of confidence of 95% are written in italics. Values of *H* for which the hypothesis *H*=1 is not rejected at the level of confidence of 95% (or 99%) are written bold (respectively bold and in italics).[11]

Table 2.2 Empirical results for *H* for various bank-size samples and various years

	All banks		**Small banks**		**Medium-sized banks**		**Large banks**	
	1991	**1997**	**1991**	**1997**	**1991**	**1997**	**1991**	**1997**
Australia	0.50[1]	0.57[1]	*-0.14*[2]		0.67[1]	0.70[1]	0.63[1]	0.68[1]
Austria	0.87[1]		**0.93**[2]		0.91[1]	0.89[1]	0.91[3]	
Belgium	0.89[1]		**0.95**[2]		0.88[3]		0.86[1]	0.88[1]
Canada	0.60[1]	0.62[1]	0.74[1]		0.63[1]		0.56[1]	0.60[1]
Denmark	0.32[1]	0.36[1]	0.31[1]	0.34[1]	0.75[1]		***1.16***[2]	
Finland	0.78[1]		**0.67**[2]		0.76[3]		0.70[1]	
France	0.70[1]		0.54[1]	0.59[1]	0.74[1]	0.79[1]	***0.89***[2]	
Germany	0.60[1]	0.63[1]	0.56[1]	0.59[1]	0.68[1]	0.70[1]	**1.05**[2]	**1.03**[2]
Greece	0.76[1]		*0.01*[2]		0.75[3]		**1.01**[4]	**0.94**[4]
Ireland	0.65[1]		**0.99**[2]		0.63[1]		**0.93**[3]	
Italy	0.82[1]		0.75[1]		0.89[1]	0.86[1]	0.83[1]	0.81[1]
Japan	0.58[1]	0.54[1]	**0.43**[2]		0.07[3]	0.11[3]	0.64[1]	0.61[1]
Korea (South)	0.68[1]		-		**0.72**[2]		**0.77**[3]	
Luxembourg	0.93[1]		0.94[2]		0.94[2]	0.95[2]	0.90[1]	0.91[1]
Netherlands	0.75[1]		**0.74**[2]		0.87[1]		**0.91**[3]	**0.95**[3]
New Zealand	0.86[1]		-		**1.11**[2]	***1.13***[3]	0.86[4]	
Norway	0.74[1]	0.77[1]	0.80[1]		0.71[1]	0.75[1]	0.66[1]	0.71[1]
Portugal	0.83[1]		***0.84***[2]		0.88[1]	0.84[1]	***0.91***[3]	
Spain	0.55[1]	0.62[1]	0.56[1]	0.64[1]	0.52[1]	0.59[1]	0.61[1]	0.66[1]
Sweden	0.80[1]		0.84[2]		0.69[1]	0.76[1]	**0.95**[3]	
Switzerland	0.55[1]	0.58[1]	0.51[1]	0.54[1]	**0.95**[2]	0.92[3]	**1.01**[4]	
United Kingdom	0.61[1]	0.64[1]	0.41[1]		0.81[1]	0.85[1]	1.20[1]	
United States	0.54[1]	0.56[1]	0.61[1]	0.62[1]	0.53[1]	0.54[1]	0.68[1]	0.72[1]
Averages[a]	*0.70*		*0.63*		*0.75*		*0.86*	
Maximum	0.93		0.99		1.12		1.20	
Minimum	0.34		-0.14		0.09		0.58	
Avgs Europe	0.72		0.68		0.79		0.91	
Avgs RoW	0.63		0.41		0.63		0.70	

[1] For each country, the superscripts refer to the acceptance or rejection of the null hypothesis *H*=0 and *H*=1, as is explained in the footnotes of the respective tables in Appendix 1. [a] Where the underlying model includes a time trend, averages are taken over *H*-values of 1991 and 1997. Subsequently, averages are taken over the 23 countries.

[11] When the probability of the nil hypothesis is 5% or more the nil hypothesis is accepted or not rejected, when the probability of the nil hypothesis is below 1% the nil hypothesis is rejected, and when the probability of the nil hypothesis is between 1 and 5% we state that the nil hypothesis is rejected at the (stringent) confidence level of 99%.

For the all-banks samples of all 23 countries, both H=0 (perfect cartel[12]) and H=1 (perfect competition) are rejected firmly, that is at the 99% level of confidence, and for almost all countries even at the 99.9% level. This implies monopolistic competition for all countries, without any exception. However, this uniform picture becomes more diverse when the banking market is split into components: the market for (i) small banks which operate more locally, (ii) middle-sized banks which operate both locally and nationally, and (iii) large banks which operate also internationally. For small banks in two countries, Australia and Greece, the hypothesis H=0 cannot be rejected, which suggests that these markets are characterised by perfect collusion. A caveat is that these results are based on relatively small sample sizes. In any case, these results indicate a lower level of competition. For a number of bank-size/country combinations, the hypothesis H=1 can not be rejected, which implies that these markets may be characterised by perfect competition. This holds in particular for a number of the large-bank markets.

In this paper, we interpret H as a continuous measure of the level of competition, in particular between 0 and 1, in the sense that higher values of H indicate stronger competition than lower values. This does not follow automatically from Panzar and Ross (1987), which concentrates only on the testing of the hypotheses H=0 (or more precise H=0) and H=1. However, it can be shown that under stronger assumptions (in particular a constant price elasticity of demand across bank-size markets and countries) our 'continuous' interpretation of H and the comparison between countries or bank-size markets is correct. The averages across all countries (in the bottom rows of Table 2.2) make clear that H is substantially lower for small-bank markets (0.63), somewhat larger for medium-sized bank markets (0.75) and largest for large-banks markets (0.86). Apparently, in line with expectations, smaller banks operate in a less competitive environment than larger banks, or, put differently, local markets are less competitive than national and international markets. This pattern is not only reflected in the averages, but also appears for many of the individual countries. The values of H for small-bank markets range from -0.14 to 0.99, whereas for large banks they range from 0.58 to above 1.

In Europe, all large banks appear to operate in a very competitive environment. Exceptions are two Scandinavian countries (Finland, Norway) and Spain with H values of around 0.7. The competitive environment for smaller banks is weak in Greece and Denmark, and limited in France, Germany, Spain, Switzerland and the UK. In general, competition seems to be weaker in non-European countries. For instance, in the US, Canada and Australia, H ranges from 0.5 to 0.7 against 0.7 to 0.9 in Europe. Of course, this conclusion does not necessarily hold for, say, the largest 10 banks in the US. In Japan competition is even slightly weaker and in New Zealand and South Korea somewhat stronger. A caveat should be put that these comparisons of H across countries are based on stronger assumptions

[12] In all countries, the number of banks is much higher than 1. Hence, H=0 reflect perfect collusion instead of monopoly.

than in the standard P-R model (see above). Differences across countries in economic and institutional conditions could also have affected the estimation results.

To compare our results with those in the literature, Table 2.3 summarises the results of other studies applying the P-R model. Shaffer (1982) in his pioneering study on banks in New York observed monopolistic competition. For Canadian banks, Nathan and Neave (1989) found perfect competition for 1982 and monopolistic competition for 1983-1984. Lloyd-Williams *et al.* (1991) and Molyneux *et al.* (1986) revealed perfect collusion for Japan. Molyneux *et al.* (1994) obtained values for *H* which, for 1986-1989, are significantly different from zero and unity for France, Germany (except for 1987 when 'monopoly' was found), Spain and the UK, thus pointing to monopolistic competition. For Italy, during 1987-1989, the hypotheses of 'monopoly' could not be rejected. The strong shifts in *H* and even market structure over the years are less plausible. Our pooled time series-cross section approach ensures less volatile results. Unlike Molyneux *et al.*, Coccorese (1998), who also analysed the Italian banking sector, obtained quite non-negative values for *H*, which were significantly different from zero. The value of *H* was also significantly different from unity, except in 1992 and 1994.

Table 2.3 P-R model results in other studies

Authors	Period	Countries considered	Results
Nathan and Neave (1989)	1982-1984	Canada	1982: perfect comp.; 1983-1984: monopolistic comp.
Shaffer (1982)	1979	New York	monopolistic competition
Lloyd-Williams *et al*. (1991)	1986-1988	Japan	monopoly
Molyneux *et al*. (1994)	1986-1989	France, Germany, Italy, Spain and United Kingdom.	mon.: Italy; mon. comp.: France, Germany, Spain, UK
Vesala (1995)	1985-1992	Finland	monopolistic competition for all but two years
Molyneux (1996)	1986-1988	Japan	monopoly
Coccorese (1998)	1988-1996	Italy	monopolistic competition
De Bandt and Davis (1999)	1992-1996	France, Germany and Italy	large banks: mon. comp. in all countries; small banks: mon. comp. in Italy, monop-oly in France, Germany
Rime (1999)	1987-1994,	Switzerland	monopolistic competition
Bikker and Groeneveld (2000)	1989-1996	15 EU countries	monopolistic competition

For the Finish banking industry in the years 1985-1992 ,Vesala (1995) always found positive values of *H*, which differed significantly from zero and unity only in 1989 and 1990. De Bandt and Davis (1999) investigate banking markets in France, Germany and Italy for groups of large and small banks. They obtain estimates of *H* which are significantly different from zero and unity for large banks in all three countries. The *H*-statistics estimated for the sample with small banks indicate monopolistic competition in Italy, and monopoly power in France and Germany. The latter results are in flat contradiction to our findings. For Switzerland, Rime (1999) observed monopolistic competition. Bikker and Groeneveld (2000) applied the P-R method to all EU-countries similarly to this study, but

without distinction between size classes. Their results are rather similar, apart for the larger countries, for which they used smaller samples of (only) the largest banks. Therefore, for these countries, their *H* values can be seen as overestimated.

The empirical P-R studies sometimes present far from uniform outcomes. Nevertheless, apart from Japan, and, according to some authors, from Italy, they point to monopolistic competition in the countries considered.

2.3 CONCLUSIONS

The present P-R study, applied to banks from 23 countries and over around 10 years, provides strong evidence that the banking markets in the industrial world are characterised by monopolistic competition. If distinction is made between various banking sizes, in order to capture different geographic markets, perfect collusion cannot be excluded for the small-banks or local markets in Australia and Greece, whereas, for a number of markets of various banking sizes in other countries, perfect competition can not be excluded. Competition is stronger for large banks (which operate more in international markets) and weaker for small banks (which operate more on local markets). In some countries, competition has increased significantly over time. Competition in Europe seems to be somewhat stronger than in countries like the US, Canada and Japan. Due to the large sample and the pooled regression approach, our results are pretty robust. In general, the results are in line with comparable studies in the literature, which also point to monopolistic competition in most countries.

3 THE BRESNAHAN MODEL

The second method applied in this paper in order to assess the market structure of the banking industry is the Bresnahan model. Bresnahan (1982) seeks to determine the degree of market power of the *average* bank in the short run, l, which can be derived from an Industrial Organisations type of model of profit maximising oligopoly banks. Assuming *n* banks in the industry supplying a homogeneous product, the profit function of the average bank takes the form:[13]

(3.1) $$\Pi_i = px_i - c_i(x_i, EX_S) - F_i$$

[13] Our Bresnahan model is based on the intermediation paradigm of the bank, as in Shaffer (1989, 1993), who furthermore assumes that banks produce only one product and use various input factors. Suominen's (1994) and Swank's (1995) employ two-product models (deposits and loans) and assume the interdependence of product demand and marginal cost functions, but neither of them employs cost functions including factor input prices. As proposed by Shaffer (1989, 1993), our cost functions are based on factor input prices. Taking for granted that factor inputs are not the same for loans and deposits, the model separates the costs of banking activities, *i.e.* it ignores the interdependence of cost functions for the two products. We estimate the demand and supply relations

where $?_i$ is profit, x_i is the volume of output, p is the output price, c_i are the variable costs, EX_S are exogenous variables affecting the marginal costs, but not the industry demand function, and F_i are the fixed costs of bank i. Banks face a downward sloping market demand function, the inverse of which is defined as:

$$p = f(X, EX_D) = f(x_1 + x_2 + ... + x_n, EX_D) \tag{3.2}$$

where EX_D are exogenous variables affecting industry demand but not marginal costs. The first order condition for profit maximising of bank i yields:

$$\frac{d\Pi_i}{dx_i} = p + f'(X, EX_D)\frac{dX}{dx_i}x_i - c_i'(x_i, EX_S) = 0 \tag{3.3}$$

Summing over all bank gives:

$$p + f'(X, EX_D)\frac{dX}{dx_i}\frac{1}{n}X - c'(x_i, EX_S) = 0$$

such that:

$$p = -lf'(X, EX_D)X + c'(x_i, EX_S) \tag{3.4}$$

where $l = (dX/dx_i)/n = (1 + d\sum_{i\neq j} x_j/dx_i)/n$. Thus, $?$ is a function of the conjectural variation of the average firm in the market.[14] For the average bank in a *perfectly competitive* market, the restriction $l = 0$ holds, as, in a competitive equilibrium, price equals marginal cost. Since prices are assumed to be exogenous to the firm in a perfectly competitive market, an increase in output by one firm must lead to an analogous decrease in output by the remaining firms, in line with equation (3.4). Under *Cournot equilibrium*, the conjectural variation ($d\sum_{i\neq j} x_j/dx_i$) for firm i equals zero. The Cournot model assumes that a firm does not expect retaliation from other firms as response to changes in its own output, so that $l = 1/n$.[15] Under *perfect collusion*, an increase in output by one of the colluders leads to an equiproportional increase in output by all other colluders, yielding

separately for the deposit and loan markets assuming that banks are maximising profits at the product level rather than taking advantage of possible cross-subsidisation between products.

[14] The conjectural variation of firms is defined as the change in output of all remaining firms anticipated by firm *i* in response to an initial change in its own output.

[15] The assumptions underlying the Cournot oligopoly theory according to Hause (1977) are: homogeneous products, *n* firms with strictly increasing marginal cost functions (which need not be identical), independent (non-co-operative) behaviour of firms to maximise their own profits, no entry, and industry demand is strictly decreasing.

$l = \left(1 + d\sum_{i \neq j} x_j / dx_i\right) / n = \left(1 + \left(X - x_i\right) / x_i\right) / n = X / x_i n = 1, \ \forall i$. Hence, under normal conditions, the parameter *?* takes values between zero and unity.

3.1 EMPIRICAL BRESNAHAN MODEL

We apply the Bresnahan model to the two most prominent sub-markets of the banking industry: the loan and deposit markets. To assess the degree of market power, we simultaneously estimate market demand and supply curves, obtaining the value of *?* which indicates the degree of competition, comparable to *H* in the P-R approach. For the empirical model of the deposit market, the theoretical demand function (3.2) is redefined as linear aggregate demand function for deposit *facilities* by households and banks as:

(3.5) $$DEP = a_0 + a_1 r_{dep} + a_2 EX_D + a_3 EX_D r_{dep} + e$$

where *DEP* is the real value of total deposits, r_{DEP} is the market deposit rate, EX_D are exogenous variables affecting industry demand for deposits but not marginal costs, such as disposable income, unemployment, the number of bank branches and interest rates for alternative investment: the money market rate and the government bond rate, and e is the error term. Equation (3.5) should also include one or more cross terms between the deposit rate and at least one of the exogenous variables determining demand for deposit facilities (in order for the parameter *?* to be identified, see below). The time subscripts in (3.5) and later equations are deleted for convenience. The marginal cost function for bank *i* - $c'\left(x_i, EX_X\right)$ in equation (3.3) - is defined as:

(3.6) $$MC_i = b_0 + b_1 DEP_i + b_2 EX_{S\,i} + n_i$$

where EX_S are exogenous variables influencing the supply of deposits (costs of input factors for the production of deposits, for instance, wages) and n is the error term. Re-arranging the aggregate demand function yields the price function as:

(3.7) $$r_{dep} = \frac{1}{a_1 + a_3 EX_D}\left[DEP - a_0 - a_2 EX_D - e\right]$$

which, multiplied by the deposits of bank *i* yields its total revenue as:

(3.8) $$TR_i = \frac{1}{a_1 + a_3 EX_D}\left[DEP - a_0 - a_2 EX_D - e\right]DEP_i$$

and brings forth, derived with respect to the deposits of bank *i*, the marginal revenues of bank *i*:

(3.9)
$$MR_i = \frac{dTR_i}{dDEP_i} = \frac{1}{a_1 + a_3 EX_D}\left[DEP - a_0 - a_2 EX_D - e\right] + \frac{1}{a_1 + a_3 EX_D}\frac{dDEP}{dDEP_i} DEP_i = r_{dep} + \frac{ln}{a_1 + a_3 EX_D} DEP_i$$

where l is defined as below equation (3.4). Market equilibrium requires the equality of marginal revenues and marginal costs, so that for each bank:

(3.10)
$$r_{dep} + \frac{ln}{a_1 + a_3 EX_D} DEP_i = b_0 + b_1 DEP_i + b_2 EX_{Si} + n_i$$

The aggregate relation for supply of deposit *facilities* by the banks follows from taking averages:

(3.11)
$$r_{dep} = -l\,\frac{DEP}{a_1 + a_3 EX_D} + b_0 + b_1 DEP + b_2 EX_S + n$$

Equations (3.5) and (3.11) are estimated simultaneously to determine λ, the degree of competition of the average bank in the deposit markets of the various countries. In a similar manner, the aggregate demand function for *loans* by households and banks can be defined as:

(3.12)
$$LOANS = a_0 + a_1 r_{lend} + a_2 EX_D + a_3 EX_D r_{lend} + e$$

where real *LOANS* are explained by r_{lend}, the lending rate, by EX_D, exogenous variables influencing the demand for loans, such as income, unemployment, the number of bank branches, the share of labour in total value added and the utilisation rate of capital, and by e, the error term. Again, the equation should contain at least one cross-term consisting of the lending rate and one of the other variables determining demand for loans facilities (in order for the parameter *?* to be identified, see below). The supply relationship for loans can be derived similarly to the supply equation for deposits, presented above:

(3.13)
$$r_{lend} = -l\,\frac{LOANS}{a_1 + a_3 EX_D} + b_0 + b_1 LOANS + b_2 EX_S + n$$

The simultaneous equations (3.12) and (3.13) can be estimated to obtain the value of λ, as long as that parameter is identified. Lau (1981) and Bresnahan (1982) show that, whereas both the demand and the supply relation are identified, the parameter λ is identifiable only when the demand function includes the endogenous interest rate (or 'price') and a cross-term with one of the explanatory (other) variables and this interest rate. In other words, λ is identified when the assumptions a_1 ? 0 and a_3 ? 0 both hold.

3.2 ESTIMATION RESULTS

The Bresnahan model has been applied to the deposit and loan markets of nine EU countries: Belgium, France, Germany,[16] Italy, the Netherlands, Portugal, Spain, Sweden and the UK. The models are based on time series of quarterly data from a variety of databases and institutions: the International Financial Statistics (*IFS*), the Bank of International Settlements (*BIS*), the Organisation of Economic Co-operation and Development (*OECD*), Data Stream (*DS*), the Dutch Central Planning Bureau (*CPB*), the Dutch Central Bureau of Statistics (*CBS*) and various central banks, see Appendix 3. For a number of countries and variables, the availability of the required data and the length of the series are limited. Often, there exists the trade off between quality (series without breaks) and quantity (longer series). The data constrains furthermore hamper complete consistency in the definition of the underlying market across countries: deposit and loan volumes are available for the banking market for all countries, except Belgium, for which a broader definition of the market, *i.e.* one accounting for all credit institutions, is applied.

Market for deposit facilities

Demand equation (3.5) determines the volume of deposits by its price (the deposit rate) and exogenous variables, such as the money market rate, the government debt rate, the volume of GDP, unemployment and inflation.[17] Deposits are defined as the sum of time and savings accounts, whereas *real* deposits are deflated by the available price index. The coefficient of the deposit rate should have a positive sign, since a higher return on deposits makes deposits more attractive. The return on government debt and the money market rate are the prices of two substitutes. They have negative coefficients, as the opportunity cost of holding money in deposit increases with the price of any one of the substitutes. Real GDP proxies income or wealth and should reflect the positive relationship between income and the propensity to save, or between wealth and investment. The coefficient of unemployment is positive if the increased probability of facing unemployment encourages savings, but can also be negative if dis-saving supplements a decline in incomes in the case of unemployment. Hence, *a priori* its sign is indeterminate. The impact of inflation on the demand for deposits can also be twofold, having an offsetting effect. The direct effect of inflation on deposits is negative by the argument that higher inflation increases the propensity of consumers to spend money in the short run rather than to engage in long-term investments. However, if the deposit rate (almost) fully compensates for inflation, the effect on deposits can also be positive, due to money illusion.

[16] Special attention is paid to the German data, since the time series used by our estimations cover the pre- as well as post-unification period. Data for the Western states has been available until 1990; as from 1991, both data for the Western states as well as aggregate data for the entire country are available. We used the data covering the entire country after 1990 and corrected the data for the period preceding the unification. Dummies to take account of the corrections have been included into the estimations. These dummies exhibit significant coefficients.

[17] The complete estimation results for the nine EU-countries are presented in Appendix 2.

The supply equation determines the deposit rate as a function of the volume of deposits, the main input price 'wage rate', other exogenous variables, such as inflation and a function: output times the inverse of the first derivative of the demand function. The coefficient of the latter, -?, is the sought-after measure of competition on the deposit market. For the coefficient of the volume of deposits, we expect a negative sign, as banks will pay a lower rate on deposits the more deposits they already have attracted. The coefficient of wages of bank employees should be negative, as a higher input price has a negative impact on the deposit rate. Inflation needs to be compensated by a deposit rate paying off consumers for real losses. Hence, its coefficient is expected to be positive.

Market for loans

The demand for real loans is negatively related to the price for loans, the lending rate, and positively related to increasing investment activity as indicated by a higher real GDP income and a higher capital utilisation rate. A high profit income share (or a low labour income share) indicates high profits and expectations of future profits, and hence attractive investment possibilities and increasing demand for new loans. On the other hand, if profits are high, new investment activities can also be financed internally, thus weakening the demand for loans. All in all, a priori, the sign of the coefficients of labour share is unknown. The propensity of economic agents to take out loans is encouraged when - expected - inflation is higher, such that the real value of funds decreases. Contrary, the lending rate might also rise by inflation, thus cancelling out the effects.

The loan supply relation determines the lending rate by real loans, inputs such as wages, the deposit rate and the number of branches, as well as other exogenous variables such as the money market rate, the government rate, inflation and a function: output times the inverse of the first derivative of the demand function. The coefficient of the latter, -?, is the crucial variable in our analysis, the measure of competition on the loans market. Banks translate the risk associated with a larger loan portfolio into higher prices. Likewise, increasing costs related to the provision of loans, namely higher wages, higher costs of the funds to be transformed into loans, and a larger number of bank branches increase the operating costs of banks and are reflected in higher lending rates. The money-market rate and the rate on government debt have been included into the supply relation as a comparative measure for product pricing, and are expected to have a positive influence on the lending rate. Banks will take account of real losses associated with higher inflation by adjusting their lending rate accordingly. Hence, all coefficients are expected to be positive.

The estimation results of the two Bresnahan models are reported in detail in Appendix 2. The models have been estimated by the 2SLS method.[18] In general, variables with coefficients exhibiting the wrong sign have been deleted for theoretical reasons, whereas variables with insignificant coefficients have been omitted for the sake of parsimony.[19] Whereas the results for deposits are robust for Belgium, Germany, Italy, Spain and Sweden, they are sensitive to variations in the included variables for France, the Netherlands, Portugal and the UK, probably due to inadequacy of the data. For the latter countries, we present two (opposing) results to indicate the observed sensitivity, see Table 3.1. For loans, similar problems did not occur.

Tables 3.1 and 3.2 summarise the estimated values of *?* for, respectively, deposit and loan markets in the various countries under consideration. The tables furthermore indicate the number of observations for each estimation exercise and the respective sample periods. The value for *?* in the Cournot equilibrium ($l = 1/n$, for n the number of banks) are calculated for 1987 and 1997 on the basis of the number of banks obtained from the *OECD* (1999). By the way, the figures make clear that, over these ten years, the number of banks has declined considerably by around 25%, illustrating the current and recent process of consolidation in most EU countries.

Table 3.1 Summary of the estimates of Bresnahan's model for deposit facilities

	No. of observ.	Estimation period	*?*[a]	t-value[a]	No. of banks (1987)	1/*n*	No. of banks (1997)	1/*n*
Belgium	75	1980:1-1998:3	-4.15^{E-05}	0.5	120	0.0083	131	0.0076
France	109	1971:2-1998:2	0.002 [0.015]	1.0 [1.7]	2,021	0.0005	1,288	0.0008
Germany	86	1977:3-1998:4	-0.002	1.3	4,089	0.0002	3,284	0.0003
Italy	64	1983:1-1998:4	-0.000	0.8	391	0.0026	255	0.0039
Netherlands	88	1977:1-1998:4	0.106 [-0.068]	1.3 [1.3]	170	0.0059	169	0.0059
Portugal	84	1978:1-1998:4	0.102 [-0.075]	2.3 [2.1]	29	0.0345	44	0.0227
Spain	83	1978:2-1997:4	-0.001	1.1	333	0.0030	307	0.0033
Sweden	111	1971:2-1998:4	0.000	0.8	144	0.0069	124	0.0081
UK	91	1976:2-1998:4	0.005 [0.003]	1.9 [1.6]	49	0.0204	44	0.0227

[a] Estimates of alternative specifications are between brackets.

Markets for deposit facilities

Besides the deposit rate, at least two exogenous variables proved significant in the demand equation for deposits for all countries see Appendix 2. The significance of the two substitutes, the government rate and the money market rate is rather low, and in the majority of cases, at least one of the two substitutes initially displayed the wrong (positive) sign, probably due to multicollinearity. The government rate is significant for Italy, the Netherlands, Portugal and the UK, and the money market

[18] Note that there are cross-equation restrictions imposed on the parameters: a_1 and a_3 occur in both the demand and supply equation.

[19] Note that when cross terms occur, one cannot judge the sign of coefficients of isolated variables, but should consider coefficients of variable and cross term together.

rate displays a significant coefficient for France and Sweden. In general, the money market rate is highly correlated with the deposit rate and sometimes performed equally good or even better than the deposit rate itself in explaining the volume of deposits. Between one and three cross-terms between the deposit rate and an exogenous variable are included for each of the countries. The degree of fit (adjusted R^2) is higher than 85% for all countries except Sweden (56%).

For most countries, the supply equation for the deposit rate is rather plain in the sense that the number of explanatory variables is low. The coefficient of real deposits is not significant for three countries. The input price variable wages is only significant for Germany and the Netherlands. The degree of competition, *?*, is not significantly different from zero for all countries, except Portugal. As mentioned above, the robustness of the results varies considerably between countries. For France, the Netherlands, Portugal and the UK, the results are sensitive to specification choices. Two (opposite) results shown in Table 3.1 indicate, however, that the main conclusion, namely that *?* has values around zero or $1/n$, keeps upright.

The estimated values of *?* are central in the analysis. From Table 3.1 it is clear that the *?*s for all countries are not significantly different from zero, except for Portugal in one of the two variants. Comparing these *?*'s with the values under Cournot equilibrium, the inverse of the number of banks, illustrates the difficulty of distinguishing perfect competition ($l = 0$) from Cournot equilibrium ($l = 1/n$) empirically. The main problem is the large uncertainty about the true value of *?*, whereas some questions may also arise regarding the most appropriate number of banks.[20] However, one conclusion can be drawn. The markets for deposit facilities in the EU countries considered are most probably highly competitive. This main conclusion is fully in line with the results of the P-R analysis for the whole banking market of Section 2.

Table 3.2 Summary of the estimates of Bresnahan's loans model

	No. of observ.	Period	*?*	t-value	No. of banks (1987)	1/*n*	No. of banks (1997)	1/*n*
Belgium	75	1980:1-1998:3	0.028	1.0	120	0.0083	131	0.0076
France	109	1971:2-1998:2	0.050	0.1	2,021	0.0005	1,288	0.0008
Germany	86	1977:3-1998:4	-0.003	1.9	4,089	0.0002	3,284	0.0003
Italy	64	1983:2-1998:4	-0.000	1.7	391	0.0026	255	0.0039
Netherlands	88	1977:1-1998:4	-0.000	0.4	170	0.0059	169	0.0059
Portugal	84	1978:1-1998:4	-0.000	1.0	29	0.0345	44	0.0227
Spain	75	1978:2-1997:4	-7.45^{E-05}	0.2	333	0.0030	307	0.0033
Sweden	111	1971:2-1998:4	-0.001	0.5	144	0.0069	124	0.0081
UK	88	1976:2-1998:1	0.000	0.4	49	0.0204	44	0.0227

[20] For instance, there is a difference between the number of banks with a banking licence and the number of actually active banks.

Markets for loans

In the demand for real loans equation, the lending rate and real GDP display significant coefficients for all countries, see Appendix 2. Unemployment proves also to be a significant determinant for most countries. A significant coefficient for the capital utilisation rate is found only for Portugal, whereas inflation performs well for Belgium only. For all countries, one or two cross-terms are included. The goodness of fit of the demand for loans equation is high with a $\overline{R}^2$ of 95% and above, except for Sweden, which displays a $\overline{R}^2$ value of 58%.

The loan supply equation determines the lending rate, and wages and the deposit rate perform as important input prices to the provision of loans. In this relation wages acts much better than in the deposit relationship. The number of bank branches, available for the Netherlands only, shows a highly significant coefficient. Both the money market and government rate are highly significant for the majority of countries. Conversely, real loans do not perform very well as explanatory factor. The values obtained for the measure of competition *?* are not significantly different from zero for any of the countries, i.e. the hypothesis that the loan markets in all countries are perfectly competitive can not be rejected. The latter also holds for the Cournot equilibrium: uncertainty about the true values of the *?*'s does not allow to distinguish between perfect competition and Cournot equilibrium. The goodness of fit of this second equation was higher than 85% for all countries.

Empirical applications of the Bresnahan model are rather scarce and hardly allow comparison to our results. The model has been estimated by Shaffer (1989, 1993) for, respectively, the US loan markets and for the Canadian banking industry. In both cases *?*'s have been found to be not significantly different from zero, hence implying perfect competition or Cournot oligopoly. To the best of our knowledge, only two studies applied the Bresnahan method to the European banks, namely Suominen (1994) to the Finish banking deposit and loan market, and Swank (1995) to the Dutch mortgage and savings deposit market. Suominen finds estimates for *?*, which are not significantly different from zero for the years until 1985 with regulated interest rates, and values of *?* indicating the use of market power after the deregulation of the loan market. Swank detects that both markets under consideration were significantly more oligopolistic than in Cournot equilibrium and that *?* increases over time.

3.3 CONCLUSIONS

The measure of competition from the Bresnahan model indicates for both the deposit and loan markets in all nine EU countries under consideration that the degree of competition is high. The hypothesis of perfect competition (*?* = 0) cannot be rejected, and, due to the uncertainty around the 'true' value of *?*, this also holds for the hypothesis of Cournot equilibrium (*?* = 1/*n*). The only exception is the

Portuguese deposit market, which is probably better characterised by oligopoly. This assessment of highly competitive banking markets in EU countries is in line with the results of the P-R model, which also indicates the possibility of perfect competition in some countries and (at least) the existence of monopolistic competition for almost all countries.

4 CONCENTRATION INDICES AND IMPACT ON COMPETITION

Given the current wave of mergers in the EU banking market and the expectation of continuing or even accelerating of consolidation, some concern has risen about competitive conditions in the EU banking markets. This holds in particular for market segments such as local markets and retail markets. More precisely, the question emerges whether concentration might affect the conduct of banks or the degree of competition. The relationship between the structure of the market and behaviour of banks is captured by the well-known Structure-Conduct-Performance Paradigm (*SCP*). This model has frequently been applied in empirical estimations, even though it lacks a formal theoretical origin. However, whereas dependencies between market structure (proxied by a measure of concentration) and market performance have been investigated many times[21], the relevance of banks' conduct for competitive conditions, as proposed in the original version of the model, has almost entirely been ignored.[22] This section aims to investigate this ignored relationship and seeks to assess a possible impact of concentration on competition.

The first part of this section presents and explains the two most frequently used concentration measures, the k-bank concentration ratio and the Herfindahl index, and applies these measures to the banking markets of the 23 countries for which the *H*-statistic of the P-R model has been calculated. The second part of this section shows how both concentration measures are embedded in the theoretical *SCP*-relationships. Finally, the last part of this section presents an empirical model, which relates a conduct measure, namely the *H*-statistic to market structure, proxied by concentration and the number of banks operating in the market.

The constituting parts of concentration measures are the number of banks (fewness) and the distribution of the bank sizes (inequality) in a given market, and a very general form of those concentration indices is given by:

(4.1) $$CI = \sum_i^n s_i w_i$$

[21] An overview of those studies can be found in Molyneux *et al.* (1994).

[22] See Calem and Carlino (1991) for an example of the empirical approximation of conduct.

where s_i is the market share of bank *i*, w_i is the weight that the index attaches to the corresponding market share and *n* is the number of banks in the market under consideration. The weights attached to the individual market shares determine the sensitivity of the indices towards changes in the tail of the bank-size distribution. Marfels (1971) and Dickson (1981) give an overview of measures exhibiting this form. Summing only over the market shares of the *k* largest banks in the market, the *k*-bank concentration ratio takes the form

(4.2) $$CR_k = \sum_{i=1}^{k} s_i$$

giving equal emphasis to the *k* leading banks, but neglecting the many small banks in the market. There is no rule determining the optimal value of *k*, i.e. the number of top banks included into the index. The index ranges between zero and unity, approaching zero for an infinite number of infinitesimally small banks (given that the *k* chosen for the calculation of the concentration ratio is comparatively small compared to the total number of banks) and it equals unity if the banks included into the calculation of the concentration ratio make up the entire industry. As a result of its definition, for $CR_k = 1$, the *k*-bank concentration ratio can not discriminate between monopoly ($k = 1$) and oligopoly ($k > 1$ and $n = k$). Furthermore, changes in the index with the entry of an additional bank depend upon which of the pre-existing banks would loose market share to the new bank entering the market. The index provides information only about shifts in market shares between the top *k* banks and the remaining fringe, but does not capture changes in distribution within these two groups.

The Herfindahl index *(HI)* is the most widely treated measure of concentration which for its calculation takes into account all *n* banks in a market. For that reason, this index is often called the "full-information" index. In the United States, the *HI* plays a significant role in the enforcement process of antitrust laws in banking. The application for merger of two banks will be approved without further investigation, if the basic guidelines for the evaluation of the concentration in deposit markets are satisfied. Those guidelines imply that the post-merger market *HI* does not exceed 0.18, and that the increase of the index from the pre-merger situation is less than 0.02 (Cetorelli, 1999). The *HI* has the following form:

(4.3) $$HI = \sum_{i}^{n} s_i^2$$

The equation follows from equation (4.1), if market shares are taken as weights. The definition of the *HI* stresses the importance of larger banks by giving them a higher weight than smaller banks, and it incorporates each bank separately and differently so that arbitrary cut-offs and insensitivity to the share distribution are avoided. The *HI*-index ranges between $1/n$ and 1; it reaches its lowest value, the

reciprocal of the number of banks, when all banks in a market are of equal size, and it reaches unity in the case of monopoly.

Adherents of either index are numerous, and a theoretical dispute accompanies the empirical application of both indices. Supporters of the k-bank concentration ratio maintain the view that the behaviour of a market dominated by a small number of large banks is very unlikely to be influenced by the total number of enterprises in the market. The advocates of the view that every bank in the market influences market behaviour stress a severe disadvantage of the k-bank concentration ratio. They argue that this measure not only ignores the structural changes in those parts of the industry which are not embraced by the index of concentration, but also neglects the competitive influence of small banks on the decisions of the large players in the market.

Table 4.1 presents the k-bank concentration ratio for k = 3, 5, 10 and the Herfindahl index for 1997 for all 23 countries analysed earlier. Total assets have been taken as measure of bank size. The value of the k-bank concentration ratios always exceeds the value of the *HI,* since the latter attaches lower weights to the markets shares (the weights again being market shares) than the former (unit weights). The results for the various indices are rather similar, displaying a high degree of correlation. The highest correlations are found between CR_3 and CR_5, CR_5 and CR_{10}, and, surprisingly, *HI* and CR_3. In terms of ranking, the correlation between *HI* and CR_3 is, at 98%, by far the highest. This illustrates that the *HI* is determined mainly by the (squares of the market shares of) the highest banks, which plays down the 'theoretical' disadvantage of the CR_k's compared to the *HI* that they ignore the effects of smaller banks. All indices are negatively related to the number of banks.

For countries where the number of banks in the available sample is low, as in Finland, Korea and New Zealand, the results are less reliable. High concentration is found in Denmark, Greece, the Netherlands and Switzerland, where the three largest bank take more than two-third of the total market in terms of total assets. For Canada, concentration is high only when at least five banks are taken in consideration. Switzerland is the most concentrated country according to *HI*, which may look remarkable given the large number of banks. When more than three Swiss banks are taken into account, concentration hardly rises. Concentration appears to be low in France, Germany, Italy, Luxembourg and the US, where the largest three have a share of less than one-third. By all measures, concentration is lowest in the US. In Germany, where the number of banks in our sample is largest, concentration is somewhat lower.

Table 4.1 Concentration indices for 23 countries, based on total assets (1997)

	Herfindahl Index	CR_3	CR_5	CR_{10}	No. of banks
Australia	0.14	0.57	0.77	0.90	31
Austria	0.14	0.53	0.64	0.77	78
Belgium	0.12	0.52	0.75	0.87	79
Canada	0.14	0.54	0.82	0.94	44
Denmark	0.17	0.67	0.80	0.91	91
Finland	0.24	0.73	0.91	1.00	12
France	0.05	0.30	0.45	0.64	336
Germany	0.03	0.22	0.31	0.46	1,803
Greece	0.20	0.66	0.82	0.94	22
Ireland	0.17	0.65	0.73	0.84	30
Italy	0.04	0.27	0.40	0.54	331
Japan	0.06	0.39	0.49	0.56	140
Korea	0.11	0.45	0.68	0.96	13
Luxembourg	0.03	0.20	0.30	0.49	118
Netherlands	0.23	0.78	0.87	0.93	45
New Zealand	0.18	0.63	0.90	n.a.	8
Norway	0.12	0.56	0.67	0.81	35
Portugal	0.09	0.40	0.57	0.82	40
Spain	0.08	0.45	0.56	0.69	140
Sweden	0.12	0.53	0.73	0.92	21
Switzerland	0.26	0.72	0.77	0.82	325
United Kingdom	0.06	0.34	0.47	0.68	186
United States	0.02	0.15	0.23	0.38	717

Both indices can be derived as proxy for market structure in theoretical *SCP* relationships. One formal derivation of this relationship has, among others, been proposed by Saving and Geroski (Reid, 1987). Their derivation assumes a *k*-bank cartel and *n-k* fringe competitors. The fringe competitors are price takers and equilibrate price and marginal cost for profit maximising purposes. The model yields the price-cost margin for the *k*-bank cartel as:

(4.4)
$$\frac{p - c'_j}{p} = \frac{C_k}{h_{D_T} - h_{S_{n-k}}(1 - C_k)}$$

where CR_k is the k-bank concentration ratio, h_{D_T} and $h_{S_{n-k}}$ are, respectively, the elasticities with respect to industry demand and the supply of the competitive fringe. The *SCP* relationship is thus theoretically justified for a market with a *k*-bank cartel and *n-k* small banks. An Industrial Organisations model, comparable to that used for the derivation of the Bresnahan model in Section 3, has been used by Cowling (1976) and Cowling and Waterson (1976) for the derivation of an average price-cost margin as:

(4.5)
$$\left(\sum_i^n p x_i - \sum_i^n c'_i(x_i) x_i \right) \Big/ pX = -\frac{HI}{h_D}(1 + g)$$

where *HI* is the Herfindahl index, h_D is the price elasticity of demand and g is a term capturing the conjectural variation. These derivations show that, from a theoretical point of view, there are arguments to include either the *k*-bank concentration ratio or the Herfindahl index into the empirical estimations of *SCP* relationships. The derivations furthermore show that the conduct of market participants (resulting from the underlying market structure) is equally important in the determination of market performance.

The relationship between conduct and market structure in the banking industry has been investigated by relating the *H*-statistic, a measure of competition as proxy of conduct, to the concentration index (*CI*), and the logarithm of the number of banks in the markets (log *n*), together characterising the market structure. A conduct variable is not explicitly included into our analysis; however, since estimated from a non-structural model of competition, the *H*-statistic appears to be a reasonable measure of conduct. The estimated values of *H* have been taken from the 'all-bank' sample. A concentration index, as described above, is a one-dimensional measure taking account of two dimensions, the number of banks and the distribution of their sizes. For some concentration indices, the index can be rewritten in a measure of the distribution and the number of banks. For instance, the Herfindahl index can be rewritten as (see Haaf (2000), equation (2.6)):

$$HI = \left(h_0^2 + 1\right)/n \tag{4.6}$$

where h_0^2 is the coefficient of variation of the bank size distribution. To restore this two-dimensionality in our empirical analysis, we include the number of banks as a separate measure of market structure. Further, we take logarithms to scale the variable *n*. Hence, the estimated regression is given by:

$$H = a_0 + a_1 CI + a_2 \log n + a_3 dummy(Europe) \tag{4.7}$$

A dummy variable “Europe” is included, because *H* is substantial higher for Europe than for non-European banking markets, which may be due to economic and institutional conditions. The upper part of Table 4.2 presents the estimation results for equation (4.7) for three CI's. For all three regressions, the coefficient on the concentration index displays the expected negative sign, indicating that the competition is decreasing with increasing market concentration. The significance of CR_3 is highest, whereas also the effect of its coefficient is strongest, taken the average size of the indices into account. Thus, the result seems to support the view that the share of the *k* largest banks rather than the entire size distribution of banks in a market is most determinative for the competitive conditions in a market.

Table 4.2 Relationship between competition and concentration for the all bank sample

	HI	CR_3	CR_5
Constant	1.01 (7.0)	1.23 (7.1)	1.31 (5.5)
Concentration Index	-0.93 (1.9)	-0.53 (2.9)	-0.47 (2.3)
Log *n*	-0.07 (2.8)	-0.09 (3.6)	-0.10 (3.2)
Dummy (Europe)	0.15 (2.3)	0.16 (2.8)	0.14 (2.3)
$\overline{R}^2$	0.25	0.37	0.30
Constant	0.90 (7.0)	1.05 (6.6)	1.14 (5.3)
Concentration Index	-0.71 (1.8)	-0.38 (2.4)	-0.37 (2.1)
Log *n*	-0.07 (3.1)	-0.08 (3.6)	-0.09 (3.3)
Share of bank deposits	0.85 (3.6)	0.83 (3.7)	0.80 (3.5)
$\overline{R}^2$	0.42	0.48	0.45

Explanatory note: T-values between parenthesis. The critical value of the one (and two) sided t-value test is 1.73 and 2.09, respectively.

In principal, a larger number of banks indicate more potential for competition. For that reason, one expects a positive sign. On the other hand, when the size distribution is very skew and a few banks dominate the market, a large number of banks mainly indicate a fringe of powerless dwarfs. The more banks, the less ability to make their presence felt. The latter effect appears to be dominant, as the net effect of the number of banks on competition is negative.[23] Obviously, where a few large banks occur with together a large share of the market, such as typically measured by the CR_3 or CR_5, competition is affected more heavily. The dummy variable for Europe proves to be significant for all three regression equations, indicating the different conditions for European banks, which are not taken into account by the other explanatory variables.

It is difficult to discover which different conditions explain the diverging levels of competition for European and non-European banks. If the national share of bank demand deposits in total assets is included in equation (4.7), the Europe-dummy becomes insignificant and can be dropped, see the lower part of Table 4.2. This share reflects one aspect of the average funding habits of banks. European banks make more extensive use of the interbank market for funding. The higher degrees of fit suggest that this variable may be important but a convincing theoretical explanation is missing.[24]

The above provides evidence that conduct such as competitive behaviour is indeed related to characteristics of the market structure such as concentration and the number of banks. This follows from the significant coefficients of the CI and the number of banks, as well as from a Wald test, which test the significance of these two coefficients simultaneously.[25] Hence, the continuing process of consolidation

[23] An alternative interpretation is that the effect of the number of banks as taken into account by the concentration index is overestimated.

[24] One possible explanation is that where banking and financial markets are more developed, (1) the interbank market is more developed and (2) competition is heavier. In that case, the share of bank deposits acts as an indicator of financial sophistication.

[25] For all (six) equations, the hypothesis 'both coefficients are zero' is rejected at the 95% level of confidence.

in the banking industry may raise the concern of policy makers about competitive conditions in the banking markets. This concern, however, is very often related to market segments rather than entire markets, such as, for instance, deposits or certain local areas. Unfortunately, the limited availability of data does not allow more refined analyses.

5 CONCLUSIONS

The ongoing drastic structural changes in the banking industry, in particularly in Europe may affect competition in particular on local markets and for bank's retail services. This paper seeks to assess competitive conditions and concentration in the banking markets of not less than 23 industrialised countries inside and outside Europe. Moreover, it investigates the interaction between competition and concentration. To obtain a broader view, two non-structural models of competition have been employed to estimate competitive conditions: the Panzar-Rosse and the Bresnahan model. The P-R approach has been applied to 23 countries over a time span of more than 10 years. The resulting *H*-statistic provides strong evidence that the banking markets in the industrial world are characterised by monopolistic competition, whereas sometimes even perfect competition cannot be excluded. We have attempted to take account of the geographical dimension of banking operations by defining three sub-markets in terms of bank sizes for each country and have estimated their degree of competition. Small banks seem, on average, to operate under less competitive conditions than large banks, whereas medium-sized banks take an intermediate position. For two countries, Australia and Greece, perfect collusion can not be excluded for small-banks or local markets. In some countries, perfect competition has been found for large banks. For a number of countries, estimates of the *H*-statistic over time indicate a significant increase in competition. Competition in Europe seems to be somewhat stronger than in countries like the US, Canada and Japan.

In order to make a distinction between various products, the Bresnahan model has been applied to both deposit and loan markets. We have estimated the model for nine EU-countries. The hypothesis of perfect competition cannot be rejected for most of the deposit and loan markets, except for the Portuguese deposit market, which exhibits oligopolistic characteristics. This assessment of highly competitive deposit and loan markets in EU-countries is in line with the results for the markets for all banking activities obtained from the P-R model.

Concentration in the banking markets of 23 industrialised countries has been measured by various k-firm concentration ratios and the Herfindahl index. Empirical studies on the impact of market concentration on banks' conduct are rare. To investigate the relationship between competition and concentration, the estimated *H*-values as proxies of competition or conduct are related to the concentration indices considered, as well as the absolute number of banks operating in these markets. The

impact of the latter measures of market structure on competition appears to be significant, the strongest when the concentration index CR_3 is used. The latter confirms that the few large (cartel) banks restrict competition and that the many fringe competitors cannot make themselves felt.

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APPENDIX 1: ESTIMATION RESULTS OF THE P-R MODELS FOR 23 COUNTRIES AND VARIOUS SIZE CLASSES

Table A.1 Empirical results for Australia (1991-98)

	All banks		**Small banks**		**Medium-sized banks**		**Large banks**	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.44	*9.7*	0.01	*0.1*	0.66	*13.5*	0.52	*10.9*
Wage rate	0.03	*3.6*	-0.16	*1.0*	0.03	*3.0*	0.05	*3.0*
Capital price	-0.00	*0.9*	0.01	*0.0*	-0.05	*4.0*	0.02	*1.5*
Time	17.64	*3.8*			7.58	*2.3*	13.15	*4.3*
Loans	0.35	*10.6*			0.25	*7.0*		
Other Income			-0.80	*5.8*			-0.05	*2.9*
Total Assets							0.02	*2.4*
Equity			1.63	*3.7*	-0.06	*3.4*		
Cash & DFB							-0.02	*2.5*
Intercept	-0.80	*6.4*	11.4	*4.3*	0.06	*0.3*	1.19	*6.8*
Adj. R^2	0.67		0.85		0.82		0.91	
No. of observ.	168		13		104		56	
H ('91-'97)	**0.50**[1]	**0.57**[1]	**-0.14**[2]		**0.67**[1]	**0.70**[1]	**0.63**[1]	**0.68**[1]

[1] H=0 and H=1 rejected (level of confidence 99.9%); [2] H=0 accepted (level of confidence 95%);

Table A.2 Empirical results for Austria (1989-98)

	All banks		**Small banks**		**Medium-sized banks**		**Large banks**	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.62	*34.3*	0.55	*14.6*	0.76	*32.3*	0.82	*34.1*
Wage rate	0.20	*12.0*	0.32	*10.1*	0.14	*7.6*	0.08	*10.2*
Capital price	0.05	*5.8*	0.07	*4.7*	0.03	*2.6*	0.01	*1.1*
Time					-3.89	*3.0*		
Loans	0.09	*8.8*	0.12	*7.0*				
Other Income	-0.12	*9.6*	-0.21	*9.5*	-0.05	*3.5*		
Total Assets					-0.03	*3.3*		
Bank Deposits	-0.02	*3.2*			-0.05	*5.4*	-0.05	*3.7*
Equity					0.06	*2.4*		
Dem. Dep. C.			0.4	*2.7*	0.01	*2.2*		
Cash & DFB							0.01	*2.7*
Intercept	-0.44	*5.2*	-0.43	*2.3*	0.01	*0.1*	0.08	*1.2*
Adj. R^2	0.82		0.77		0.96		0.99	
No. of observ.	426		189		170		32	
H ('91-'97)	**0.87**[1]		**0.93**[2]		**0.91**[1]	**0.89**[1]	**0.91**[3]	

[1] H=0 and H=1 rejected (level of confidence 99.9%); [2] H=1 not rejected (level of confidence 95%); the F-statistic is 2.53 and the probability level (of the null hypothesis) is 11.4%; [3] H=0 and H=1 rejected (level of confidence 99%).

Table A.3 Empirical results for Belgium (1989-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.76	*32.5*	0.88	*21.7*	0.77	*24.9*	0.77	*32.1*
Wage rate	0.07	*6.2*	0.03	*1.1*	0.10	*7.1*	0.07	*7.6*
Capital price	0.06	*5.3*	0.04	*2.4*	0.01	*1.4*	0.00	*0.1*
Time							4.37	*3.7*
Loans ratio	0.14	*10.1*	0.10	*6.6*	0.11	*6.7*		
Other Income							-0.01	*2.1*
Total Assets			0.05	*2.8*				
Bank Deposits			-0.03	*4.7*	-0.02	*4.2*		
Equity							0.07	*4.3*
Cash & DFB	0.02	*2.4*			0.02	*2.5*	0.02	*2.7*
Intercept	0.17	*1.7*	-0.20	*-1.0*	0.28	*2.2*	-0.12	*1.4*
Adj. R^2	0.78		0.79		0.83		0.99	
No. of observ.	407		191		156		64	
H ('91-'97)	**0.89**[1]		**0.95**[2]		**0.88**[3]		**0.86**[1]	**0.88**[1]

[1] H=0 and H=1 rejected (level of confidence 99.9%); [2] H=1 not rejected (level of confidence 95%); the F-statistic is 0.65 and the probability level (of the null hypothesis) is 42.3%; [3] H=1 rejected (level of confidence 99%);

Table A.4 Empirical results for Canada (1988-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.55	*20.6*	0.69	*29.2*	0.60	*16.0*	0.52	*19.7*
Wage rate	0.08	*5.4*	0.08	*4.4*	0.09	*4.5*	0.03	*0.8*
Capital price	-0.04	*4.0*	-0.02	*1.6*	-0.06	*3.3*	-0.02	*0.9*
Time	5.90	*3.2*					10.99	*4.7*
Loans ratio	0.18	*8.1*			0.40	*9.4*	0.17	*3.4*
Total Assets			-0.05	*3.8*				
Bank Deposits			-0.02	*2.8*				
Equity	0.04	*2.2*						
Cash & DFB	0.03	*5.2*						
Intercept	-0.45	*4.6*	-0.05	*0.4*	-0.30	*2.0*	-0.76	*4.6*
Adj. R^2	0.77		0.86		0.70		0.96	
No. of observ.	304		140		140		59	
H ('91-'97)	**0.60**[1]	**0.62**[1]	**0.74**[1]		**0.63**[1]		**0.56**[1]	**0.60**[1]

[1] H=0 and H=1 rejected (level of confidence 99.9%);

Table A.5 Empirical results for Denmark (1990-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.32	*11.0*	0.33	*10.7*	0.60	*17.5*	0.64	*20.4*
Wage rate	-0.01	*1.0*	-0.03	*2.7*	0.16	*12.2*	0.48	*11.3*
Capital price	-0.02	*3.6*	-0.02	*2.2*	-0.01	*0.9*	0.04	*1.6*
Time	21.37	*4.2*	17.31	*3.2*				
Loans ratio	0.28	*20.1*	0.27	*19.7*	0.27	*10.8*		
Other Income								
Total Assets	0.04	*7.1*						
Bank Deposits	-0.01	*3.0*	-0.02	*4.7*				
Equity	0.06	*3.2*			0.15	*4.6*		
Dem. Dep. C.	0.04	*2.8*	0.04	*2.6*				
Cash & DFB								
Intercept	-1.05	*9.5*	-1.19	*14.3*	-0.21	*1.4*	1.37	*7.0*
Adj. R^2	0.79		0.77		0.92		0.97	
No. of observ.	514		415		79		26	
H ('91-'97)	**0.32**[1]	**0.36**[1]	**0.31**[1]	**0.34**[1]	**0.75**[1]		**1.16**[2]	

[1] H=0 and H=1 rejected (level of confidence 99.9%); [2] H=1 not rejected (level of confidence 95%); the F-statistic is 6.55 and the probability level (of the null hypothesis) is 1.8%;

Table A.6 Empirical results for Finland (1990-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.67	*18.0*	1.08	*5.1*	0.51	*9.3*	0.75	*29.7*
Wage rate	0.12	*3.7*	-0.13	*0.7*	0.22	*3.8*	-0.04	*2.4*
Capital price	-0.01	*1.0*	-0.28	*2.6*	0.03	*1.0*	-0.01	*-0.6*
Time								
Loans ratio	0.22	*6.1*					0.09	*2.0*
Other Income	-0.07	*2.3*			-0.15	*2.6*		
Bank Deposits	-0.03	*2.1*					-0.15	*6.6*
Equity	-0.11	*2.8*					-0.16	*3.1*
Intercept	-0.21	*1.3*	-0.17	*0.1*	-0.85	*3.8*	-0.65	*5.6*
Adj. R^2	0.88		0.79		0.80		0.97	
No. of observ.	67		10		32		34	
H (' -'97)	**0.78**[1]		**0.67**[2]		**0.76**[3]		**0.70**[1]	

[1] H=0 and H=1 rejected (level of confidence 99.9%); [2] H=1 not rejected (level of confidence 95%); the F-statistic is 3.03 and the probability level (of the null hypothesis) is 13.2%; [3] H=0 and H=1 rejected (level of confidence 99%);

Table A.7 Empirical results for France (1988-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.59	*54.0*	0.41	*16.3*	0.56	*30.4*	0.82	*20.1*
Wage rate	0.09	*12.2*	0.08	*5.8*	0.11	*11.6*	0.00	*0.*
Capital price	0.02	*3.7*	0.01	*1.5*	0.04	*5.3*	0.07	*3.9*
Time			14.42	*3.9*	10.05	*6.6*		
Loans ratio	0.13	*21.9*	0.16	*13.0*	0.09	*12.6*	0.14	*8.0*
Total Assets	-0.03	*7.5*						
Bank Deposits					-0.02	*3.0*	-0.09	*4.9*
Equity	-0.05	*5.5*	-0.06	*4.7*			0.13	*4.*
Intercept	-0.09	*1.5*	-0.58	*5.6*	-0.28		-0.52	*3.4*
Adj. R^2	0.60		0.57		0.67		0.70	
No. of observ.	2,416		759		1,313		340	
H ('91-'97)	**0.70**[1]		**0.54**[1]	**0.59**[1]	**0.74**[1]	**0.79**[1]	**0.89**[2]	

[1] H=0 and H=1 rejected (level of confidence 99.9%); [2] H=1 rejected (level of confidence 99%); the F-statistic is 5.36 and the probability level (of the null hypothesis) is 2.1%;

Table A.8 Empirical results for Germany (1988-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.45	*74.1*	0.39	*53.7*	0.50	*50.9*	0.92	*28.1*
Wage rate	0.13	*35.9*	0.13	*27.5*	0.16	*25.4*	0.14	*17.2*
Capital price	0.00	*0.3*	0.01	*4.8*	-0.01	*2.3*	0.00	*0.1*
Time	7.07	*19.0*	9.68	*18.8*	4.72	*9.3*	-2.32	*2.6*
Loans ratio	0.07	*32.0*	0.09	*33.0*	0.04	*10.0*		
Other Income	-0.05	*23.6*	-0.06	*21.0*	-0.05	*13.7*		
Total Assets	-0.01	*8.9*					-0.03	*4.7*
Bank Deposits	-0.01	*6.8*	-0.00	*2.1*	-0.01	*6.0*	-0.12	*12.5*
Equity	-0.04	*12.5*	-0.02	*5.3*	-0.03	*5.4*	-0.22	*18.5*
Dem. Dep. C.	0.01	*4.5*	0.02	*8.2*				
Cash & DFB	0.01	*7.3*	0.01	*7.0*	0.01	*5.4*		
Intercept	-0.64	*26.3*	-0.83	*27.6*	-0.45	*11.2*	1.05	*8.8*
Adj. R^2	0.69		0.69		0.71		0.84	
No. of observ.	10,513		6,523		3,672		458	
H ('91-'97)	**0.60**[1]	**0.63**[1]	**0.56**[1]	**0.59**[1]	**0.68**[1]	**0.70**[1]	**1.05**[2]	**1.03**[2]

[1] H=0 and H=1 rejected (level of confidence 99.9%); [2] H=1 not rejected (level of confidence 95%);

Table A.9 Empirical results for Greece (1990-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.62	*17.2*	0.41	*5.0*	0.61	*10.7*	0.91	
Wage rate	0.11	*4.8*	-0.11	*1.7*	0.09	*2.1*	0.08	
Capital price	0.03	*1.7*	-0.29	*4.5*	0.05	*1.4*	0.09	
Time							11.70	
Other Income								
Total Assets							-0.08	
Bank Deposits			0.11	*3.9*				
Equity			0.22	*3.5*				
Dem. Dep. C.			0.07	*4.2*				
Cash & DFB			0.10	*3.0*				
Intercept	-0.31	*2.6*	-1.37	*4.4*	-0.39	*1.7*	0.80	
Adj. R^2	0.80		0.88		0.81		0.99	
No. of observ.	102		29		37		19	
H ('91-'97)	**0.76**[1]		**0.01**[2]		**0.75**[3]		**1.01**[4]	**0.94**[4]

[1] H=0 and H=1 rejected (level of confidence 99.9%); [2] H=0 not rejected (level of confidence 95%); the F-statistic is 0.00 and the probability level (of the null hypothesis) is 94.7%; [3] H=1 rejected (level of confidence 99%); the F-statistic is 7.88 and the probability level (of the null hypothesis) is 0.8%; [4] H=1 not rejected (level of confidence 95%);

Table A.10 Empirical results for Ireland (1992-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.71	*17.9*	0.49	*6.0*	0.76	*20.0*	0.54	
Wage rate	0.02	*0.8*	0.08	*1.4*	-0.01	*0.4*	0.37	
Capital price	-0.08	*2.6*	0.43	*4.5*	-0.12	*3.8*	0.01	
Time								
Loans ratio					0.05	*1.9*		
Total Assets					-0.14	*3.7*		
Bank Deposits	-0.07	*2.4*			-0.07	*2.1*	0.05	
Equity	0.12	*3.5*						
Non-perf. loans							0.04	
Intercept	-0.78	*4.6*	-1.43	*3.9*	0.62	*1.8*	0.84	*6.7*
Adj. R^2	0.71		0.74		0.84		1.00	
No. of observ.	127		15		96		14	
H	**0.65**[1]		**0.99**[2]		**0.63**[1]		**0.93**[3]	

[1] H=0 and H=1 rejected (level of confidence 99.9%); [2] H=1 not rejected (level of confidence 95%); the F-statistic is 0.00 and the probability level (of the null hypothesis) is 97.0%; [3] H=1 not rejected (level of confidence 95%); the F-statistic is 4.25 and the probability level (of the null hypothesis) is 7.3%;

Table A.11 Empirical results for Italy (1988-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.64	*58.6*	0.64	*39.0*	0.76	*44.2*	0.68	*14.2*
Wage rate	0.19	*19.6*	0.12	*8.9*	0.17	*22.2*	0.26	*8.1*
Capital price	-0.00	*0.4*	-0.01	*1.5*	-0.02	*2.*	-0.09	*5.3*
Time					-4.68	*6.2*	-4.02	*2.1*
Loans ratio	0.58	*8.5*	0.11	*12.9*	0.02	*3.4*		
Total Assets	-0.03	*15.4*	-0.03	*4.8*	-0.06	*8.2*	-0.07	*5.0*
Equity					-0.06	*5.6*	-0.08	*3.1*
Dem. Dep. C.	-0.01	*2.8*						
Cash & DFB	-0.01	*3.5*					-0.08	*6.8*
Intercept	0.27	*6.1*	0.14	*1.7*	0.79	*9.7*	0.71	*3.4*
Adj. R^2	0.72		0.66		0.80		0.72	
No. of observ.	1,780		812		897		225	
H ('91-'97)	**0.82**[1]		**0.75**[1]		**0.89**[1]	**0.86**[1]	**0.83**[1]	**0.81**[1]

[1] H=0 and H=1 rejected (level of confidence 99.9%);

Table A.12 Empirical results for Japan (1989-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.56	*21.9*	0.73	*5.6*	0.19	*4.5*	0.56	*24.4*
Wage rate	0.05	*3.0*	-0.54	*2.6*	-0.11	*5.8*	0.08	*6.2*
Capital price	0.01	*0.8*	0.24	*2.8*	-0.03	*6.0*	0.04	*3.4*
Time	-11.9	*6.2*			72.43	*4.5*	-9.59	*5.6*
Loans ratio	0.08	*2.6*			0.36	*9.2*	0.10	*4.0*
Total Assets	-0.05	*8.7*						
Bank Deposits							-0.01	*3.2*
Equity	0.04	*3.1*					0.05	*4.2*
Dem. Dep. C.	0.04	*4.1*						
Cash & DFB	0.02	*3.0*	-0.13	*2.9*	0.07	*3.6*	0.03	*6.9*
Intercept	-0.37	*3.7*	-2.50	*5.1*	-2.40	*23.5*	-0.76	*7.9*
Adj. R^2	0.91		0.67	0.73	0.77		0.95	
No. of observ.	915		17		429		583	
H ('91-'97)	**0.58**[1]	**0.54**[1]	**0.43**[2]		**0.07**[3]	**0.11**[3]	**0.64**[1]	**0.61**[1]

[1] H=0 and H=1 rejected (level of confidence 99.9%); [2] H=0 not rejected (level of confidence 95%); the F-statistic is 4.29 and the probability level (of the null hypothesis) is 6.0%; [3] H=0 and H=1 rejected (level of confidence 99%);

Table A.13 Empirical results for South Korea (1992-98)

	All banks		Small banks[0]		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.61	*7.0*			0.58	*4.2*	0.76	*6.7*
Wage rate	0.04	*2.0*			0.09	*3.8*	0.01	*0.5*
Capital price	0.03	*2.2*			0.05	*4.1*	-0.01	*0.3*
Time								
Other Income					-0.14	*5.7*		
Total Assets					0.17	*6.0*	-0.08	*2.1*
Equity					0.29	*5.1*		
Cash & DFB					-0.05	*3-6*		
Intercept	-0.70	*2.6*			-3.29	*7.3*	0.31	*0.6*
Adj. R^2	0.43				0.79		0.63	
No. of observ.	63				27		28	
H	**0.68**[1]				**0.72**[2]		**0.77**[3]	

[0] Number of observations is too low; [1] H=0 and H=1 rejected (level of confidence 99%); [2] H=1 not rejected (level of confidence 95%); the F-statistic is 3.31 and the probability level (of the null hypothesis) is 8.5%; [3] H=1 not rejected (level of confidence 95%); the F-statistic is 2.78 and the probability level (of the null hypothesis) is 10.9%;

Table A.14 Empirical results for Luxembourg (1990-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.84	*107.9*	0.85	*70.5*	0.80	*52.4*	0.84	*46.9*
Wage rate	0.08	*12.3*	0.07	*6.0*	0.11	*12.0*	0.06	*7.0*
Capital price	0.01	*4.6*	0.02	*3.4*	0.02	*4.3*	-0.01	*0.8*
Time					1.84	*2.0*	2.66	*2.8*
Loans ratio	0.01	*3.8*	0.01	*3.0*	0.01	*2.5*		
Other Income	-0.05	*11.7*	-0.06	*6.7*	-0.05	*8.2*	-0.03	*3.4*
Total Assets	0.02	*5.9*			0.06	*8.3*		
Equity	0.02	*2.9*						
Dem. Dep. C.							-0.02	*2.9*
Cash & DFB					-0.02	*3.5*		
Intercept	-0.39	*8.1*	-0.21	*3.8*	-0.60	*8.3*	-0.20	*3.7*
Adj. R^2	0.94		0.94		0.94		0.98	
No. of observ.	774		308		358		93	
H ('91-'97)	**0.93**[1]		**0.94**[2]		**0.94**[2]	**0.95**[2]	**0.90**[1]	**0.91**[1]

[1] H=0 and H=1 rejected (level of confidence 99.9%); [2] H=0 and H=1 rejected (level of confidence 99%);

Table A.15 Empirical results for the Netherlands (1991-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.75	*48.5*	0.70	*23.1*	0.85	*48.9*	0.67	*19.1*
Wage rate	0.08	*5.0*	-0.01	*0.2*	0.06	*4.7*	0.09	*9.2*
Capital price	-0.07	*2.9*	0.05	*0.3*	-0.05	*2.2*	0.12	*4.3*
Time							6.80	*4.4*
Loans ratio	0.04	*3.4*			0.04	*4.76*	0.27	*4.8*
Other Income	-0.05	*5.1*	-0.06	*3.1*	-0.03	*2.9*		
Total Assets	0.01	*2.3*			0.03	*3.2*	0.02	*3.1*
Equity	0.12	*8.7*	0.14	*5.6*	0.07	*4.5*		
Intercept	-0.73	*8.8*	-1.31	*7.9*	-0.44	*4.5*	-0.20	*1.6*
Adj. R^2	0.75		0.90		0.95		0.95	
No. of observ.	296		96		139		61	
H ('91-'97)	**0.75**[1]		**0.74**[2]		**0.87**[1]		**0.91**[3]	**0.95**[3]

[1] H=0 and H=1 rejected (level of confidence 99.9%); [2] H=1 not rejected (level of confidence 95%); the F-statistic is 2.33 and the probability level (of the null hypothesis) is 13.0%;[3] H=1 not rejected (level of confidence 95%); the F-statistic is, respectively, 2.72 and 0.92, and the probability level (of the null hypothesis) is, respectively, 10.5% and 34.1%.

Table A.16 Empirical results for New Zealand (1990-98)

	All banks		Small banks[0]		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.67	*25.3*			0.80	*32.4*	0.65	*25.6*
Wage rate	0.15	*5.9*			0.30	*10.6*	0.16	*5.2*
Capital price	0.04	*3.1*			-0.01	*0.5*	0.05	*2.0*
Time					3.66	*4.0*		
Loans ratio	0.12	*7.6*						
Other Income					-0.13	*4.9*		
Total Assets	-0.04	*8.5*			0.05	*4.9*		
Equity					-0.23	*10.0*		
Dem. Dep. C.	0.20	*7.1*					0.17	*5.1*
Intercept	0.47	*3.8*			0.15	*1.0*	0.06	*0.4*
Adj. R^2	0.95				0.99		0.98	
No. of observ.	52				22		20	
H ('91-'97)	**0.86**[1]				**1.11**[2]	**1.13**[3]	**0.86**[4]	

[0] Number of observations is too low; [1] H=0 and H=1 rejected (level of confidence 99.9%); [2] H=1 not rejected (level of confidence 95%); the F-statistic is 3.84 and the probability level (of the null hypothesis) is 7.0%; [3] H=1 not rejected (level of confidence 99%); the F-statistic is 6.24 and the probability level (of the null hypothesis) is 2.6%; [4] H=0 and H=1 rejected (level of confidence 99%);

Table A.17 Empirical results for Norway (1989-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.58	*19.2*	0.69	*38.8*	0.57	*15.1*	0.63	*14.0*
Wage rate	0.13	*7.5*	0.14	*7.6*	0.13	*9.7*	-0.05	*1.0*
Capital price	0.0	*1.4*	-0.03	*2.1*	-0.02	*2.1*	0.03	*3.0*
Time	7.41	*3.6*			9.78	*3.9*	14.20	*3.1*
Other Income	-0.02	*2.2*						
Total Assets			-0.07	*3.8*	0.05	*4.1*	-0.09	*4.2*
Bank Deposits	-0.03	*5.7*	-0.02	*2.9*	-0.02	*2.3*		
Equity					0.07	*3.0*		
Dem. Dep. C.	0.04	*3.9*					0.16	*4.0*
Intercept	-0.27	*2.7*	0.47	*3.3*	-0.67	*4.4*	0.23	*0.7*
Adj. R^2	0.93		0.96		0.92		0.99	
No. of observ.	179		72		113		26	
H ('91-'97)	**0.74**[1]	**0.77**[1]	**0.80**[1]		**0.71**[1]	**0.75**[1]	**0.66**[1]	**0.71**[1]

[1] H=0 and H=1 rejected (level of confidence 99.9%);

Table A.18 Empirical results for Portugal (1991-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.76	*48.5*	0.83	*17.4*	0.85	*22.6*	0.66	*23.0*
Wage rate	0.10	*7.3*	-0.01	*0.1*	0.08	*4.3*	0.25	*8.8*
Capital price	-0.02	*2.6*	0.01	*0.4*	-0.02	*2.3*	0.00	*0.*
Time					-7.98	*3.7*		
Loans ratio	0.07	*8.9*			0.08	*9.2*		
Other Income	-0.03	*3.6*			-0.05	*5.2*	-0.06	*2.4*
Total Assets			-0.08	*2.1*	0.03	*2.8*		
Bank Deposits	-0.05	*4.8*	-0.08	*2.1*	-0.03	*3.2*		
Equity					0.03	*2.3*		
Dem. Dep. C.			0.09	*3.1*	-0.02	*2.0*		
Non-perf. loans							0.06	*3.8*
Cash & DFB					0.02	*3.1*	0.03	*3,1*
Intercept	-0.15	*2.3*	0.29	*1.0*	-0.45	*2.9*	0.51	*3.7*
Adj. R^2	0.92		0.87		0.96		0.97	
No. of observ.	257		53		137		49	
H ('91-'97)	**0.83**[1]		**0.84**[2]		**0.88**[1]	**0.84**[1]	**0.91**[3]	

[1] H=0 and H=1 rejected (level of confidence 99.9%); [2] H=1 rejected (level of confidence 95%); the F-statistic is 4.31 and the probability level (of the null hypothesis) is 4.3%; %); [3] H=1 rejected (level of confidence 95%); the F-statistic is 6.26 and the probability level (of the null hypothesis) is 1.6%;

Table A.19 Empirical results for Spain (1990-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.42	*18.0*	0.42	*9.3*	0.39	*11.4*	0.44	*11.3*
Wage rate	0.06	*7.3*	0.04	*2.0*	0.09	*7.5*	0.11	*6.8*
Capital price	0.02	*3.1*	0.04	*3.4*	-0.01	*1.2*	0.02	*1.0*
Time	20.00	*7.8*	21.2	*3.6*	20.9	*5.5*	14.41	*4.4*
Loans ratio	0.11	*16.0*	0.16	*10.8*	0.06	*5.7*	0.12	*8.3*
Total Assets	-0.01	*2.5*			-0.03	*3.2*	-0.04	*6.8*
Bank Deposits	-0.03	*8.1*	-0.03	*3.2*	-0.03	*5.9*		
Equity							0.08	*3.3*
Dem. Dep. C.							-0.06	*4.3*
Cash & DFB							0.02	*2.8*
Intercept	-0.66	*9.4*	-0.71	*4.8*	-0.52	*4.4*	-0.21	*1.2*
Adj. R^2	0.81		0.79		0.83		0.93	
No. of observ.	801		179		453		152	
H ('91-'97)	**0.55**[1]	**0.62**[1]	**0.56**[1]	**0.64**[1]	**0.52**[1]	**0.59**[1]	**0.61**[1]	**0.66**[1]

[1] H=0 and H=1 rejected (level of confidence 99.9%);

Table A.20 Empirical results for Sweden (1989-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.71	*29.2*	0.72	*18.2*	0.49	*9.5*	0.90	*27.7*
Wage rate	0.06	*6.9*	0.17	*5.4*	0.14	*4.7*	0.05	*4.6*
Capital price	0.02	*3.6*	-0.05	*2.1*	0.01	*0.8*	-0.00	*0.0*
Time					16.4	*3.8*		
Loans ratio							0.07	*2.7*
Other Income					-0.04	*2.4*		
Total Assets					0.13	*3.9*		
Bank Deposits	-0.04	*3.6*			-0.05	*3.0*	-0.09	*3.5*
Equity							0.09	*3.3*
Intercept	-0.30	*3.3*	0.32	*2.8*	-1.44	*4.8*	1.01	*3.2*
Adj. R^2	0.86		0.97		0.87		0.93	
No. of observ.	145		18		44		75	
H ('91-'97)	**0.80**[1]		**0.84**[2]		**0.69**[1]	**0.76**[1]	**0.95**[3]	

[1] H=0 and H=1 rejected (level of confidence 99.9%); [2] H=0 and H=1 rejected (level of confidence 99%); [3] H=1 not rejected (level of confidence 95%); the F-statistic is 1.60 and the probability level (of the null hypothesis) is 21.0%;

Table A.21 Empirical results for Switzerland (1988-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.43	*32.8*	0.38	*24.3*	0.82		0.74	
Wage rate	0.06	*6.1*	0.07	*5.1*	0.09	*32.5*	0.20	
Capital price	0.03	*7.3*	0.02	*4.6*	0.06	*4.7*	0.07	
Time	8.87	*6.2*	12.18	*6.0*	-5.87	*10.1*		
Loans ratio	0.09	*16.0*	0.08	*11.0*	0.08	*9.2*	0.08	
Other Income	-0.04	*5.1*	-0.04	*3.9*	-0.08	*5.8*	-0.10	
Total Assets			0.03	*4.2*				
Bank Deposits	-0.01	*3.8*	-0.01	*2.8*	-0.01	*2.9*	-0.04	
Equity			-0.03	*3.3*	0.04	*3.0*	0.08	
Cash & DFB					0.03	*4.2*		
Intercept	-1.35	*27.0*	-1.52	*17.4*	-0.34	*3.4*	-0.29	
Adj. R^2	0.73		0.71		0.88		0.94	
No. of observ.	1.805		1.257		470		71	
H ('91-'97)	**0.55**[1]	**0.58**[1]	**0.51**[1]	**0.54**[1]	**0.95**[2]	**0.92**[3]	**1.01**[4]	

[1] H=0 and H=1 rejected (level of confidence 99.9%); [2] H=1 not rejected (level of confidence 95%); [3] H=1 rejected (level of confidence 99%); the F-statistic is 8.03 and the probability level (of the null hypothesis) is 0.5%; [4] H=1 not rejected (95%);

Table A.22 Empirical results for the United Kingdom (1989-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.50	*21.8*	0.34	*10.6*	0.66	*15.8*	0.91	*31.6*
Wage rate	0.08	*4.3*	0.05	*1.5*	0.09	*4.6*	0.22	*6.6*
Capital price	0.02	*2.4*	0.02	*1.4*	0.03	*2.2*	0.07	*3.4*
Time	6.68	*2.7*			8.21	*2.9*		
Loans ratio	0.20	*21.9*	0.18	*13.2*	0.18	*11.2*	0.23	*9.2*
Other Income	-0.03	*2.7*	-0.05	*2.3*			-0.19	*6.0*
Total Assets			-0.06	*3.2*	-0.05	*2.4*		
Equity	0.13	*8.5*	0.18	*6.3*				
Cash & DFB					0.03	*3.4*	0.04	*7.6*
Intercept	-1.03	*-11.2*	-1.65	*8.5*	0.51	*2.5*	0.49	*4.5*
Adj. R^2	0.62		0.45		0.69		0.90	
No. of observ.	1.114		458		383		193	
H ('91-'97)	**0.61**[1]	**0.64**[1]	**0.41**[1]		**0.81**[1]	**0.85**[1]	**1.20**[1]	

[1] H=0 and H=1 rejected (level of confidence 99.9%);

Table A.23 Empirical results for the United States (1991-98)

	All banks		Small banks		Medium-sized banks		Large banks	
	Coeff.	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*	*Coeff.*	*t-values*
Funding rate	0.40	*46.7*	0.40	*29.0*	0.40	*35.8*	0.43	*19.6*
Wage rate	0.07	*13.7*	0.18	*16.1*	0.06	*8.4*	0.13	*8.7*
Capital price	0.06	*19.7*	0.02	*3.2*	0.06	*14.1*	0.10	*15.4*
Time	3.62	*4.4*	3.08	*2.9*	3.52	*3.0*	8.01	*4.8*
Loans ratio	0.12	*20.0*	0.09	*11.2*	0.12	*14.1*	0.21	*18.3*
Other Income			-0.04	*6.4*				
Total Assets	-0.02	*10.1*			-0.02	*4.5*		
Equity	0.06	*7.4*	0.03	*2.5*	0.05	*4.7*		
Non-perf. loans	0.01	*4.3*			0.01	*3.7*		
Cash & DFB	0.03	*11.9*	0.02	*5.2*	0.04	*9.6*		
Intercept	-0.76	*16.3*	-0.63	*8.3*	-0.76	*11.2*	-0.02	*2.6*
Adj. R^2	0.51		0.48		0.52		0.70	
No. of observ.	3.835		1.350		2.216		463	
H ('91-'97)	**0.54**[1]	**0.56**[1]	**0.61**[1]	**0.62**[1]	**0.53**[1]	**0.54**[1]	**0.68**[1]	**0.72**[1]

[1] H=0 and H=1 rejected (level of confidence 99.9%);

APPENDIX 2: ESTIMATION RESULTS OF THE BRESNAHAN MODELS OF DEPOSITS AND LOANS FOR NINE COUNTRIES

Table B.1 Empirical results for deposit markets (demand equation)

	France		Germany		Italy		Netherlands		UK	
	coeff.	*t-value*	coeff.	*t-value*	coeff.	*t-value*	coeff.	*t-value*	coeff.	*t-value*
const	-18.348	*5.7*	0.012	*0.0*	287812.5	*4.7*	-6.792	*14.6*	-1999.627	*1.4*
deprate	3.526	*5.2*	0.129	*3.0*	17744.76	*2.6*	0.643	*11.5*	277.634	*2.4*
gdp	1.99^{E-05}	*11.0*	0.013	*21.5*			4.42^{E-05}	*31.6*	0.044	*8.0*
govrate					-6004.894	*5.7*	-0.187	*6.9*	-55.900	*1.4*
mmrate	-0.326	*3.7*								
unemp			0.188	*6.5*	16482.25	*2.8*	0.471	*10.9*	-167.935	*3.6*
inflation									-0.002	*2.4*
pz1	0.037	*2.5*								
pz2										
pz3			-0.022	*4.0*	-1596.854	*2.2*	-0.053	*9.5*		
pz4	-2.25^{E-06}	*5.6*							-112.029	*3.0*
seas(1)			0.728	*10.3*			0.297	*6.3*	257.446	*2.6*
seas(2)			0.373	*6.1*			-0.070	*1.6*	319.394	*3.0*
seas(3)			0.167	*2.8*			0.314	*6.6*	207.786	*2.3*
s1							0.021	*0.3*		
s2							0.200	*2.6*		
s3							0.055	*0.9*		
s4							0.148	*2.2*		
dummy(1)			-1.014	*5.5*						
dummy(2)			0.331	*2.0*						
dummy(3)			-0.418	*4.2*						
trend					-5238.749	*36.6*				
No. of obs.	109		86		64		88		91	
Adj. R^2	0.92		0.99		0.99		0.96		0.94	

Explanatory note: dummy(1)=dumdepbreuk(germany) 1970:2 – 1990:1, dummy(2)=dumgdpbreuk(germany) 1970:1 – 1990:4, dummy(3)=dumunempbreuk(germany) 1970:1 1991:4, pz1=deprate*mmrate, pz2=deprate*govrate, pz3=deprate*unemp, pz4=mmrate*gdp, pz4=deprate*infl

Table B.1 Empirical results for deposits (demand equation) (continuation)

	Portugal (1)		Portugal (2)		Spain		Sweden		Belgium	
	Coeff.	*t-value*	coeff.	*t-value*	coeff.	*t-value*	coeff.	*t-value*	coeff.	*t-value*
const	-127.92	*6.6*	-129.10	*7.0*	-85853.20	*9.7*	2001.66	*3.3*	-20.63	*6.6*
deprate	3.63	*4.7*	6.27	*5.6*	2499.41	*3.3*	305.64	*3.4*	0.84	*2.4*
gdp	0.06	*12.3*	0.05	*9.2*	7.04	*18.2*	0.01	*8.2*	0.04	*25.0*
govrate	-0.35	*1.0*	-2.26	*3.5*						
mmrate							-62.98	*3.9*		
unemp	1.54	*2.3*	9.09	*5.0*	2087.63	*6.7*			-0.49	*6.1*
inflation					890.27	*5.0*			0.25	*1.5*
pz1										
pz2	-0.08	*3.2*	0.03	*0.8*					-0.13	*3.7*
pz3			-0.58	*4.0*	-153.51	*3.7*				
pz4							-0.001	*2.7*		
seas(1)									2.19	*5.6*
seas(2)									-0.40	*1.2*
seas(3)									2.56	*6.7*
No. of obs.	84		84		83		111		75	
Adj. R^2	0.85		0.87		0.97		0.56		0.98	

Table B.2 Empirical results for deposits (supply equation)

	France		France		Germany		Italy	
	coeff.	*t-value*	coeff.	*t-value*	coeff.	*t-value*	Coeff.	*t-value*
const	3.675	*27.2*	7.069	*9.4*	61.537	*2.8*	3.238	*8.1*
-?	-0.002	*1.0*	-0.015	*1.7*	0.002	*1.3*	0.000	*0.8*
deposits			-0.130	*2.2*	-2.183	*4.1*		
wage					-30.875	*1.7*		
inflation	0.290	*13.8*			54.247	*1.8*	0.740	*16.0*
seas(1)					1.780	*2.1*		
seas(2)					2.904	*3.1*		
seas(3)					0.818	*0.8*		
dummy(1)					-5.166	*3.2*		
No. of obs.	109		109		86		64	
Adj. R^2	0.60		-6.62		-1.82		0.84	

Table B.2 Empirical results for deposits (supply equation) (continuation)

	Netherlands		Netherlands		UK		UK	
	coeff.	*t-value*	coeff.	*t-value*	coeff.	*t-value*	coeff.	*t-value*
const	12.676	*14.3*	22.700	*4.9*	12.595	*13.9*	9.401	*9.6*
-?	-0.106	*1.3*	0.068	*1.3*	-0.005	*1.9*	-0.003	*1.6*
deposits	-1.766	*4.1*			-0.001	*4.6*	-0.001	*2.5*
wage			-0.169	*4.3*				
inflation			56.893	*5.3*			0.251	*3.4*
seas(1)					0.201	*0.2*		
seas(2)					-0.063	*0.1*		
seas(3)					-0.249	*0.3*		
s1	-0.073	*0.1*	-1.208	*2.3*				
s2	0.090	*0.1*	-0.881	*2.2*				
s3	0.086	*0.1*	-0.448	*1.1*				
s4	-0.542	*0.8*	-1.047	*3.0*				
No. of obs.	84		84		95		91	
Adj. R^2	0.37		0.57		-0.19		0.22	

Netherlands: dummy 1982:1 – 1986:1, s1=dummy*seas(1), etc.

Table B.2 Empirical results for deposits (supply equation) (continuation)

	Spain		Sweden		Belgium		Portugal (1)		Portugal (2)	
	coeff.	*t-value*	coeff.	*t-value*	coeff.	*t-value*	coeff.	*t-value*	coeff.	*t-value*
const	5.430	*4.2*	3.95	*9.7*	7.720	*10.4*	-1.597	*1.0*	0.848	*0.8*
-?	0.001	*1.1*	-0.000	*0.8*	4.15^{E-05}	*0.53*	-0.102	*2.3*	0.075	*2.1*
deposits	-2.77^{E-05}	*1.3*			-0.089	*4.3*				
wage										
inflation			0.570	*11.7*	0.270	*6.5*			0.905	*24.1*
mmrate	0.182	*2.5*								
govrate							1.307	*20.3*		
No. of obs.	75		111		75		84		84	
Adj. R^2	0.18		0.42		0.63		0.82		0.87	

Table B.3 Empirical results for loans (demand equation)

	France		Germany		Italy		Netherlands		UK	
	coeff.	*t-value*	coeff.	*t-value*	coeff.	*t-value*	Coeff.	*t-value*	coeff.	t-value
const	-9.227	*3.3*	92.991	*4.1*	70142.22	*0.2*	9.754	*2.1*	-16857.15	*11.1*
lendingrate	-2.183	*6.6*	-14.552	*8.7*	-48018.63	*2.7*	-1.533	*4.9*	-254.748	*3.6*
gdp	3.82^{E-05}	*21.6*	0.067	*27.7*	3.746	*5.7*	6.91^{E-05}	*21.8*	0.074	*16.4*
labourshare			-1.450	*5.2*			-0.142	*2.7*	113.4	*7.2*
utgrade										
unemp	-3.452	*8.1*			-74479.05	*7.8*	-0.327	*3.0*	-34.914	*3.2*
inflation										
pz1	0.279	*7.0*					0.026	*2.3*		
pz2			0.177	*8.3*			0.015	*3.8*		
pz3										
pz4					0.118	*2.9*			0.001	*3.0*
seas(1)			3.224	*9.8*	161442.2	*10.3*	0.352	*4.1*	751.846	*9.6*
seas(2)			2.095	*6.7*	91937.98	*6.0*	-0.187	*2.4*	854.338	*10.8*
seas(3)			1.466	*4.8*	123268.0	*7.4*	0.405	*4.9*	415.449	*5.4*
s1							0.371	*2.7*		
s2							0.495	*3.2*		
s3							0.313	*2.0*		
s4							0.551	*3.4*		
No. of obs.	109		86		64		88		88	
Adj. R^2	0.95		0.97		0.95		0.98		0.98	

Explanatory note: dummy(1)=dumdepbreuk(germany), dummy(2)=dumgdpbreuk(germany), dummy(3)=dumunempbreuk(germany), pz1=lendingrate*unemp, pz2=lendingrate*labourshare, pz3=lendingrate*utgrade, pz4=gdp*unemp, pz4=gdp*lendingrate

Table B.3 Empirical results for loans (demand equation) (continuation)

	6 SPAIN		Sweden		Belgium		Portugal	
	Coeff.	*t-value*	coeff.	*t-value*	coeff.	*t-value*	Coeff.	*t-value*
const	25644.86	*0.1*	110312.3	*4.5*	-58.883	*20.2*	-118.111	*4.1*
lendingrate	-26364.89	*3.8*	-10147.88	*5.4*	-2.012	*3.5*	-6.124	*18.3*
gdp	89.404	*24.3*	0.045	*13.4*	0.059	*40.9*	0.057	*18.6*
labourshare	-4564.057	*2.0*	-1375.209	*4.8*			1.185	*9.6*
utgrade							0.694	*3.0*
unemp	-3252.831	*8.1*	-2428.345	*6.8*			-13.610	*12.7*
inflation					-49.097	*2.8*		
pz1			180.903	*6.6*	-0.045	*4.3*	0.855	*19.5*
pz2	505.782	*4.4*	117.767	*5.2*	0.045	*6.1*		
pz3	-141.202	*3.8*						
pz4								
seas(1)			952.647	*3.6*	3.248	*7.1*		
seas(2)			1052.306	*4.0*	0.962	*2.1*		
seas(3)			2743.539	*8.4*	4.791	*10.5*		
No. of obs.	76		111		75		84	
Adj. R^2	0.99		0.58		0.97		0.96	

Table B.4 Empirical results for loans (supply equation)

	France		Germany		Italy		Netherlands		UK	
	coeff.	t-value	coeff.	t-value	coeff.	t-value	coeff.	*t-value*	coeff.	*t-value*
const	2.588	*4.7*	-48.636	*4.8*	2.556	*2.3*	-89.591	*5.9*	-0.316	*0.1*
-?	-0.050	*0.92*	0.003	*1.9*	0.000	*1.7*	0.000	*0.4*	-0.000	*0.4*
loans			0.503	*7.4*			0.336	*1.7*	0.000	*1.0*
wage			39.803	*4.5*	2.400	*1.1*	0.627	*6.1*	1.486	*0.3*
deposit rate			0.183	*0.5*	0.747	*10.9*	1.749	*14.5*	0.350	*3.1*
mmrate			0.215	*0.6*	0.194	*4.7*			0.504	*3.3*
govrate	0.746	*28.7*	0.488	*4.1*						
inflation			49.035	*4.9*	8.800	*1.5*			11.477	*2.9*
branches							3.245	*4.2*		
seas(1)			-1.265	*3.5*						
seas(2)			-1.540	*4.0*						
seas(3)			1.329	*3.6*						
s1							1.650	*2.4*		
s2							0.133	*0.4*		
s3							-0.856	*1.3*		
s4							0.918	*3.2*		
dummy(1)										
No. of obs.	109		86		64		88		88	
Adj. R^2	0.85		0.89		0.98		0.89		0.92	

Explanatory note: Netherlands: dummy 1982:1 – 1986:1, s1=dummy*seas(1), etc.

Table B.4 Empirical results for loans (supply equation) (continuation)

	Spain		Sweden		Belgium		Portugal	
	coeff.	*t-value*	coef.	*t-value*	Coeff.	*t-value*	Coeff.	*t-value*
const	2.401	*5.8*	2.339	*4.1*	-3.680	*2.4*	-5.391	*2.6*
-?	7.45^{E-05}	*0.2*	0.001	*0.5*	-0.028	*1.0*	0.000	*1.0*
loans			0.000	*2.4*	0.128	*4.6*	0.072	*4.1*
wage	0.831	*2.6*						
deposit rate	1.470	*23.9*	0.582	*10.1*	0.711	*6.0*	0.387	*3.6*
mmrate	0.150	*3.1*	0.310	*5.1*				
govrate			0.177	*2.5*	0.692	*8.1*	1.206	*9.2*
inflation	-11.893	*2.8*					-0.242	*3.6*
No. of obs.	75		111		75		84	
Adj. R^2	0.92		0.95		0.91		0.93	

APPENDIX 3 DATA SOURCES FOR THE BRESNAHAN MODEL

Table C.1 Data Sources for Belgium

Estimation period: 1980:1-1998:3		
Time series	**Definition**	**Source**
Deposits	savings and time deposits in bef (nsa)	own calculations on basis of BIS data
Loans	claims of credit institutions on non-financial residents (nsa)	IFS
Deposit rate	deposit rate	IFS
Lending rate (1970:1-1984:4)	interest rate on investment loans by national industry credit company (credits of 4 yr or more with rate flexibility every 5 yrs), end month data, disc.	BIS
Lending rate (1985:1-1999:4)	prime lending rate	IFS
GDP	GDP, 1995 prices (nsa)	BIS
Money market rate	3-months treasury bill rate	OECD
Government bond rate	5 year central government bond	OECD
Unemployment rate	unemployment rate (nsa)	BIS
Price deflator	CPI all items (nsa)	OECD
Wages	relative normalised unit labour costs (sa)	OECD
Labour share	labour share	Dutch central bank
Capital utilisation	capital utilisation in industry	BIS

Table C.2 Data Sources for France

Estimation period: 1971:2-1998:2		
Time series	**Definition**	**Source**
Deposits	other than demand deposits (national residency)	IFS
Loans	claims of banking institutions on other resident sectors; break 1978:1 corrected on the basis of yearly growth	IFS
Deposit rate	deposit rate; 1986:1 and 1986:2 n.a. – calculated by taking the average of period before and after	IFS
Lending rate	lending rate; 1986:1 and 1986:2 n.a. – calculated by taking the average of period before and after	IFS
GDP	GDP, 1995 prices (sa), 1970:1-1977:4 calculated with GDP index	BIS (index: IFS)
Money market rate	treasury bill rate	IFS
Government bond rate	yield on long term (> 7 years) government bonds on secondary market	BIS
Unemployment rate	unemployment rate (sa)	IFS
Price deflator	GDP total index, 1980 prices, (sa)	BIS
Wages	unit labour cost index, total economy (sa)	BIS

Table C.3 Data Sources for Germany

Estimation period: 1977:3-1998:4		
Time series	**Definition**	**Source**
Deposits	non-demand deposits of other resident sectors with banks	IFS
Deposit dummy	1970:2 until 1990:1 (time period where series includes only GDP of the western states)	
Loans	claims of banks on other resident sectors	IFS
Deposit rate	3 months deposits (< 1 mio DM)	IFS
Lending rate	lending rate on CA credit (< 1 mio DM)	IFS
GDP	GDP at 1995 prices, market prices (nsa), until 1990:4 GDP only for the western states	BIS
GDP dummy	1970:1 until 1990:4	
Money market rate	interest rates on 3-months loans (money market)	BIS
Government bond rate	redemption yield, 10 year benchmark bond	DS
Unemployment rate	unemployment rate, dependent labour (sa)	DS
Unemployment dummy	1970:1 until 1991:4 (time period where the unemployment series has been corrected)	
Price deflator	GNP implicit price deflator (nsa)	DS
Wages	unit labour cost index, temporarily discontinued (sa)	DS

Table C.4 Data Sources for Italy

Estimation period: 1983:1-1998:4		
Time series	**Definition**	**Source**
Deposits	nsa-savings and time deposits with banks (end-month) in m2	BIS
Loans	nsa-domestic loans by banks	BIS
Deposit rate	interest rate on total deposits, quarterly average	BIS
Lending rate	interest rate on bank loans, quarterly average	BIS
GDP	GDP, 1995 prices, market prices, (nsa)	BIS
Money market rate	3-months treasury bill rate	IFS
Government bond rate	Italian government long-term bond yield (9-10 year)	IFS
Unemployment rate	unemployment rate (nsa)	BIS
Price deflator	(GDP, current prices)/(GDP, 1995 prices)	own calculations
Wages	unit labour costs in whole economy (sa)	BIS
Labour share		Dutch central bank

Table C.5 Data Sources for the Netherlands

Estimation period: 1977:1-1998:4		
Time series	**Definition**	**Source**
Deposits	other than demand deposits with banks from non-bank institutions with banks, discontinued	IFS
Loans	claims of banks on other resident sectors than government, discontinued	IFS
Deposit rate	rate on deposits 2 years (fixed)	DNB
Lending rate	lending rate	IFS
GDP	GDP, 1995 prices, purchaser's value (nsa)	BIS
Money market rate	3-months money market rate, discontinued, mean (nsa)	DS: Eurostat
Government bond rate	medium term (5-8 yr) central government bond yield, secondary market, month-end data	BIS
Unemployment rate		OECD
Price deflator	GDP price deflator, market prices (nsa)	BIS
Wages	hourly wage rates in private sector, dicontinued, completed with series hourly wage rates in manufacturing sector	DS: CBS
Utilisation grade	utilisation grade of industry	CBS
Labour share	labour share market sector	CPB

Table C.6 Data Sources for Portugal

Estimation period: 1978:1-1998:4		
Time series	**Definition**	**Source**
Deposits	Time and savings deposits, (bln PE)	IFS database
Loans (loans_priv)	Claims on private sector	IFS database
Deposit rate	Average interest rate on time deposits	DS: IFS
Lending rate	Average lending rate, excl. doubtful debt	DS: IFS
GDP (gdp_comp)	GDP, 1990=100, from 1998:1 completed on the basis of growth of data series 18299B.PYF	DS: IFS
Government bond rate	Government bond yield	DS: IFS
Unemployment rate	Unemployment rte, originally yearly data	OECD
Price deflator	GDP price deflator, from 1998:4 completed	DS: IFS
Wages	unit labour cost index, total economy, originally yearly figures	OECD
Labour share		Dutch central bank

Table C.7 Data Sources for Spain

Estimation period:	Deposits 1978:2-1997:4 Loans 1978:1-1997:4	
Time series	**Definition**	**Source**
Deposits	savings and time deposits, average of month-end data	BIS
Loans	total credit to private sector, month average (nsa)	BIS
Deposit rate	weighted average of rate on savings deposits and rate on time deposits	own calculations
Lending rate	interest rate on medium-term credit (1-3 yr), month-end	BIS
GDP	constant GDP, 1990 prices (sa); quarterly data calculated from quarterly data on yearly basis	DS: IFS
Money market rate	interest rate money market, 3 month inter-bank deposits, month average	BIS
Government bond rate	monthly average bond yield (bonds 2 yr maturity)	DS: IFS
Unemployment rate	unemployment rate, in % of total labour force (nsa)	BIS
Price deflator	GDP implicit price deflator index, calculated from yearly data	DS: OECD
Wages	hourly wages (nsa)	DS: IFS
Labour share	labour share	Dutch central bank
Capital utilisation	capacity utilisation in industry, excl. construction (nsa)	BIS

Table C.8 Data Sources for Sweden

Estimation period: 1971:2-1998:4		
Time series	**Definition**	**Source**
Deposits	demand, time, savings and foreign currency deposits	IFS
Loans	claims of private banks on private sector	IFS
Deposit rate	deposit rate	IFS
Lending rate	lending rate	IFS
GDP	GDP, 1991 prices (nsa)	BIS
Money market rate	treasury bill rate	IFS
Government bond rate	central government bonds yield, 10 yr bonds	OECD
Unemployment rate	unemployment rate (nsa)	BIS
Price deflator	CPI, all items, 1995=100 (nsa)	DS: OECD
Wages	hourly labour cost (nsa)	OECD
Capital utilisation	capital utilisation in economy (sa)	BIS
Labour share		Dutch central bank

Table C.9 Data sources for the UK

Estimation period:	Deposits 1976:2-1998:4 Loans 1976:2-1998:1	
Time series	**Definition**	**Source**
Deposits	sterling deposits from public and private sectors with banks (nsa)	BIS
Loans	UK bank lending to residents – private sector, discontinued	IFS
Deposit rate	UK instant access savings accounts interest rate	IFS
Lending rate	UK minimum base rate of London clearing banks	IFS
GDP	GDP, 1995 prices, market prices (nsa)	BIS
Money market rate	interest rate money market, treasury bills, 91-day, average allotment rate, end-month	BIS
Government bond rate	Medium-dated (10-year) government stock yield, secondary market, month-end	BIS
Unemployment rate	unemployment rate (nsa)	BIS
Price deflator	GDP price deflator, 1995=100, discontinued series, market prices (nsa)	BIS
Wages	unit wage and salary costs in whole economy (index) (sa)	BIS
Utilisation grade	utilisation grade, volume, mean of stock	BIS
Labour share	labour share firms	Dutch central bank