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Competitive conditions in the Swedish banking system

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Abstract

The Swedish banking system is characterized by high asset concentration where the share of the four largest banks accounts for about 79 percent of the total assets of the whole system. Since there has been a general perception that high industry concentration impairs competitiveness, it is worthwhile to examine the competitive nature of the system. Besides, the recent global financial crisis and actions taken in the aftermath as a response to the crisis could have an impact on competition. This paper presents empirical assessment of the competitive conditions in the banking system of Sweden over the period 2003-2010. I apply the Panzar-Rosse and the Boone indicator methods on bank-level data. The results suggest that banks in Sweden generate their revenues under a monopolistically competitive environment. Furthermore, the hypothesis for perfect competition among commercial banks is not rejected, suggesting that commercial banks operate in a more competitive environment than savings banks. Finally, the Boone indicator suggests a slight decline in the degree of competition in the banking system after the recent global financial crisis.

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1. Introduction

The recent global financial crisis (GFC) has proven that instability in the financial sectorhas far-reaching consequences that extend to the whole economy. The banking system constitutes a dominant position in the financial sector of a country.The vital role of the sector makes the study of competition in the banking sector very important. Specific to the sector, banking competition has implications for productive efficiency, incentive to innovation and quality of products and services provided in the sector. Excessive market power in the system has a negative impact on households and business's access to external financing and financial services and consequently on economic growth. The effectiveness of monetary policy instruments depends on the degree of competition in the banking system. Accordingly, examining the current competitive nature of the system carries implications for macroeconomic policies, competition policy and financial stability.

The competitive environment of the banking system of the European Union countries has experienced several changes in recent decades. The deregulation of financial services in the European Union (EU) allows member countries' banks to freely establish branches and provide financial services throughout EU. Technological advancements and financial innovations have brought a change in the way financial services are provided. Furthermore, the recent global financial crisis severely hits the banking system of several EU countries and forces states to intervene in the financial sector. All these events can bring a change in concentration and competition in the banking systems.

The Swedish banking system has experienced all the events discussed above which can affect the competitive landscape of the system. However, relatively few studies have investigated the competitive condition of the Swedish banking system. That is to say there is a limited body of literature in the competitive environment of the Swedish banking system[1].

This paper aims to contribute to the literature by comprehensively examining the competitive environment of the Swedish banking system over the period 2003-2010. The GFC and measures taken by the state as a response to the crisis could have an impact on the

[1] To my knowledge only one recent study has investigated the competitive environment of the Swedish banking system as a single country study. Sjöberg (2007) employs the Bresnahan and Lau (1982) model to study competition in the system over the period 1996-2002.

competitiveness of the system. The sample period includes the recent GFC and allows us to investigate a change in competitive environment after the crisis. Furthermore, commercial banks and savings banks might not operate in a similar competitive environment. The paper thus examines and compares the competitive environment between commercial banks and savings banks.

This paper employs two models of the non-structural approach to measure competition: the Panzar-Rosse (PR) model and the Boone indicator model. The PR (1987) model attempts to identify the competitive structure of a system from bank-level conduct. The model introduces '*H- statistic*' which measures the response of a bank's equilibrium revenues to changes in input prices. The *H-statistic* is estimated from a reduced-form bank revenues equation and allows to test whether a bank-level conduct corresponds to any of the three market structures: Monopoly, Monopolistic Competition and Perfect Competition. The Boone (2008) indicator measures competition from the relation between efficiency and performance. The main idea behind the Boone indicator is the impact of efficiency on performance increases as the market becomes more competitive. The indicator exploits the difference in bank's performance that results from difference in efficiency to measure competition. This method has the advantage of measuring the evolution of competition annually.

The paper employs the two methods on bank-level data over the period 2003-2010. The findings indicate that banks in Sweden generate their revenues under monopolistic competition over the sample period. In view of high concentration in the Swedish banking system, this finding may have policy implications that relate to the market contestability theory. As long as potential entry possessesthreat to the incumbents, banks in concentrated systems can still behave competitively. The findings further indicate that commercial banks operate under a more competitive environment than savings banks. Finally, the Boone indicator suggests a very slight decline in the degree of competition after the recent GFC.

This paper is organized as follows. Section 2 provides a review of the literature on banking sector competition. Section 3 presents a brief overview of the Swedish banking system. Section 4 reports the data. Section 5 discusses the methodology. Section 6 presents the main empirical results and finally section 7 concludes the paper.

2. Literature Review

In the banking industry literature the measurement of competition has been categorized into two approaches: structural and non-structural approaches. The structural approach measures competition based on market structure indicators such as concentration ratios.The non-structural approach on the other hand examines competitive conditions based on bank-level behavior.

There are two competing explanations about the relationship between market concentration and firms' performance (profit) that are at the center of the structural approach: the structure-conduct-performance (SCP) hypothesis and the efficient-structure (ES) hypothesis. The SCP paradigm assumes that in concentrated markets, banks can easily arrange collusive agreement and exercise market power. Empirically, a positive relationship between profitability and market concentration indicates that the market is less competitive. The ES hypothesis(Demsetz, 1974) on the other hand asserts that the positive relationship between profit and concentration in concentrated markets could result from the banks' efficiency gains (cost advantage) contrary to the collusive behavior. Banks with superior managerial capability or production technology have lower costs which enable them to take a larger market share and generate higher profit. Under the ES hypothesis the positive statistical relation between profitability and industry concentration could be explained by efficiency gains of banks. Empirical evidences support both hypotheses. Smirlock (1985) finds evidence in favour of the ES hypothesis using U.S. banks. Berger (1995) also finds that the ES hypothesis holds in the U.S. banking system. In contrast, Goddard et al. (2001) find evidence in favour of the SCP paradigm for European banking systems.

The other approach, the non-structural one, emerges to the bankingliterature in reaction to the lack of a strong theoretical foundation that supports the structural approach (Bikker, J.A., Haaf, K., 2002). The models of the non-structural approach (Bresnahan, 1982, Lau, 1982,Panzar and Rosse, 1987) have emerged under the development of the New Empirical Industrial Organization(NEIO) literature. These models try to infer competitive conditionsfrom the bank-level behavior(Brissimis and Delis, 2011). The measurement of market structure indicators is not a requirement and the non-structural approach has the advantage of theoretical foundation on explicit optimization models and equilibrium

conditions (Brissimis and Delis,2011). Besides the Bresnahan and Lau and the PR models, Boone (2008) has contributed to the literature a new method to measure competition. The Boone indicator measures competition based on the relation between performance and efficiency.

Most recent studies in the banking industry employ models of the non-structural approach to examine competition. This paper uses two models of the non-structural approach: the Panzar and Rosse (PR) model and the Boone indicator. There are a large number of papers that apply the PR model to study competition both in cross-country and single-country studies. Tabak et al. (2011) provide more detail review of the results from recent studies that apply the PR model to different countries.

Shaffer (1982) is the first to apply the PR model to the banking industry and finds monopolistic competition for a sample of banks in New York. Casu and Girardone (2006) employ the PR for several European Union countries including Sweden. The result indicates banks in Sweden operate under monopolistic competition for the period 1997-2003. Molyneux et al. (1994) apply the PR for several EU countries for the period 1986-1989. Banks in France, Germany, Spain and the UK operate under monopolistic competition where the monopoly hypothesis is not rejected for Italy. Nathan and Neave (1989) employ the PR model for Canada banking system. They find perfect competition for 1982 and monopolistic competition for 1983 and 1984. Vesala (1995) examines competitive conditions for Finland over the period 1985-1992 and finds monopolistic competition for most of the sample years.

Finally, very few studies have employed the Boone indicator to examine the evolution of competitive behavior over time.Leuvensteijn et al. (2007) are the first to apply the Boone indicator on banking data. They investigated competition in the lending markets of France, Germany, Italy, the Netherlands, Spain, the UK, the U.S. and Japan. Over the period 1994-2004 their findings indicate that U.S. has the most competitive loan market. In the EU, German and Spain were found to have a competitive loan market. They also found commercial banks to operate under a more competitive environment than savings banks. Tabak et al. (2011) on 10 Latin American countries' banking systems, Schaeck and Cihak (2008, 2010) on banks in European countries and rural U.S. banks, and Leuvensteijn et al. (2008) on eight European countries, apply the Boone indicator.

3. Overview of the Banking System in Sweden

The financial industry has an important position in the economy of Sweden. The main players in Sweden's financial system are banks, mortgage credit institutions, insurance companies, and pensions and mutual funds. The financial system accounts for 4.3% of the total production of the country in 2010. The financial industry employees a total number of 85,000 people which is about 2% of the country's total number of employees. The 2010 balance sheet values of the financial companies in the system amounts to SEK 14,940 billion which is 4.5 times the country's GDP the same year.

The banking sector has a dominant position in the financial system of Sweden. It accounts for 39% of total assets of the financial industry as of 2010. The banking system is dominated by the four largest banks. The market share of the four banks accounts for about 78 percent of the total assets and 75 percent of the total deposits of the banking system. The total number of banks in Sweden declined from 124 in 2000 to 114 in 2010. During the sample period the number of commercial and foreign banks increases whereas the number of savings banks declines significantly. The banking system has experienced a wide range of events in recent decades. The deregulation of the banking system in Sweden was undertaken in the mid -1980s. This deregulation[2] was followed by an increase in the number of banks. In the beginning of the early 1990s, the banking system was severely hit by crisis. This banking crisis was followed by a decline in the number of banks in the system. This forces the government to intervene and the financial system starts to restore stability in 2003.

The banks have also broadened their business segments in the last ten years. Consequently, most of the large banks have been involved in life insurance operations whilst insurance companies start to own banking companies. Technological advancement has also brought a change in the system. The expansion of Internet banking has reduced the importance of branch offices and online banking becomes the main way to get banking services. The technology advancement has also facilitated the emergence of niche banks. These banks provide services mainly through Internet banking and phone and have an impact on the competitiveness of the system.

[2] The 1986 legislation allows foreign banks to open subsidiaries only. The 1990s legislation extends the rights for foreign banks to open branches.

4. Data and Variables

Table 1

Definition and description of variables

Variable	Definition
Total Revenue (TR)	Total interest and dividend income plus non-interest operating income.
Total Cost (TC)	Total operating expenses. It includes interest expenses, personnel expenses, and other operating expenses.
Gross Interest Income (GII)	Interest income on loans, other interest income, and dividend income.
Return on Assets (ROA)	The ratio of before-tax profit to total assets. It captures all sources of income.
Price of deposits (W1)	Ratio of interest expenses to total deposit and short-term funding (Current accounts, saving accounts, time deposits, interbank deposits and alternative funding sources such as securities). It is a proxy for the unit price of borrowing funds.
Price of physical capital (W2)	Ratio of depreciation expenses and administrative expenses to total assets. Administrative expenses include such as advertisement, security, information technology, and insurance expenses. The variable is used as a proxy for the unit price of physical capital.
Price of labor (W3)	Ratio of personnel expenses to total assets. Personnel expenses include wages and salaries, and other staff-related expenses. It is used as a proxy for the unit price of labor.
Marginal cost (MC)	It is the cost of producing one more unit of output. It is calculated by estimating a separate cost function (7).
Loans ratio (Z1)	Ratio of net loans to total assets. Net loan is calculated as gross loans minus provision for non-performing loans. The variable is used to capture risk preference.
Total assets (Z2)	It is the sum of the value of equity and liability. The variable is used to capture possible scale economy.
Equity ratio (Z3)	Ratio of equity to total assets. It captures the impact of leverage.
Output (q)	It is the total earning assets. It includes loans, securities, insurance assets and investments in property. The variable is used as a proxy for bank level output.

I use bank-level unbalanced panel data over the period 2003-2010 obtained from Bankscope database. The data are publicly available in the annually published Balance Sheet accounts and Income Statements of individual banks. The sample consists of 436 bank-year observations representing 59(25 commercial and 34 savings) banks operating in Sweden. Foreign banks are not included in the sample due to lack of sufficient data. The dataset of this study accounts for about 85 percent of the total assets of the Swedish banking system.

Table 2

Summary statistics of the variables used in the empirical analysis

Variable	Mean	Std. Dev.	Min	Max
Total Revenue (TR)	3,321.86	11,522.61	29.00	79,027.00
Interest Income (GII)	2,670.71	9,604.46	3.00	68,873.00
Total Cost (TC)	2,553.65	9,055.12	18.00	73,228.00
Output (q)	76,403.83	278,613.70	202.00	1,595,846.00
Total Assets (Z2)	80,520.47	294,410.80	487.00	1,708,500.00
Return On Assets (ROA)	0.015	0.014	-0.136	0.087
Price of Deposits (W1)	0.019	0.014	0.003	0.141
Price of Capital (W2)	0.016	0.021	0.002	0.250
Price of Labor (W3)	0.016	0.023	0.002	0.339
Loans Ratio (Z1)	0.724	0.183	0.019	0.968
Capital Ratio (Z3)	0.137	0 .062	0.022	0.695

Notes:All variables are obtained from Bankscope database for the period 2003-2010. The table displays summary statistics(mean,standard deviation,minimum, and maximum) for the variables used in the empirical analysis. The sample contains 436 bank-year observations. Variables are defined in Table 1. Total revenue (TR),gross interest income(GII), total cost (TC), output (q), and total assets (Z2) are expressed in million Swedishkrona.

Table 3

Evolution of the variables used in the empirical analysis over the period 2004-2010

Year	TR	GII	TC	q	Z2	ROA	W1	W2	W3	Z1	Z3
2004	140,180	107,033	102,524	3,173,699	3,382,428	1.8609	2.10	0.71	0.77	36.81	6.10
2005	152,029	113,080	121,294	3,697,376	3,905,152	0.9824	2.41	0.65	0.70	36.51	5.32
2006	217,014	173,115	148,123	4,144,991	4,365,171	1.6800	2.92	0.55	0.72	37.49	5.78
2007	246,620	205,319	199,425	4,913,063	5,157,371	0.9311	3.89	0.56	0.64	43.69	5.04
2008	293,193	255,519	248,416	5,887,040	6,184,332	0.6201	4.75	0.53	0.55	40.83	4.48
2009	195,267	152,474	146,433	5,689,892	5,978,627	0.6349	2.27	0.52	0.56	41.26	6.15
2010	185,554	144,380	132,542	5,603,747	5,918,414	0.7839	1.90	0.54	0.61	40.61	6.54

Notes:All variables are obtained from Bankscope database. The table presents the evolution of the variables used in the empirical analysis. The sample contains 436 bank-year observations. Variables are defined in Table 1.Total revenues (TR),gross interest income (GII), total costs (TC), output (q), and total assets (Z2) are expressed in million Swedish krona. Return on assets (ROA), price of deposits (W1), price of physical capital(W2), price of labor (W3), net loans to total assets ratio (Z1), and capital to total assets ratio (Z3) are expressed in percentage.

Table 4

Market concentration in the Swedish banking system over the period 2004-2010

Year	Number of Banks	Asset		Deposit	
		CR4	Sample	CR4	Sample
2004	126	81.16	86.70	75.82	91.13
2005	127	79.64	85.21	70.59	81.01
2006	126	78.28	84.76	68.15	78.62
2007	126	79.11	84.78	76.13	87.15
2008	118	80.43	82.80	78.03	85.11
2009	117	81.80	86.07	76.78	84.39
2010	114	78.14	84.76	75.12	85.29

Notes: Number of banks column presents the total number of banks in the market. CR4 column presents the market share of the four largest banks in terms of both asset and deposit. The sample column presents the market share of the banks included in the sample. All the variables are own calculations based on the data obtained from Bankscope database and the Swedish Bankers' Association. The figures are expressed in percentage.

The sample of banks used in this study (Table 4) represents on average 85 percent of the total assets and 84 percent of the total deposits of the Swedish banking system over the period of study. The four-bank concentration ratio (CR4) presented in Table (4) shows that, the four largest banks account for on average 79 percent of the total assets and 74 percent of the total deposits of the banking system during the period of study. The four largest banks are: Swedbank AB, Svenska Handelsbanken, Nordea Bank AB and Skandinaviska Enskilda Banken AB. The market share of the four largest banks in terms of total assets has declined slightly from 81 percent in 2004 to 78 percent in 2010, whereas their market share in terms of deposit has shown no significant change between the year 2004 and 2010. The number of banks in the banking system was 126 in 2004 and this number has declined to 114 in 2010. During the sample period, whereas the number of commercial banks increased from 29 in 2004 to 36 in 2010, the number of savings banks declined from 76 in 2004 to 50 in 2010.

5. Theoretical Framework

In the banking industry literature the measurement of competition has been categorized into two approaches: structural and non-structural approaches. The structural approach measures competition based on market structure indicators such as concentration ratios. It is assumed that high industry concentration facilitates the formation of collusive agreement and that allows firms to exercisemarket power. In this approach, concentratedmarkets are generally considered less competitive. The non-structural approach on the other hand examines competitive conditions based on bank-level behavior. In this approach, firms can still behave competitively in highly concentrated industries for fear of potential entrants. Market contestability such as access to entry plays a role in measuring competition.

This paper employs two models of the non-structural approach to examine the competitive structure of the banking system in Sweden. The first isthe Panzer-Rosse model.The second is the Relative Profit Differences (The Boone Indicator) model.

5.1 The Panzar-Rosse Model

The Panzar and Rosse (PR) model formulates a testable restrictions based on the models of profit maximization and equilibrium condition. The method attempts to identify the competitive conduct of banks by estimating a reduced-form revenue equation without the need to use explicit information on marketstructure indicators such as concentration ratio.The PR model infers competitiveness based on observation of a bank's equilibrium revenues response to changes in bank input prices. Put differently, the method attempts to infer the competitive structure of a market by observing the response of a bank's equilibrium revenues to changes in cost of production.

The PR approach introduces '*H-Statistic'*, which is the sum of the elasticities ofbank revenue function with respect to input prices. It is estimated from bank revenues function and serves to identify the competitive structure of a market. The j^{th}bank equilibrium revenue function derived from the zero profit equilibrium condition can be written as:

$$R_j^* = R\left(W_j, Z_j, Y_j^*, X_j\right), \quad (1)$$

where R_j^* represents equilibrium revenue of bank *j*, W_j stands for input prices, Z_j stands for other exogenous variables that affect the cost function, Y_j stands for equilibrium output,and X_j stands for vector of exogenous variables that affect the demand function. From the derivative of the revenue function with respect to factor prices, the PRH-Statistic (*H*) is given by:

$$H = \sum_{k=1}^{m} \frac{\delta R_j^*}{\delta W_k} \frac{W_k}{R_j^*}$$, where*k*stands for input type. (2)

The H-statistic measures the percentage change of equilibrium revenue resulting from a unit percentage change in factor prices. Delis (2010) asserts that banks respond differently in terms of pricing strategy to the change in factor prices depending on the market structure each bank operates in. For instance, a profit maximizing monopoly bank and a profit maximizing competitive bank respond differently in terms of equilibrium revenue to changes in input prices. The method utilizes this unique characteristic of different market structures to infer competitive conduct.

Panzar and Rosse (1987) provide proof using comparative statics that the value of the *H-statistic* is less than zero when the market structure is monopoly or a perfectly colluding oligopoly. Since the profit maximizing monopoly firm operates on the price-elastic portion of the market demand curve, an increase in output price (that follows from an increase in input prices) will result in a decline in revenue. Under a perfectly competitive market structure, the *H-statistic* is equal to unity. Coccorese (1998) demonstrates that an increase in input prices will shift both marginal and average costs by the same proportion without altering the bank's optimal quantity. As a result certain banks will exit from the market eventually, thereby increasing the residual demand for the remaining banks. In what follows, the output price as well as the revenue of those banks that survive in the market will increase by the same proportion. Finally, in a monopolistically competitive market, which is an intermediate case of the two polar competitive structures, the value of the H-statistic is less than unity and greater than zero. It is based on Chamberlin's tangency solution for equilibrium and an increase in input prices raises the revenue positively but the increase in revenue is proportionately smaller than the increase in factor prices (Goddard and Wilson, 2009).

In empirical applications, the rejection of the null hypothesis $H<0$ rules out the monopoly market structure and the rejection of both $H<0$ and the $H=1$ (but not the $H<1$) hypothesis indicates monopolistic competition. If we do not reject the $H=1$ hypothesis, itindicates perfect competition.

In the econometric analysis this paper estimates the *H-statistic* from the following log-linear reduced-form bank revenue equation for a panel dataset:

$$\ln TR_{it} = \alpha_{0i} + \beta_1 \ln W_{1it} + \beta_2 \ln W_{2it} + \beta_3 \ln W_{3it} + \beta_4 \ln Z_{1it} + \beta_5 \ln Z_{2it} + \beta_6 \ln Z_{3it} + \sum_{t=1}^{T-1} \gamma_t d_t + \varepsilon_{it} \quad (3)$$

where TR_{it} stands for total revenues of bank i at year t.There are three input prices and three bank-specific variables in the right-hand side of the equation.W_1 Isa proxy for input price of deposits. It is the ratio of total interest expenses to total deposits and money market funding.W_2 is a proxy for input price of equipment and other fixed capital. It is the ratio of other operating expenses over total assets.W_3 is a proxy for input price of labor. It is the ratio of personnel expenses over total assets.

To capture bank-specific effects, three control variables are included in the equation (3). Z_1 represents the ratio of net loans to total assets to capture the risk component, Z_2 stands for total assets to account for possible scale economies, and Z_3 denotes the ratio of equity to total assets to capture the impact of capitalization. α_{0i} captures bank-specific factors and ε_{it} is a random disturbance term. Delis (2010) asserts that the use of log specification improves the regressions' goodness of fit.

The Panzar-Rosse '*H-statistic*' that serves to measure competitive structure is given by $H = \beta_1 + \beta_2 + \beta_3$ which is the sum of the elasticities of the revenue equation (3) with respect to the three input prices.

A working assumption of the Panzar-Rosse framework is that the model should be estimated on observations generated by long-run equilibrium behavior. Following closely the common practice in banking literature[3] , we conduct the test for equilibrium by substituting

[3] Claessens and Laeven (2004), Delis (2010), Delis et. el. (2008) have applied similar testing approach.

the return on assets (ROA) as a dependent variable in the regression equation (3) as shown in the following equation:

$$\ln ROA_{it} = \gamma_{0i} + \gamma_1 \ln W_{1it} + \gamma_2 \ln W_{2it} + \gamma_3 \ln W_{3it} + \gamma_4 \ln Z_{1it} + \gamma_5 \ln Z_{2it} + \gamma_6 \ln Z_{3it} + \eta_{it}, \quad (4)$$

where ROA_{it} is the ratio of pre-tax profits to total assets that measures abank's return on assets[4].The subscript i denotes bank i, and the subscript t denotes year t.All the variables in the right-hand side of the equation are similar to the variables in equation (3).

In this framework the E-statistic as a test for equilibrium is defined as the sum of the coefficients of the three input prices, i.e. $E = \gamma_1 + \gamma_2 + \gamma_3$.Thus, the banking sector is in long-run equilibrium when $E = 0$ and in disequilibrium when $E \neq 0$.Delis(2010) demonstrates that the test is based on the idea that if the market is in equilibrium, the equilibrium rate of return should not be statistically correlated with input prices since banks should have equal risk-adjusted rate of return in competitive capital markets.

5.2 Relative Profit Differences (The Boone Indicator)

The relative profit differences (RPD) method as a measure of competition was first introduced by Boone et al. (2004) and further developed by Boone (2008). Shaeck and Cihak (2010) assert that the RPD which is also called 'The Boone Indicator' has a similar theoretical explanation as the efficient-structure (ES) hypothesis. The ES hypothesis claims that some firms have higher performance than others in terms of profit as a result of superior efficiency (lower marginal costs). The ES hypothesis asserts that banks with better efficiency have lower costs and therefore achieve higher profits.

The main idea behind the relative profit differences (RPD) method is that firms with superior efficiency i.e. banks with lower cost, gain more benefit in terms of profit as a result of market share reallocation from less efficient firms to more efficient ones and this effect becomes stronger in a highly competitive market structure.

Boone (2008) asserts that if output reallocation effect is a general feature of intense competition, the Boone indicator provides a robust measure of competition. In this model

[4]The dependent variable is computed as $\ln(1 + ROA_{it})$ just to avoid negative values of return on assets in the log specification.

the output reallocation effect from less to more efficient firms increases (monotonically) in intensity of competition since less efficient firms sacrifice more for being in a cost disadvantage position. As competition becomes more intense in the market, the relative gain of more efficient firms is higher than the less efficient ones (Boone, 2008).

In the empirical application, following the methodology of Leuvensteijnvet et al. (2008) and Schaeck and Cihak (2010), the Boone indicator can be estimated from the following simple linear equation for profit:

$$\ln \pi_{it} = \gamma + \beta \ln\left(MC_{it}\right) + \mu_{it}, \quad (5)$$

where the subscript i denotes bank i, the subscript t denotes year t, π_{it} stands for profit of bank i at year t, β is referred to as the Boone indicator and MC_{it} denotes marginal costs of bank i at year t.The profit is proxied by return on assets(ROA) and the marginal cost is estimated in a separate equation below.

From equation (5), we expect a negative value for β i.e. the increase in costs reduces profit. The main idea behind the Boone indicator is that the effect of efficiency on profitability is stronger in more competitive markets. Put differently, the punishment for being inefficient is higher in a highly competitive market than in the less competitive one. In what follows, a larger value of the parameter β (in absolute terms) is thus an indication of more competitive conditions in that particular market and therefore, β is monotone in intensity of competition.

In this paper we have an interest in measuring the evolution of competition annually. Besides, we include the time dummies to capture factors common to all banks in the market and specific to each year. We estimate the Boone indicator from the following equation:

$$\ln \pi_{it} = \gamma_0 + \sum_{t=1}^{T} \beta_t d_t \ln\left(MC_{it}\right) + \sum_{i=1}^{T-1} \gamma_t d_t + \mu_{it}, \quad (6)$$

where d_t is time dummy for each year, β_t is the Boone indicatorfor each year and μ_{it} is the error term.

Estimating equation (6) needs the computation ofmarginal cost (mc_{it}) for each bank and year. As marginal costs are not observable directly from accounting data, we estimate them by using the transcendental logarithmic (translog) cost function which is commonly used in the banking literature.

$$\ln TC_{it} = a_o + \delta_o \ln q_{it} + \frac{\delta_1}{2}\left(\ln q_{it}\right)^2 + \sum_{j=1}^{3} a_j \ln W_{jit} + \ln q_i \sum_{j=1}^{3} \delta_{j+1} \ln W_{jit} + \frac{1}{2}\sum_{j=1}^{3}\sum_{k=1}^{3} a_{jk} \ln W_{jit} \ln W_{kit} + \sum_{t=1}^{T-1} \alpha_t d_t + \varepsilon_{it} \quad ,(7)$$

where TC_{it} stands for total costs(operating plus financial) of bank i at year t, q_{it} represents output of bank i at year t captured by total earning assets, W denotes the three input prices and ε_{it} is an error term. Time dummies (d_t) for each year are also included to capture technological progress.

The marginal cost of bank i at year t can be obtained from the first-order derivative of equation (7) as follows:

$$MC_{it} = \frac{\delta TC_{it}}{\delta q_{it}} = \frac{TC_{it}}{q_{it}}\left(\delta_o + \delta_1 \ln q_{it} + \sum_{j=1}^{3} \delta_{j+1} \ln W_{j,it}\right) \quad (8)$$

The cost function must be homogeneous of degree one in input prices which imposes some restrictions on the parameter estimates. Linear homogeneity means that the percentage increase in all the three input prices raises the value of the cost by that same proportion. This property implies that the value of the three inputs included in the cost function represent the total cost. The linear homogeneity in input prices property requires the following restrictions on the parameter estimates to hold: $\sum_{j=1}^{3} a_j = 1$; $\sum_{j=1}^{3} \delta_{j+1} = 0$; $\sum_{j=1}^{3}\sum_{k=1}^{3} a_{jk} = 0$.

6. Empirical results

6.1 The Panzar-Rosse Model

This sectionpresents the estimation of the regression model and the competitive structure tests of the Panzar-Rosse *H- statistic*. The reduced-form revenue equation (3) is estimated using ordinary least square (OLS) and fixed effects(FE) estimators.When I estimate the regression equation (3) using FE estimator, the Wooldridge test for autocorrelation is performed and the result supports that there is no first-order autocorrelation. The Breusch-Pagan/Cook-Weisberg test indicates the presence of hetroskedasticity in the error term. The use of cluster-robust standard error corrects the hetroskedasticity problem.The estimation of equation (3) using OLS is also presented for comparison purpose.

The regression results of equation (3) for the full sample arereported in Table 5.The estimates obtained from the FE estimator indicate that the coefficients of input prices of deposits (W_1) and labor (W_3) are positive and statistically significant at 1 percent level. The coefficient of the price of physical capital is positive and significant at the 10 percent level, however its impact is very small compared to the other two input prices. These results indicate that the unit prices of funds and that of labor are more important than the unit price of physical capital in explaining the variation of the total revenues of banks. The coefficients of the control variables exert a positive and significant impact on bank revenues. Specifically, the coefficients of total assets (Z_2) and equity ratio (Z_3) are positively related to revenue. This may indicate that banks with high equity capital can boost the confidence of their customers, thereby leading to higher revenue. The positive coefficient on total assets (Z_2) indicates the presence of economies of scale. Banks of large size enjoy scale economy and achieve higher revenue.

We now turn to the results of competitive structure tests of the Panzar-Rosse *H-Statistic* presented in table 5. The estimation of the revenue equation (3) using FE produces *H-statistic* of 0.60 as reported in column 4 of Table 5.The Wald test (*F*-test) on the *H-statistic* rejects the null hypothesis of *H=0*. The test for perfect competition (*H=1*) hypothesis is performed using the Wald test (*F*-test). The result rejects the null hypothesis of *H=1* at the 1 percent significance level, suggesting the market is not characterized by perfect competition.

We recall from section 5.1that a positive *H-statistic* value between zero and unity represents monopolistic competition.

Therefore, the *H-statistic*result of 0.60 that is significantly different from both zero and unity suggests that banks in Sweden earn their revenues under monopolistic competition over the period 2003-2010. The result is supported by both OLS and FE estimators. The result is consistent with Casu and Girardone (2006) who found monopolistic competition for the period 1997-2003.Monopolistic competition is a market structure that is an intermediate case of perfect competition and monopoly. The goods and services provided by the banks are similar but slight differences in product quality and advertising often exist. As such, banks in a monopolistically competitive market structure are not price takers and each has a slight power as to what to charge for their products and services. Monopolistic competition is much closer to the perfect competition condition.

In view of high concentration in the Swedish banking system, the result of this study indicates that banks in Sweden generate their revenues in a quite competitive environment. Put differently, the result does not givesupport to the prediction of the structure-conduct performance hypothesis that relates market concentration to excess market power. Looking at the fact that few large banks dominate the banking system of Sweden, one might have hypothesized excess market power in the system. The theory of market contestability might help understand the behavior of banks in the Swedish banking system.

According to this theory, even if there is high concentration in the system, the interaction between banks can still be highly competitive if the banking system exhibits the characteristics of market contestability. Contestable markets have the characteristics of lower barriers to entry,both economic and legal, less activity restriction, and banks do not suffer much when they want to leave the market. There is high price-elasticity of demand for the industry product. According to the theory, if a market possesses these features of contestability, the players in the market demonstrate competitive conduct due to the threat of potential entrants. So long as potential banks can easily enter the system, the incumbents interact competitively even in a highly concentrated system.

This theory helps describe the competitive environment result we obtained despite high concentration in the system. It is convincing to argue that the banking system of Sweden at least partially satisfies the assumptions of a contestable market. This could be due to advancement in technology such as Internet banking, legislations that reduce barriers to foreign banks and deregulation of the banking and financial related services that allow even non-bank financial institutions to provide banking services. All these help the system exhibit contestability characteristics and enhance not only actual but also potential competition in the system. Contestability seems to play a greater role than industry structure in explaining competition in the banking system of Sweden.Claessens and Laeven (2004) find that banking systems with greater foreign entry and fewer entry and activity restrictions operate in amore competitive environment. They further found no evidence of negative correlation between concentration and competitiveness.

Table 5

Competitive structure test for the whole sample

	OLS		FE	
	coef.	*t-stat*	*coef.*	*t-stat*
Price of Deposits (w_1)	0.30***	10.33	0.23***	6.12
Price of Capital (w_2)	0.29***	9.68	0.10*	1.86
Price of Labor (w_3)	0.30***	9.40	0.27***	3.24
Loans Ratio (Z_1)	-0.09***	-3.99	0.04	0.70
Total Assets (Z_2)	0.99***	134.16	0.90***	7.27
Capital Ratio (Z_3)	0.10***	5.68	0.14**	2.07
Constant	1.19***	7.05	0.93	1.67
R^2	0.99		0.85	
Hausman test			142.25	0.00
H-statistic	0.89		0.60	
Wald test (*F*-test) for *H=0*	580.76[a]	0.00	22.80[a]	0.00
Wald test (*F*-test) for *H=1*	7.55[b]	0.00	9.75[b]	0.00
observations	436		436	

Note: The table presents coefficients and t-statistics from the estimation of equation (3) for the whole sample (436 observations) using ordinary least square (OLS) and fixed effects (FE) estimation techniques. The dependent variable is *lnTR*, the logarithm of total revenues. Variables are explicitly defined in Table 1. Both regressions include year dummies (not reported). The reported t-statistics (*t-stat*) are based on robust standard errors. The *H-statistic* is computed as the summation of the coefficients of the three input prices (i.e. w_1+ w_2+ w_3). The Wald test (*F*-test) along with associated p-values is applied to test the *H = 0* and *H = 1* null hypothesis.The Hausman test along with its P-value is used to test the suitability of the fixed effects model against the random effects model. [a] denotes *H = 0* is rejected, [b] denotes *H=1* is rejected. *, ** and *** represent significance at 0.1, 0.05 and 0.01 levels, respectively.

6.1.1The test for competition among commercial and savings banks

The dataset contains two categories of banks in the Swedish banking system: commercial banks and savings banks. There is an apparent difference between the two categories in terms of geographic business scope, type of products and services provided and business strategy pursued. Given these differences, it is worthwhile to examine the competitive conduct of commercial banks and savings banks separately. Table 6reports competitive structure test results for commercial and savings banks separately. I conduct the test by estimating equation (3) for the two categories separately. The FE estimation produces *H-statistic* of 0.74 and 0.28 for commercial banks and savings banks respectively. The Wald test (*F*-test) performed on the *H-statistic* of commercial banks does not reject the null hypothesis that commercial banks operate under perfect competition. The Wald test indicates monopolistic competition for savings banks.However, we recall from section 5.1 that these results to be valid, the long-run equilibrium assumption should hold for each category of banks.

Table6

Competitive structure test results among Commercial Banks and Savings Banks.

	Commercial Banks				Savings Banks			
	OLS		FE		OLS		FE	
	coef.	*t-stat*	*coef.*	*t-stat*	*coef.*	*t-stat*	*coef.*	*t-stat*
Price of Deposits(lnw_1)	0.26***	7.36	0.26***	5.17	0.09***	2.89	0.12**	2.41
Price of Capital (lnw_2)	0.34***	12.5	0.20**	2.68	-0.01	-0.38	-0.02	-0.59
Price of Labor (lnw_3)	0.28***	6.82	0.27***	3.14	0.28***	6.37	0.18**	2.41
Loans Ratio (Z_1)	-0.04	-1.48	0.04	0.66	-0.04	-1.15	-0.07	-0.91
Total Assets (Z_2)	1.00***	92.61	0.95***	7.03	1.01***	103.48	0.68***	6.91
Capital Ratio (Z_3)	0.10***	4.08	0.15	1.54	0.09***	4.43	-0.01	-0.17
Constant	1.15***	6.00	1.19	1.43	-1.20***	-5.02	0.72	0.98
H-statistic	0.88		0.74		0.36		0.28	
Wald test (*F*-test) for *H=0*	390.28[a]	0.00	24.45[a]	0.00	55.95[a]	0.00	14.66[a]	0.00
Wald test (*F*-test) for *H=1*	5.23[b]	0.02	2.87[c]	0.10	176.91[b]	0.00	92.37[b]	0.00
observations	125		125		271		271	

Note: The dependent variable is *lnTR*, the natural logarithm of total revenue. The table presents coefficients and t-statistics from the estimation of equation (3) for commercial banks and savings banks using ordinary least square (OLS) and fixed effects (FE) estimators. Variables are explicitly defined in Table 1. All regressions include year dummies (not reported). The reported t-statistics (*t-stat*) are based on robust standard errors. The *H-statistic* is computed as the summation of the coefficients of the three input prices (i.e. lnw_1+ lnw_2+ lnw_3). The Wald test (*F*-test) along with associated p-values is applied to test the *H = 0* and *H = 1* null hypothesis. [a] denotes *H = 0* is rejected, [b] denotes *H=1* is rejected and [c] denotes *H=1* is not rejected. *, ** and *** represent significance at 0.1, 0.05 and 0.01 levels, respectively.

6.1.2The test for long-run equilibrium

It has been discussed in the theoretical framework part of this paper that the validity of the Panzar-Rosse model depends on the assumption that the test should be undertaken on observations generated by long-run equilibrium behavior. It has been discussed that the *H-statistic* is derived based on a long-run equilibrium assumption.The empirical test for long-run equilibrium is conducted by estimating the regression equation (4) using FE and OLS estimators.

The long-run equilibrium test result is reported in Table 7. The estimation of equation (4) for the whole sample using FE produces an equilibrium statistic (*E-statistic*) value of -0.004. The Wald test (*F-test*) does not reject the null hypothesis of *E=0* (equilibrium condition), suggesting that the whole banking system is characterized by long-run equilibrium condition during the period 2003-2010.Theresult is supported by both OLS and FE estimators. A similar equilibrium test is conducted for commercial banks and savings banks separately. The results indicate that the observations for commercial banks are in long-run equilibrium, validating the competitive structure result for commercial banks. However, the equilibrium test for savings banks does not support the existence of equilibrium condition,indicating that we should interpret the competitive structure result for savings banks with caution. The savings banks have experienced a large number of mergers and acquisitions and exit during the sample period. It is noted that the number of savings banks has reduced from 76 in 2004 to 50 in 2010. This could help explain the disequilibrium condition in savings banks during the sample period.

Table7

Equilibrium test: - OLS and FE estimation results of equation (4) for the period 2003-2010.

	Full sample				Commercial Banks				Savings Banks			
	OLS		FE		OLS		FE		OLS		FE	
	coef.	*t-stat*	*coef.*	*t-stat*	*coef.*	*t-stat*	*coef.*	*t-stat*	*coef.*	*t-stat*	*coef.*	*t-stat*
Price of Deposits (w_1)	-.004	-0.94	-.012	-1.59	-.005	-1.09	-.015	-1.09	-.009	-4.00	-.006	-1.64
Price of Capital (w_2)	.004	1.83	-.007	-1.23	.005	2.09	-.007	-0.83	-.006	-2.38	-.003	-1.20
Price of Labor (w_3)	-.004	-0.86	-.006	-1.04	-.006	-0.93	-.006	-0.95	-.001	-0.46	-.008	-1.50
Loans Ratio (Z_1)	-.005	-1.82	-.005	-1.15	-.005	-1.44	-.008	-1.14	.000	0.11	.000	0.04
Total Assets (Z_2)	.001	1.30	.009	1.14	.000	0.48	.002	0.17	.000	0.80	.010	1.10
Capital Ratio (Z_3)	.009	6.02	.016	1.84	.010	4.66	.006	0.51	.008	5.00	.022	3.49
Constant	.010	0.35	-.128	-1.47	.004	0.13	-.104	-0.68	-.042	-2.33	-.092	-1.35
R^2		0.35		0.39		0.23		0.19		0.69		0.71
E-statistic	-.004		-.025		-.006		-.028		-.016		-.017	
Wald test (*F*-test) for *E=0*	0.31[a]	0.58	2.04[a]	0.16	0.43[a]	0.51	1.08[a]	0.31	18.04[b]	0.00	7.19[b]	0.01
observations	436		436		436		436		436		436	

Note: The table presents coefficients and t-statistics from the estimation of equation (4) for the full sample, commercial banks and savings banks using ordinary least square (OLS) and fixed effects (FE) estimators. The dependent variable is *lnROA*, the natural logarithm of return on assets. Variables are explicitly defined in Table 1. All regressions include year dummies (not reported). The reported t-statistics (*t-stat*) are based on robust standard errors. The *E-statistic* is computed as the summation of the coefficients of the three input prices (i.e. $w_1 + w_2 + w_3$). The Wald test (*F*-Stat) along with associated p-values is applied to test the *E = 0* null hypotheses (long-run equilibrium). [a] denotes E-statistic not significantly different from zero, [b] denotes *E*-statistic significantly different from zero.

6.1.3 Robustness test

I conduct various robustness tests to ensure that the results obtained are not affected by alternative specifications of the main models. First, I run the main regression model (3) by using an alternative dependent variable for both the full sample and commercial banks alone. Several studies that apply the Panzar-Rosse model use total revenue divided by total asset as a dependent variable. The regression model of this paper uses total revenue as a dependent variable. I employ the ratio of total revenue to total assets as dependent variable for both the full sample and commercial banks (specification I and III) to see the sensitivity of the main results where total revenue was used as dependent variable.

I also checked on the robustness of the main results by excluding some bank-specific control variables. Specifically, I have checked on the sensitivity of the main results for both the full sample and commercial banks by excluding the ratio of loans to total assets (Z_1) and the ratio of capital to total assets (Z_3) from the main model (Specification II and IV).Table 8reports the results of the alternative specification tests. Specification I and III present both type of alternative specifications for the whole sample whereas specification II and IV columns for commercial banks. The sensitivity analysis results are in agreement with the main results.

Table8

Sensitivity analysis:- Estimation results from alternative specifications of the main regression model (3)

	Full sample				Commercial Banks			
	Specification I		Specification II		Specification III		Specification IV	
	coef.	*t-stat*	*coef.*	*t-stat*	*coef.*	*t-stat*	*coef.*	*t-stat*
Price of Deposits(w_1)	0.23***	6.12	0.25***	5.69	0.26***	5.17	0.29***	5.26
Price of Capital (w_2)	0.09*	1.86	0.09*	1.68	0.20**	2.68	0.20**	2.69
Price of Labor (w_3)	0.27***	3.24	0.27***	3.11	0.27***	3.14	0.27***	3.02
Loans Ratio (Z_1)	0.03	0.70			0.04	0.66		
Total Asset (Z_2)	-0.10	-0.84	0.77***	8.01	-0.04	-0.34	0.81***	8.28
Capital Ratio (Z_3)	0.13**	2.07			0.15	1.54		
Constant	0.93	1.67	1.67***	3.62	1.19	1.43	2.18***	3.47
R^2	0.79		0.84		0.76		0.85	
H-statistic	0.59		0.61		0.73		0.76	
Wald test (*F*-test) for *H=0*	22.80[a]	0.00	20.13[a]	0.00	24.45[a]	0.00	23.89[a]	0.00
Wald test (*F*-test) for *H=1*	9.75[b]	0.00	7.26[b]	0.00	2.87[c]	0.10	1.94[c]	0.17
observations	436		436		165		165	

Note: The table presents coefficients and t-statistics from the estimation of alternative specifications of equation (3) for the whole sample (specifications I and II) and commercial banks (specifications III and IV) using fixed effects (FE) estimator. Specification I and III uses the natural logarithm of the ratio of total revenue to total assets as a dependent variable in equation (3). Specification II and IV represent when two control variables (loans ratio(Z_1) and capital ratio(Z_3)) are excluded from equation (3). Variables are explicitly defined in Table 1. All regressions include year dummies (not reported). The reported t-statistics (*t-stat*) are based on robust standard errors. The *H-statistic* is computed as the summation of the coefficients of the three input prices (i.e. w_1+ w_2+ w_3). The Wald test (F-test) along with associated p-values is applied to test the *H = 0* and *H = 1* null hypothesis. [a] denotes *H = 0* is rejected, [b] denotes *H=1* is rejected and [c] denotes *H=1* is not rejected *, ** and *** represent significance at 0.1, 0.05 and 0.01 levels, respectively.

6.2 The Boone Indicator

6.2.1 Marginal costs

The estimation of the Boone indicator requires the computation of marginal costs for each bank and year. The first step in calculating the marginal costs is the estimation of the translog total cost function (TCF). Previous studies (Maslovych, 2009 and Van Leuvensteijn et al., 2007) employ ordinary least squares (OLS) to estimate the parameters of the cost function owing to its simplicity. However, since the translog cost function includes a large number of explanatory variables, it is highly likely that OLS will produce imprecise parameter estimates resulting from the multicollinearity problem.

As an alternative, this paper uses a seemingly unrelated regression (SUR) technique to estimate the translog cost function. Christensen and Green (1976) assert that SUR produces moreefficient parameter estimates than OLS would produce since it uses additional pieces of

information (degrees of freedom) in estimating the coefficients of the parameters. The parameter estimates of the TCF using fixed-effect is also presented for comparison purposes.

The regression results of the TCF are reported in Table 9. The specification of the TCF in logarithmic form allows interpreting the first-order coefficients as cost elasticities. Most of the parameter estimates have the expected signs. We note that most of the second-order and interaction terms are statistically significant, suggesting their impact on the cost estimation. The cost function gives good fit to the data and more precise estimates of marginal cost is expected. The marginal cost is computed by substituting parameter estimates from TCF into equation (8).

Table 9

Estimation results of the translog cost function for the whole sample.

	FE		SUR	
	coef.	*t-stat*	*coef.*	*z-stat*
Output (lnq)	1.099***	10.63	1.114***	30.05
Price of Deposits (w_1)	0.084	0.73	0.135**	1.98
Price of Capital (w_2)	0.548***	3.96	0.547***	7.11
Price of Labor (w_3)	0.664***	3.46	0.679***	8.11
lnq lnW_1	0.001	0.42	-0.002	-0.81
lnq lnW_2	-0.016*	-1.95	-0.016***	-3.46
lnq lnW_3	-0.023*	-1.80	-0.024***	-2.89
lnW_1 lnW_2	-0.288***	- 6.35	-0.286***	-14.21
lnW_1 lnW_3	-0.049	-0.93	-0.051**	-2.38
lnW_2 lnW_3	-0.439***	-7.55	-0.435***	-18.09
Constant	1.583**	2.46	2.660***	9.57
R^2		0.98		0.99

Note: The dependent variable is *lnTC,* the natural logarithm of total cost. The table presents coefficients and t-statistics from the estimation of the translog cost equation (7) for the whole sample (436 observations) using fixed effects (FE) and seemingly unrelated regression (SUR). Variables are explicitly defined in Table 1. Both regressions include year dummies and bank-fixed effects (not reported). The reported t-statistics (*t-stat*) are based on robust standard errors. *, ** and *** represent significance at 0.1, 0.05 and 0.01 levels, respectively.

Table 10

Estimates of the Boone indicator (over years and pre and post global financial crisis)

	The whole sample							Pre-GFC (2003-2007)	Post-GFC (2008-2010)
year	2004 (1)	2005 (2)	206 (3)	2007 (4)	2008 (5)	2009 (6)	2010 (7)	(2003-2007) (8)	(2008-2010) (9)
Boone	-0.281	-0.035***	-0.005***	-0.010***	-0.007**	0.004***	-0.001	-0.023***	-0.017*
	(0.31)	(-3.03)	(-4.51)	(-3.22)	(-2.02)	(4.00)	(-1.46)	(-3.87)	(-1.86)
Constant	0.131	-0.002	0.008***	0.004**	0.006***	0.014***	0.014***	-0.072***	-0.054*
	(0.35)	(-0.43)	(8.54)	(1.98)	(2.75)	(16.23)	(11.31)	(-3.16)	(-1.83)
Anderson corr.	0.065	11.218	41.496	13.741	10.835	74.833	82.609	17.591	12.044
Prob>*F*	(0.798)	(0.004)	(0.000)	(0.003)	(0.004)	(0.000)	(0.000)	(0.000)	(0.007)
Hansen *J*-test	0.00	2.605	4.366	2.708	0.804	1.209	21.846	1.560	1.741
P-value		(0.107)	(0.113)	(0.258)	(0.369)	(0.546)	(0.000)	(0.458)	(0.418)

Note: The dependent variable is *lnROA*, the natural logarithm of return on assets. The table presents the estimates of the Boone indicator from equation (6) for the full sample using a two-step GMM estimator. Marginal cost from the translog cost function is used as an explanatory variable. Column (8) represents before the global financial crisis period (2003-2007) and column (9) represents after the global financial crisis period (2008-2010). One, two and three year lagged values of the average cost are used as instruments. The z-statistics (z-stat) based on robust standard errors appear in parenthesis. The Hansen *J*-test is used to test the validity of instruments. The Anderson canonical correlation likelihood ratio is employed to test the relevance of instruments. *, ** and *** represent significance at 0.1, 0.05 and 0.01 levels, respectively.

6.2.2 The Boone indicator over the years

We now proceed to the estimation of the Boone indicator (β) based on the relation between efficiency and profitability of individual banks as specified in equation (6). The estimates of the Boone indicator are presented over the years and for the three categories (full sample, commercial banks and savings banks). It is estimated using Generalized Method of Moments (GMM) whereby one, two and three year lagged values of the average cost are used as instruments. The use of GMM technique is to mitigate concerns that profitability and costs are jointly determined. The validity of the instruments is tested using Hansen J-test which is a test of overidentifying restrictions. The null hypothesis is that instruments are uncorrelated with the error terms. The relevance of the excluded instruments is tested by the Anderson canonical correlation testwhere the null hypothesis is that the equation is underidentified. Rejection of the null, however, does not rule out weak instruments problems.

Table 10 reports the estimates of the Boone indicator (β) for each year (2004-2010) and for pre and post global financial crisis (GFC) periods. The estimates of yearly β for the full sample are presented in Column (1) up to (7). The estimates of β for pre and post GFC periods are presented in Column (8) and (9) respectively.The yearly estimates of β for the full sample indicate a small variation over the sample period. This suggests that there was a small variation in the degree of competition in the banking system over the sample period. However, the interpretation needs caution as some of the estimates of β are insignificant. The β for year 2008 coincides with the peak time of the global financial crisis. The estimated β indicates a less competitive environment for that particular year. It could be argued that the involvement of the government by providing liquidity assistance[5]might have slightly distorted the competitive playing field. For instance some important banks might get funding advantages compared to small and medium sized banks. Overall, the estimates of β for the full sample show a decreasing trend over the sample period suggesting a slight decline in competition after the GFC. However, this interpretation needs careful consideration. First, the estimates ofβ for some years are insignificant. Furthermore, the yearly estimates of β usea limited number of observations that call for careful interpretation. To address this issue the sample is divided in-to two periods: pre-GFC (2003-2007) and post-GFC (2008-2010) to infer competitive conduct before and after the GFC.

[5]The central bank of Sweden (Riksbank) has provided liquidity assistance to financial institutions amounting to over SEK 450 Billion.

6.2.3 Before and after the global financial crisis

This section considers whether the global financial crisis (GFC) and related measures taken by the state in the aftermath bring a change in the competitive environment of the system. Consequently, to identify a change in the degree of competition, the entire sample period is divided into two sub-periods: pre GFC (2003-2007) and post-GFC (2008-2010). The Boone indicator is estimated for each sub-period separately. Column (8) and (9) of Table 10 reportthe estimates of the Boone indicator (β) before and after the GFC respectively. The result shows a slight decline in β (in absolute terms) from -0.023 to -0.017, suggesting that overall competition seems to have slightly declined after the GFC, if not to say no change at all. Sun (2011) employs the Panzar-Rosse model and finds a decline in competition in several euro area countries and the United States after the recent GFC. This paper's findings might be related to the actions taken by the government in the aftermath of the crisis. For instance, the state aid to the financial sector as a response to the crisis might slightly affect the competitive playing field. Some important banks might get a funding advantage compared to small and medium sized banks. The exit of some foreign banks' branches and a commercial bank after the GFC could have an impact on competition.

However, we should note that the banking system of Sweden is among the least affected banking systems by the crisis compared to other countries. This could be related to the highly concentrated structure of the system. International evidences show that highly concentrated banking systems like in Canada and Australia have been the least affected by the recent GFC. Beck et al. (2006) find a result that supports a strong positive relation between banking system concentration and financial stability.

6.2.4 Competition among commercial and savings banks

Column (1) and (2) of Table 11 present the estimates of the Boone indicator for commercial and savings banks respectively. Overall, commercial banks tend to operate in a stronger competitive environment than savings banks for most of the period. This finding is consistent with the Panzar Rosse model result in section 6.1.Sjöberg (2007), who employs a structural simultaneous-equation model over the period 1996-2002, found similar results. The author found 20% more competitive conduct among commercial banks than savings banks in the Swedish banking system. This finding can be attributed to the fact that savings banks operate at regional or local markets where the provision of services highly depends on a network of branches. The cost of establishing new branch networks could be high given the small scale of the local market. This suggests the existence of customer loyalty and entry barriers compared to the environment for commercial banks where online banking is the main way of providing services. The difference in entry barriers between the two categories might help explain the difference in intensity of competition. Furthermore, foreign banks focus more on corporate banking which is the main business segment of domestic commercial banks. The competition they face from foreign banks and capital markets may force commercial banks to behave more competitively than savings banks.

Table 11

Estimates of the Boone indicator for commercial and savings banks.

	Commercial Banks		Savings Banks	
	1		2	
Year	*Boone*	*z-stat*	*Boone*	*z-stat*
2004	-0.005**	-2.08	'-0.001***	-5.35
2005	-0.007***	-4.51	-0.006***	-16.46
2006	-0.006***	-3.04	-0.002***	-6.69
2007	-0.005***	-2.81	-0.001***	-5.43
2008	-0.002	-0.96	0.004***	7.63
2009	-0.003	-1.52	-0.0002	-0.52
2010	-0.004*	-1.70	0.001**	2.43
constant	0.002	0.28	0.011***	12.93

Note: The table presents the estimates of the Boone indicator from equation (4) for commercial banks and savings banks using a two-step GMM estimator. The dependent variable is *lnROA*, the natural logarithm of return on assets. One, two and three year lagged values of the average cost are used as instruments. The reported z-statistics (*z-stat*) are based on robust standard errors. . *, ** and *** represent significance at 0.1, 0.05 and 0.01 levels, respectively.

7. Conclusion

This paper aims to empirically assess the competitive structure of the Swedish banking system over the period 2003-2010. The deregulation of financial services in the EU, technological advancement and the recent GFC could have an implication on the competitiveness of the system. The existence of high asset concentration in the Swedish banking system and the traditional view that market concentration impairs competitiveness, makes investigating the system worthwhile. The paper employs two non-structural models: the Panzar-Rosse model and the Boone indicator.

The empirical findings suggest that banks in Sweden operate in amonopolistically competitive environment over the sample period. In view of high concentration in the system, the result may have policy implications that relate to market contestability theory. As long as the incumbents face threat from potential entrants, banks in highly concentrated systems can still behave competitively. However, the dominance of the system by few banks could lead to “too big to fail” banks. These banks might have an incentive to involve in excessive risks, assuming that the authority will provide them assistance if the worst happens. The recent GFC suggests that the interactions between competition, concentration and financial stability remain an important area of research carrying policy implications.

The findings also indicate commercial banks operate in a more competitive environment than savings banks. Savings banks highly depend on network of branches to provide banking services where online banking is the main way of providing service to commercial banks. This could bring difference in the level of entry barriers. Foreign banks and non-bank financial institutions are more involved in business segments of commercial banks. This could force commercial banks to behavecompetitively. Finally, the estimates of the Boone indicator suggest a very slight decline in competition in the whole banking system after the GFC.

Finally, as in every methodological framework, the models this paper employs have their own limitations. The PR model assumes a homogeneous cost structure among banks and the test should be undertaken on observations generated from long-run equilibrium behavior. The Boone indicator assumes that banks partially transfer their efficiency gains to their customers. Furthermore, it does not take into account differences in the quality of services and products that banks provide.

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