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COMPETITION IN COMMERCIAL BANKS IN POLAND – ANALYSIS OF PANZAR-ROSSE H-STATISTICS.

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Competition in commercial banks in Poland – analysis of Panzar-Rosse H-statistics.

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ABSTRACT

This paper aims to find out how intense is the competition in Polish commercial banks loan market. Using Panzar – Rosse H-statistics and applying several estimation techniques (GLS, one-step GMM and two-step GMM) we find that this intensity is sensitive to the estimator applied. Upon analysis of results, one can conclude that competition evolves differently across years in Poland. In some years, competition was relatively high, as the H-statistics reached the level of 0.75, which is relatively close to perfect competition. In other years it gradually decreased reaching its bottom line in 2010, and took upward trend in 2011 and 2012. Generally, the values of our competitive environment measure indicate at monopolistic competition in Poland.

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Contents

1. INTRODUCTION

This paper investigates the measurement of competition in the Polish banking sector and is driven by scarce evidence in this respect. As has been proven for other industries, competition is likely to have far-reaching implications for economic growth, productivity, financial stability and, consequently, consumer welfare. Theoretical and empirical research that can assess the extent of competition in banking, therefore, has important implications for government agencies responsible for the effective regulation and supervision of the financial system (Beck et al., 2004; Boyd and De Nicoló, 2005, Boyd et al, 2006; Berger et al, 2009; Samaniego, 2010).

This paper presents estimates of competition in bank loan market in Poland using a well grounded approach, indroduced by Panzar and Rosse (1987) and developed in many studies (see table 1 and 2). The so called Panzar-Rosse H-statistics is defined as the sum of the elasticities of a bank's total revenue with respect to that bank's input prices (Panzar and Rosse, 1987; see also Turk Ariss, 2010). Under monopoly, the H-statistics should be smaller than or equal to zero. In contrast, in the models of monopolistic competition and perfect competition, the H-statistic should lie between 0 and 1. Finally, under perfect competition, the H-statistics is equal to 1. Overall, a larger H-statistics indicates a higher degree of competition. We apply the methodology used in the estimation of the H-statistics to a unique dataset of quarterly individual banks' financial items spanning the years 2008-2012.

Unlike previous papers which attempt to measure the competition intensity in Poland applying annual unbalanced financial data on banking sector available in the Bankscope database, we use data handcollected from Monitor Polski B and webpages of commercial banks. Where it is necessary we supplement this data which information accessed from Polish Financial Supervisory Authority.

Upon analysis of results, one can conclude that competition evolves differently across years in Poland. In some years, competition was relatively high, as the H-statistics reached the level of 0.75, which is relatively close to perfect competition. In other years it gradually decreased reaching its bottom line in 2010, and took upward trend in 2011 and 2012. Generally, the values of our competitive environment measure indicate at monopolistic competition in Poland.

The structure of this paper is as follows. Section 2 presents an overview of different approaches in the literature to measure competition in banking industry across the world as well as in the Polish banking market. Section 3 provides description of methodology and data applied in the invesitgation. Section 4 presents results of empirical study. Finally, Section 5 concludes.

2. COMPETITION INTENSITY MEASUREMENT – A LITERATURE REVIEW

2.1. Measures of competition intensity

The actual literature on the measurement of competition is broadly classified into two major streams (Bikker, 2004; Tabak et al., 2012). One of those streams include the so-called structural approaches which are based on the structure-conduct-performance (SCP) paradigm and use market structure measures such a concentration ratios, number of banks or Herfindahl indices. These indicators measure the actual market shares without allowing inferences on the competitive behavior of banks. They are rather crude measures that do not take into account that banks with different ownership behave differently and that banks might not compete directly with each other in the same line of business. Moreover, they do not measure the competitive conduct of banks at the margin. Thus, they may not be the most appropriate indicators for measuring bank competition (Bikker, 2004; Casu and Girardone, 2006 and 2009; Schaeck et al., 2009, Carbo-Valverde et al., 2009).

The other stream covers non-structural approaches that have been promoted in the so-called New Empirical Industrial Organisation (NEIO) literature. Within NEIO framework, there are two main types of econometric methodologies. One of them is a simulatenous-equation method, which is represented by Bresnahan (1982) and Lau (1982). This method estimates the level of competition intensity by simultaneously considering supply and demand functions to identify a parameter that measures the behaviors of banks. The most challenging issue with this approach is that it requires detailed data on bank financials, which are hardly accessible.

The second type of methodology includes approaches in which the parameters that reflect the degree of competition in specific markets are estimated with application of bank-level data and specific assumptions on the behavior of banks. The Lerner index, Panzar-Rosse H-statistics as well as the Boone indicator, fall into this part of the literature.

The Lerner index is designed with the assumption that market power may also be related to profits, in the sense that extremely high profits may be indicative of a lack of competition. This index has been widely used in recent bank research (see e.g. Claessens and Laeven, 2004; Maudos and Fernandez de Guevara, 2004; Berger et al., 2009; Fiordelisi and Cipolini, 2012; Fu, 2014) and indicates a bank's market power by considering the difference between price and marginal cost as a percentage of price. The degree of competition is given by the range 0< Lerner index <1. In the case of perfect competition, the Lerner index equals 0; under a pure monopoly, the Lerner index equals 1. A Lerner index <0 implies pricing below the marginal cost and could result, e.g., from non-optimal bank behavior.

The Panzar and Rosse (1987) H-Statistics, which measures the reaction of output to input prices, gauge the competitive behavior of banks, but impose certain restrictive assumptions on banks' cost function. Specifically, under perfect competition, increases in input prices cause total revenue and marginal cost to move together, while in imperfect competition they do not. However, the inference from this measure derived from the profit-maximizing condition is only valid if the market in question is in equilibrium. Estimates of the H-Statistics vary widely, as the studies by Claessens and Laeven (2004), Bikker and Spierdijk (2007) and Olivero et al. (2011) show, and suffer from a few flaws as is explained in Shaffer (2004).

With respect to the "Boone" indicator or the profit elasticity (PE) model for measuring bank competition, this indicator is often seen as a proxy for competition, in the sense that the most efficient banks (and therefore the most competitive ones) will gain market share at the cost of the less efficient banks. This measure has gained considerable support more recently (Van Leuvensteijn et al., 2007, 2011 and 2013; Van Leuvensteijn, 2008; Schaeck and Cihák, 2010; Delis, 2012; Tabak et al., 2012).

While the measures mentioned above have been broadly accepted, there is no consensus regarding which is the most suitable indicator for quantifying bank competition (Carbó Valverde et al., 2009). As a matter of fact, these measures whose estimation results are presented in different research papers often produce divergent conclusions for banking markets of the same countries and groups of countries (see e.g. Turk-Ariss, 2010 and Bikker and Spierdijk, 2010). This diversity in results can be inferred from Table 1, which reviews mostly contemporary literature on competition in the banking industry. Generally, the divergence in results may be explained by differences in background methodologies and differences in bank data samples applied. Notwithstanding these discrepancies, it seems that prevailing competition model in the banking industry is monopolistic competition.

Table 1. Review of empirical studies banking competition.

Study by:	Period	Countries	Type of approach	Results
Nathan and Never (1989)	1982-1984	Canada	Panzar-Rosse H-statistics	Perfect competition for 1982 and monopolistic competition competition for 1983 and 1984
Shaffer and DiSalvo (1994)	1970-1986	Pannsykvania (USA)	Panzar-Rosse H-statistics	Duopoly; high competition
Molyneux (1994)	1986-1989	France, UK, Spain, Germany, and Italy	Panzar-Rosse H-statistics	Monopoly in Italy and monopolistic competition in the rest of countries
Molyneux et al.. (1996)	1986, 1988	Japan	Panzar-Rosse H-statistics	Monopoly in 1986; monopolistic competition in 1988
Casu and Girardone (2006)	1997-2003	15 European countries	Panzar-Rosse H-statistics	Monopolistic competition in the EU. Values of H-statistics are diversified across countries, with the lowest in Greece (0.00) and the highest in Luxembourg (0.656).
Leuvensteijn et al. (2007)	1992-2004	The Euro Area	Boone indicator	The Boone indicator for Spain, Italy and Germeny suggests comparatively competitive banking markets, while Dutch banking sector takes up intermediate position.
Schaeck and Cihak (2010)	1995-2005	Two markets: European banks and US banks	Boone indicator	In the European sample, the Dutch banking system is the most competitive, and is followed by the U.K. and Switzerland. In the US there is a huge diversity of results, with Marshall market the most competitive and Christian Market the least competive.
Turk-Ariss (2010)	1999-2005	60 developing countires: including Africa, East/South Asia and Pacific, Eastern Europe and Central Asia, Latin America and Caribbean, and the Middle East.	Lerner index and funding adjusted Lerner index	The conventional Lerner figures show varying degrees of market power across countries, but the figures are generally closely aligned across all regions (around 30% price mark-up over marginal costs) except for Latin America and the caribbean where the conventional Lerner is as low as 17%. The estimated efficiency and funding-adjusted Lerner indices also vary across countries and regions.
Olivero et al. (2011)	1996-2006	10 Asian countires and 10 Latin American countries	Panzar-Rosse H	Most estimates are positive and less than 1 indicates that banks in Latin American and Asian countries seem to operate in a monopolistically competitive environment. Exceptions include India, Korea, and China from Asia and Venezuela from Latin America which are shown to have negative values of the PRH statistics. This implies a potential monopolistic environment or the presence of a structural disequilibrium in their banking markets. Banking industries in Latin America seem to be more competitive than those in Asia. While the sample mean of the PRH statistics estimated using the static revenue equation is 0.379 for Latin American banking, it is only 0.122 for Asian banking. Similarly, while the sample mean for the dynamic panel estimation is 0.704 for Latin America, it is only 0.284 for Asia.
Beck et al.. (2011)	1994-2009	79 countries	Lerner index	The values of the index are positive and suggest monopolistic competition
Tabak et al. (2011)	2001-2008	10 Latin American countries: Argentina, Brazil, Chile, Colombia, Costa Rica, Dominican Rep., Mexico, Panama, Peru, Venezuela	Boone indicator	The values of the Boone indicator exhibit strong diversity, and therefore the competition intensity is very diversified, both across countries and across time. As there are not available reference values for specific models of competition in the banking market, we cannot make inferences in this subject.
Noth (2011)	1996-2006	Germany	Lerner index	The values of the index are positive and suggest monopolistic competition
Stavarek and Repkova (2011)	2001-2009	Czech Republic	Panzar-Rosse H-statistics	Highly competitive market in period 2001-2005 and monopolistic competition in 2005-2009.
Cipollini and Fiordelisi (2012)	1996-2009	European countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, United Kingdom	Lerner index	The mean value of the Lerner index suggests monopolistic competition
Casu and Girardone (2012)	2000-2005	European countries: France, Germany, Italy, Spain, UK	Lerner index	Values of both indices are diversified across time and across countries, and suggest monopolisitc competition. Spanish and Italian banking industries seem to be the most competitive , with Lerner index close to 0.
Carbo-Valvedere et al. (2012)	1996-2012	23 OECD countries	Lerner index	Values of both indices are diversified across time and across countries, and suggest monopolisitc competition.
Xu et al. (2013)	1996-2008	China	Lerner index, elasticity adjusted Lerner index, Boone indicator	The results for both the traditional Lerner index and the elasticity-adjusted Lerner index suggest a general increasing level of bank competition up to around 2002 and a decreasing level of bank competition afterwards. The values of the Lerner index indicate monopolistic competition. In general, the development of the yearly PE indicator suggests that competitive conditions in Chinese loan markets improved, especially after WTO accession in 2001. As for the Boone indicator competition increased sharply during 2001–2003 and then declined up to 2005. It then intensified again, followed by a slight decrease in 2007 and 2008.
Fu et al. (2014)	2003-2010	Asia Pacific conutries: Australia, China, Hong Kong, India, Indonsia, Japan, Korea, Malaysia, Pakistan, Phillipines, Singapore, Sri Lanka, Taiwan, Thailand	Lerner index and efficiency adjusted Lerner index	Values of both indices are diversified across time and across countries, and suggest monopolisitc competition. The trend for the Lerner index (non-structural measure) is descending between 2005 and 2008 suggesting a decrease in pricing power. The Lerner index exhibits varying degrees of market power across countries. Singapore has the highest efficiency-adjusted Lerner index value (0.44), whereas Taiwan has the lowest value (0.22)

Source: Authors' analysis of papers cited in the table.

2.2. Competition intensity in Poland – the review of empirical evidence

The empirical evidence on the intensity of competition in Polish banking industry is rather scant. The available studies include cross country analyses in which Polish banking market is one of many other banking markets (see e.g. Beck et al., 2004; Claessens and Laeven, 2004; Turk-Ariss, 2010; Agoraki et al., 2011; Beck et al., 2013; Mirzaei et al., 2013) and only a few papers focusing on the Polish banks alone (Pawłowska 2005, 2010, 2012). These analyses apply a wide range of competition measures, from simple market structure indicators, such as concentration ratio or HHI (see e.g. Pawłowska, 2012; Mirzaei et al., 2013;) to indicators justified in the NEIO literature, i.e. the Lerner index (see e.g. Pawłowska, 2012; Turk-Ariss, 2010; Agoraki et al., 2012) and the Panzar-Rosse H – Statisitcs (see e.g. Claessens and Laeven, 2004; Bikker and Spierdijk, 2008; Pawłowska, 2005; 2010; 2012). The summary of the studies which apply NEIO approaches are presented in Table 2.

The results for both the Lerner index and Panzar-Rosse H-statistics show varying degrees of market power across year and suggest a monopolistic competition in the Polish banking industry. The Panzar-Rosse H-statistics has been usually estimated in a regression in which dependent variable is interest income normalized by total assets or loans (II/A or II/L). Generally, it can be seen that the so-called H-statistics developed by Panzar and Rosse has been employed in a small number of empirical studies on bank competition in Poland (Pawłowska, 2010, 2012).

As can be inferred from Table 2 the estimation techniques applied to compute the H-statistics are diversified, and include pooled OLS, GLS and GMM. It is worth noting here that application of pooled OLS estimator to dynamic panel data is controversial, as structural parameters obtained with its application are usually biased (Arellano and Bond, 1991; Greene, 2012; Baltagi, 2005).

Table 2. Review of empirical studies measuring competition in Polish banking industry (commercial banks)

Study by:	Type of measure of comeptition intensity	Level of the competition intensity indicator	Model of the competition	Time period of analysis	Type of dependent variable	Estimation technique
Claessens and Laeven (2004)	Panzar-Rosse H-Statisitcs	0.77	Monopolisitc competition	1994-2001	Normalized interest income	Average of several H-statistics obtained in application of several versions of OLS and GLS.
Pawłowska (2005)	Panzar-Rosse H-Statisitcs	0.75 in years 1997-1998; 0.78 in years 1998-1999; 0.60in years 1999-2000; 0.65 in years 2000-2001; 0.84 in years 2001-2002.	Monopolisitc competition	1997-2002	Normalized interest income	n.a.
Bikker and Spierdijk (2008)	Panzar-Rosse H-Statisitcs	0.03 in 2004	Monopolisitc competition	1994-2004	Non-Normalized interest income	FE GLS, Recursive least squares
Pawłowska (2010)	Panzar-Rosse H-Statisitcs	0.62 in years 1997-2007; 0.51 in years 1997-1998; 0.64 in years 1999-2003; 0.60 in years 2004-2007.	Monopolisitc competition	1997-2007	Normalized interest income	FE GLS
Pawsłowska (2012)	Panzar-Rosse H-Statisitcs	0.55 (FE), 0.49 (OLS), 0.60 (GMM) in years 1997-2001; 0.78 (FE), 0.79 (OLS), 0.84(GMM) in years 2002-2007; 0.82 (FE), 0.88 (OLS), 0.82 (GMM) in years 2008-2009.	Monopolisitc competition	1997-2009	Normalized interest income	FE GLS, pooled OLS, GMM
Turk-Ariss (2010)	Lerner index	Conventional Lerner: 0.2334; Efficiency-adjusted Lerner: 0.5095; Funding - adjusted Lerner: 0.4593.	Monopolisitc competition	1999-2005	Marginal cost function	FE GLS
Pawłowska (2012)	Lerner index	0.38 in 1997; 0.38 in 1998; 0.29 in 1999; 0.42 in 2000; 0.30 in 2001; 0.097 in 2002; 0.14 in 2003; 0.19 in 2004; 0.28 in 2005; 0.27 in 2006; 0.26 in 2007; 0.37 in 2008; 0.42 in 2009.	Monopolisitc competition	1997-2009	Marginal cost function	FE GLS

Source: Claessens and Laeven (2004), Bikker and Spierdijk (2005), Pawłowska (2005, 2010, 2012), Turk-Ariss (2010).

3. METHODOLOGY

We use the Panzar-Rosse approach to assess the competitive nature of banking market in Poland. The so-called H-statistic developed by Panzar and Rosse has been employed in a small number of empirical studies on bank competition in Poland (Pawłowska, 2010, 2012). The H-statistic is defined as the sum of the elasticities of a bank's total revenue with respect to that bank's input prices (Rosse and Panzar, 1977; Panzar and Rosse, 1987; see also Turk

Ariss, 2010). Under monopoly, the H-statistic should be smaller than or equal to zero. In contrast, in the models of monopolistic competition and perfect competition, the H-statistic should be between 0 and 1. Finally, under perfect competition, the H-statistic is equal to 1. Overall, a larger H-statistic indicates a higher degree of competition. Nathan and Neave (1989) point out that this interpretation assumes the the test is undertaken on observations that are in the long run equilibrium. We therefore also test whether the observations which we apply in our study are in long-run equilibrium.

3.1. Competitive environment test

To approximate the H-statistic empirically, we follow Bikker and Haaf (2002), Claessens and Laeven (2004) and Schaeck et al. (2009):

Eq. (1)

$$\ln II\_TA_{it} = \mu + \beta_1 \cdot \ln AFR_{it} + \beta_2 \cdot \ln PPE_{it} + \beta_3 \cdot \ln PCE_{it} + \beta_k \cdot controls_{it} + \varepsilon_{it}$$

where:

- the superscript i denotes bank i, and the uperscript t denotes quarter t;
- ln_II_TA – interest revenue to total assets (this our proxy for output price);
- ln_AFR – average funding rate, i.e. the ratio of interest expenses to total assets;
- ln_PPE – price of personal expediture is the ratio of personnel expenses to total assets (proxy for the price of labor);
- ln_PCE – price of capital expediture, i.e. the ratio of other operating and administrative expenses to fixed assets (proxy for price of fixed capital);
- controls – control variables, including: loans to assets ratio (ln_LNS_TA); stable funding to average liabilities ratio (ln_DPS_F); bank own funds to illiquid assets ratio (ln_EQ_TA), non-interest income (ln_OI_II).
- ε_{it} – random error

Here, H = β1 + β2 + β3.

We begin with a standard model that takes into consideration the panel nature of data, i.e. random-effects generalised least squares regression (GLS). As an alternative we consider a fixed effects regression. In both models the same set of explanatory variables was used, selected in accordance with the theory and the results of empirical studies examined. The choice between fixed effects and random effects models may be justified by theory – in general fixed-effects model should be used if the differences between individuals may be captured through different constant value in the model, and it is not always possible to assume that individual random effect is uncorrelated with the explanatory variables, which is assumed in the random effects model (Baltagi, 2005); may be reflected in other empirical studies (autors adapting the Panzar-Rosse approach P-R use fixed effects models); may be verified by statistical test (e.g. Breusch-Pagan and Hausman tests).

Bikker et al. (2007) and Bikker et al. (2012) demonstrate that taking interest income as share of total assets, or the inclusion of scale variables as explanatory variables, may lead to overestimate competition and distorted tests results. Instead, they suggest using unscaled variables, i.e. using interest income, as the dependent variable. However, for the analysis of the effect of competition on bank risk we use the scaled version of the H-statistics, as we would like to be able to compare our results with those of Pawłowska (2010, 2012).

3.2. Equilibrium test

Since the PR model is only valid if the market is in the long run equilibrium, we test for this assumption by estimating the following equation for the banking sector in Poland:

Eq. (2)

$$\ln ROA\_TA_{it} = \mu + \beta_1 \cdot \ln AFR_{it} + \beta_2 \cdot \ln PPE_{it} + \beta_3 \cdot \ln PCE_{it} + \beta_k \cdot controls_{it} + \varepsilon_{it}$$

Where ROA is the return on assets. We define equilibrium E-statistics as β1 + β2 + β3. We test whether E=0, using F-test. If rejected, the market is assumed not to be in equilibrium. The idea beind this test is that, in equilibrium, risk-adjusted rates of return should be equal across banks and returns on bank assets should not be related to input prices. This approach for testing whether the observations are in long-run equilibrium has previously been used in the literature (see e.g. Shaffer, 1982; Molyneux et al., 1996; Claessens and Laeven, 2004; Schaeck et al., 2009).

3.3. Dynamic panel model

An alternative method to estimate the H-statistic by Panzar and Rosse is a dynamic model, taking into account the lagged endogenous variables. Dynamic panel estimation eliminates the need for a market equilibrium assumption. This model requires an appropriate estimation procedure, due to the failure to meet the assumptions of the lack of correlation between the explanatory variable and a random component. We use the estimation procedure proposed by Arellano and Bond (1991) and its modification proposed by Blundell and Bond (1998). This approach involves the use of appropriate instruments for the explanatory variables correlated with a random component and is optimal for short time dimension panels.

Eq. (3)

$$\ln II\_TA_{it} = \mu + \alpha \cdot \ln II\_TA_{it-1} + \beta_1 \cdot \ln AFR_{it} + \beta_2 \cdot \ln PPE_{it} + \beta_3 \cdot \ln PCE_{it} + \beta_k \cdot controls_{it} + \varepsilon_{it}$$

3.4. Data

We use bank level data from financial statements available in Monitor Polski B, on web pages of commercial banks and supplement this information with data which can be accessed from the Polish Financial Supervisory Authority. We have quartely panel data for the years 2008-2012, and we include 53 commercial banks, for which, our dataset was compiled. In Table 3 and 4 is given summary information on data used in this research, i.e. descriptive statistics and correlation matrix. Additionally, in Figure A included in the Appendix we depict distribution charts of dependent variable and main independent variables.

Table 3. Descriptive statisitcs

Variable	Obs	Mean	Std. Dev.	Min	Max
ln_II_TA	963	-4.259408	.4659184	-6.524233	-2.90554
ln_AFR	960	-4.911418	.4165856	-6.845102	-3.663811
ln_PPE	961	-5.806221	.7057032	-8.001258	-3.161367
ln_PCE	962	.2623982	1.021538	-1.729499	4.274213
ln_LNS_TA	967	-.3716586	.3279276	-2.155067	-.0027834
ln_DPS_F	957	4.001777	.4272364	1.895374	5.502788
ln_EQ_TA	963	2.099587	1.351569	-.1566538	6.873696
ln_OI_II	815	3.986177	1.253111	-1.542312	9.603113
ln_ROA	768	-.1679723	1.060621	-5.146301	2.600866

Source: Authors' calculations.

Table 4. Correlation matrix

	ln_II_TA	ln_AFR	ln_PPE	ln_PCE	ln_LNS~A	ln_DPS_F	ln_EQ_TA	ln_OI_II	ln_ROA
ln_II_TA	1.0000								
ln_AFR	0.6607	1.0000							
ln_PPE	0.6444	0.1387	1.0000						
ln_PCE	-0.1280	-0.1217	-0.1987	1.0000					
ln_LNS_TA	0.2602	0.0871	0.0596	0.3126	1.0000				
ln_DPS_F	0.4084	0.3422	0.1398	-0.2623	0.3699	1.0000			
ln_EQ_TA	-0.3707	-0.3266	-0.4593	0.6620	0.3248	-0.1864	1.0000		
ln_OI_II	-0.4031	-0.0511	-0.1778	-0.0995	-0.3680	-0.3158	-0.1397	1.0000	
ln_ROA	0.0473	-0.1339	0.0582	0.1322	0.1066	-0.1560	0.1458	0.0767	1.0000

Source: Authors' calculations.

4. ESTIMATION RESULTS

4.1. Full sample estimation

In this section we present full sample estimation of our model specified following Eq. (1)-(3). In the first step we show results of GLS fixed effects estimation. Next, we proceed to analysis of long-run equilibrium. And in the last step we show results of GMM dynamic estimation. Following previous studies estimating the Panzar-Rosse H-statistics (Claessens and Laeven, 2004; Pawłowska, 2012) in our paper we also apply the conventional OLS technique. However, as the competition measures estimated with OLS are biased, we include these results – just for informative purposes, in table in Appendix.

4.1.1. GLS full sample estimation

In order to select an appropriate version of GLS model (i.e. between fixed or random effects) we have tested the validity of the panel model using the Breusch-Pagan test and Hausman test.

The Breusch-Pagan test, based on Lagrange multipliers, rejected the null hypothesis of a constant variance, i.e. it must be held that the random effects are important and that a model of pooled regresion should not be built.

Hausman test assumes that the individual effects are independent of the explanatory variables. If this hypothesis holds, both fixed effect and random effect estimators are unbiased, but the random effect estimator is considered as more efficient. In contrast, the rejection of the null hypothesis in favor of an alternative means that fixed effect estimator is consistent or an error in the model specification occured. Hausman test, comparing coefficients estimated by fixed and random effects models, indicates no statistically significant difference, thus the assumption of fixed effects should be considered correct.

Table 5. Breusch and Pagan Lagrangian multiplier test and Hausman test

```
---------------------------------------------------------------------------
Breusch and Pagan Lagrangian multiplier test for random effects
       ln_II_TA[kod,t] = Xb + u[kod] + e[kod,t]

       Estimated results:
                        |       Var     sd = sqrt(Var)
               ---------+-----------------------------
               ln_II_TA |   .1550853       .3938087
                      e |   .0098195       .0990935
                      u |   .0252608       .1589364
       Test:   Var(u) = 0
                             chibar2(01) =  2292.41
                          Prob > chibar2 =   0.0000
---------------------------------------------------------------------------
---------------------------------------------------------------------------
               ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+-------------------------------------------------------------
      ln_AFR |    .4901799     .4861424        .0040374        .0031853
      ln_PPE |      .14803      .167303       -.0192729        .0051089
      ln_PCE |    .0646951     .0552645        .0094306        .0063224
   ln_LNS_TA |    .3150666     .3168145        -.001748        .0054235
    ln_DPS_F |    .1287467     .1286282        .0001185        .0054544
    ln_EQ_TA |   -.0434595    -.0465854        .0031259        .0033299
    ln_OI_II |   -.0495534    -.0530196        .0034662        .0011208
---------------------------------------------------------------------------
                          b = consistent under Ho and Ha; obtained from xtreg
           B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       29.41
                Prob>chi2 =      0.0001
                (V_b-V_B is not positive definite)
---------------------------------------------------------------------------
```

Source: Authors' calculations.

The selected version of panel model (fixed effects) is presented in Table 6. In appendix we also present the estimation results for our baseline model (i.e. with random effects).

Among the results of estimation we should focus on the following coefficients – R^2: within=0,68 means that 68% of intragroup diversification has been explained by the explanatory variables; between=0,76 means that 76% differentiation of endogenous variable between banks has been explained by the explanatory variables; overall=0,74 means that 74% of overall differentaition of endogenous variable has been explained by the explanatory variables. The explanation of differentiation can be considered satisfactory.

The coefficients in estimated models, are in line with expectations – the sign of ln_LNS_TA turned out to be positive in the revenue equation – which can be interpreted as the fact that banks compensate themselves for credit risk by surcharges on the lending rate, which increases interest income. The influence of ln_DPS_F on interest income is rather unpredictable. The ln_EQ_TA has a negative impact on interest income, i.e. lower equity ratio implies more interest income. However, capital requirements increase as the risk increases, suggesting a positive sign of a coefficient.

In addition, the diagnostic tests for the accuracy of constructed fixed effects model were performed. The test for residuals normality – graphical analysis of the distributions shows a high similarity with the normal distribution and the concentration of the residues around zero even higher than in a normal distribution (see Figure B in Appendix). Nevertheless, the Jarque-Bera test rejects the hypothesis that the disturbances are normally distributed.

Table 6. Estimation of competition intensity using fixed-effects GLS regression.

Fixed-effects (within) regression		Number of obs =	809
Group variable: kod		Number of groups =	53
R-sq: within = 0.6798		Obs per group: min =	2
between = 0.7616		avg =	15.3
overall = 0.7368		max =	20
		F(7,749) =	227.12
corr(u_i, Xb) = 0.0959		Prob > F =	0.0000

ln_II_TA	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_AFR	.4901799	.0164554	29.79	0.000	.4578756	.5224841
ln_PPE	.14803	.0151315	9.78	0.000	.1183248	.1777353
ln_PCE	.0646951	.0141993	4.56	0.000	.0368199	.0925704
ln_LNS_TA	.3150666	.0271728	11.59	0.000	.2617226	.3684105
ln_DPS_F	.1287467	.0196612	6.55	0.000	.0901491	.1673443
ln_EQ_TA	-.0434595	.0099333	-4.38	0.000	-.0629601	-.023959
ln_OI_II	-.0495534	.0052672	-9.41	0.000	-.0598936	-.0392132
_cons	-1.104434	.1340167	-8.24	0.000	-1.367527	-.8413407
sigma_u	.19314069					
sigma_e	.09909347					
rho	.79161877	(fraction of variance due to u_i)				
F test that all u_i=0:	F(52, 749) =	34.59			Prob > F = 0.0000	

Source: Authors' calculations.

We have also tested H-statistic for estimated fixed effect model. The null hypothesis H^{fe} = 0 had to be rejected (F(1, 749) = 670.43 and prob = 0.0000) as well as the hypothesis H^{fe} = 1 (F(1,749) = 119.77 and prob = 0.0000). That means that banking sector in Poland can be described as monopolistic competition – the H-statistic is between 0 and 1.

4.1.2. Testing for long-run equilibrium

As has been metioned in the previous section, the PR model is only valid if the market is in the long run equilibrium. This long run-equilibrium is usually tested with a model in which dependent varable is ROA, and independent variables are the same as in our baseline model (i.e. Eq.(1)). For detailed estimation results of Eq.(2) please refer to Table E included in Appendix. Here we focus only on the conclusions which are derived from this test. First, the hypothesis on the long-run equilibrium in the Polish banking sector ($E = \beta 1 + \beta 2 + \beta 3 = 0$) has to be rejected at the significance level of 5% (F(1, 608) = 10.92, prob = 0.0010). Second, the hypothesis that E = 1 cannot be rejected (F(1, 608) = 0.54, prob = 0.4647), which means that it cannot be stated that H <0 and there is no long-run equilibrium. However, as is argued by Matthews et al. (2007) the restirction that E=0 (i.e. market equilibrium) is necessary for the perfect competition case, but not for the monopolistic competition case, which is typical of the Polish banking sector (see also Stavarek and Repkova, 2011).

Although the results suggest that over the whole estimation period the market was not in equilibrium, we cannot reject this hypothesis for the sub-periods. For particular years the hypothesis that E= 0 cannot be rejected (see Table 7).

Table 7. Equilibrium test for sub-periods.

2008: F(1, 92) = 0.61	prob = 0.4354
2009: F(1, 69) = 0.86	prob = 0.3575
2010: F(1, 86) = 0.23	prob = 0.6350
2011: F(1, 89) = 0.21	prob = 0.6506
2012: F(1, 85) = 4.70	prob = 0.0330.

Source: Authors' calculations.

4.1.3. Dynamic estimation

Due to the fact that our dataset exhibits dynamic features we follow procedure developed by Arellano and Bond (1991) and further elaborated by Blundell and Bond (1998) and estimate Eq.(3) which includes lagged dependent variable. Our results of estimation of the dynamic panel model with lagged dependent variable are shown in Table 8 below.

Table 8. Estimation of competition intensity using two-step GMM (Arellano-Bond / Blundell-Bond)

```
------------------------------------------------------------------------------
System dynamic panel-data estimation           Number of obs        =       762
Group variable: kod                            Number of groups     =        53
Time variable: kw
                                               Obs per group:    min =         2
                                                                 avg =  14.37736
                                                                 max =        19

Number of instruments =     43                 Wald chi2(7)         =   4521.51
                                               Prob > chi2          =    0.0000
Two-step results
------------------------------------------------------------------------------
    ln_II_TA |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    ln_II_TA |
         L1. |   .0807785   .0227319     3.55   0.000     .0362248    .1253323
             |
      ln_AFR |   .5335559   .0209704    25.44   0.000     .4924546    .5746572
      ln_PPE |   .2112995   .0125854    16.79   0.000     .1866325    .2359665
      ln_PCE |  -.0148803    .008457    -1.76   0.078    -.0314557    .0016952
   ln_LNS_TA |   .1395117   .0199613     6.99   0.000     .1003883     .178635
    ln_DPS_F |   .0539524   .0250939     2.15   0.032     .0047693    .1031355
    ln_OI_II |  -.0464487   .0061119    -7.60   0.000    -.0584277   -.0344697
       _cons |  -.0271004   .1832249    -0.15   0.882    -.3862145    .3320137
------------------------------------------------------------------------------
Warning: gmm two-step standard errors are biased; robust standard
         errors are recommended.
Instruments for differenced equation
        GMM-type: L(2/2).ln_II_TA
        Standard: D.ln_AFR D.ln_PPE D.ln_PCE D.ln_LNS_TA D.ln_DPS_F
                  D.ln_OI_II
Instruments for level equation
        GMM-type: LD.ln_II_TA
        Standard: _cons
------------------------------------------------------------------------------
```

Source: Authors' calculations.

As the quality of estimators in dynamic GMM model depends on several tests, we conduct such testing (see Table 9). The first is Arellano-Bond test regarding autocorrelation of residuals. We find that there is no reason to reject the null hypothesis of absence of autocorrelation. The other is the Sargan test of over-identyfying restrictions, which checks whether orthogonality conditions have been sufficiently met. Sargan test suggests proper application of the instruments.

Table 9. Arellano-Bond test and Sargan test

```
--------------------------------------------------------------------------
Arellano-Bond test for zero autocorrelation in first-differenced errors
  +-----------------------+
  |Order |  z     Prob > z|
  |------+----------------|
  |   1  |-2.4454  0.0145 |
  |   2  |-.65176  0.5146 |
  |   3  |-.87162  0.3834 |
  |   4  | .62739  0.5304 |
  +-----------------------+
   H0: no autocorrelation
--------------------------------------------------------------------------
--------------------------------------------------------------------------
Sargan test of overidentifying restrictions
        H0: overidentifying restrictions are valid

        chi2(35)     =  43.10649
        Prob > chi2  =    0.1633
--------------------------------------------------------------------------
```

Source: Authors' calculations.

Due to the fact that the model was estimated using a two-step procedure, errors of estimators can be biased, so the one-step procedure has been used to ensure the accuracy of standard errors. This action resulted in elimination of potential bias of the results. The analysis of the coefficients determined followig a two-step and one-step methods, leads to the conclusion that all used variables are statistically significant. Detailed estimation results for one-step estimation can be found in Table C in the Appendix.

Following previous research mentioned in this paper we test the H-statistics for our dynamic panel model. The null hypothesis $H^{2step} = 0$ had to be rejected ($Chi^2(1) = 910.80$ and prob = 0.0000) as well as the hypothesis $H^{2step} = 1$ ($Chi^2(1) = 154.83$ and prob = 0.0000). This confirms earlier results that banking sector in Poland can be described as monopolistic competition – the values of H-statistics are between 0 and 1.

4.2. Developments of the Panzar-Rosse H-statistics over time.

In this section we present the results from the Panzar-Rosse H-statistics estimation by year to consider the time evolution of competition. Table 9 shows, by year, the H-statistics for Polish commercial banks, obtained from three different estimation methods (FE GLS, two-step GMM and one-step GMM). Since each estimation technique has some specific advantages and disadvantages, we take the average of the three estimates as our measure of competition intensity in Poland. Such procedure has also been applied by Claessens and Laeven (2004:571). Upon analysis of these results, one can conclude that competition evolves differently across years in Poland. In some years, competition was relatively high, as the H-statistics reached the level of 0.75, which is relatively close to perfect competition (in 2008). Then it gradually decreased reaching its bottom line in 2010, and has been slightly increasing in since then. Generally, the values of our competitive environment measure indicate at monopolistic competition in Poland. Therefore, our results are close to those presented in other studies (see e.g. Pawłowska, 2005, 2010, 2012 and Bikker and Spierdijk, 2010).

Table 9. Developments of the Panzar-Rosse H-statistics over time – average competitive indicator

Type of H-statisitcs	2008	2009	2010	2011	2012
$Hfe = \beta_1 + \beta_2 + \beta_3$	0.560344	0.631425	0.452462	0.686967	0.721939
$H2step = \beta_1 + \beta_2 + \beta_3$	0.764525	0.761476	0.612405	0.721676	0.672786
$H1step = \beta_1 + \beta_2 + \beta_3$	0.925244	0.663498	0.675446	0.66438	0.687938
H-average	**0.750038**	**0.685466**	**0.580104**	**0.691008**	**0.694221**

Note: this table presents Panzar-Rosse H-statistics that depends on time and is calculated with application of FE GLS (Hfe), 2-step GMM (H2step) and 1-step GMM (H1step) estimators. Under monopoly, the H-statistic should be smaller than or equal to zero; in the models of monopolistic competition and perfect competition, the H-statistic should lie between 0 and 1; under perfect competition, the H-statistic is equal to 1. Overall, a larger H-statistic indicates a higher degree of competition. Hfe denotes the Panzar-Rosse H-statistics calculated for consecutive years 2008-2012. The β1, β2, and β3 are elasticity coefficients of input prices, i.e. price of deposits, labor and capital, respectively. The values of betas are presented in tables H, I, J in the Appendix.

5. CONSLUSIONS

This paper presents estimates of competition in bank loan market in Poland using a well grounded approach, indroduced by Panzar and Rosse (1987) and developed in many studies.

Unlike previous papers which attempt to measure the competition intensity in Poland applying annual unbalanced financial data on banking sector available in the Bankscope database, we use data which where handcollected from Monitor Polski B and webpages of commercial banks. Where it is necessary we supplement this data which information accessed from Polish Financial Supervisory Authority.

Upon analysis of results, one can conclude that competition evolves differently across years in Poland. In some years, competition was relatively high, as the H-statistics reached the level of 0.75, which is relatively close to perfect competition. In other years it gradually decreased reaching its bottom line in 2010, and took upward trend in 2011 and 2012. Generally, the values of our competitive environment measure indicate at monopolistic competition in Poland.

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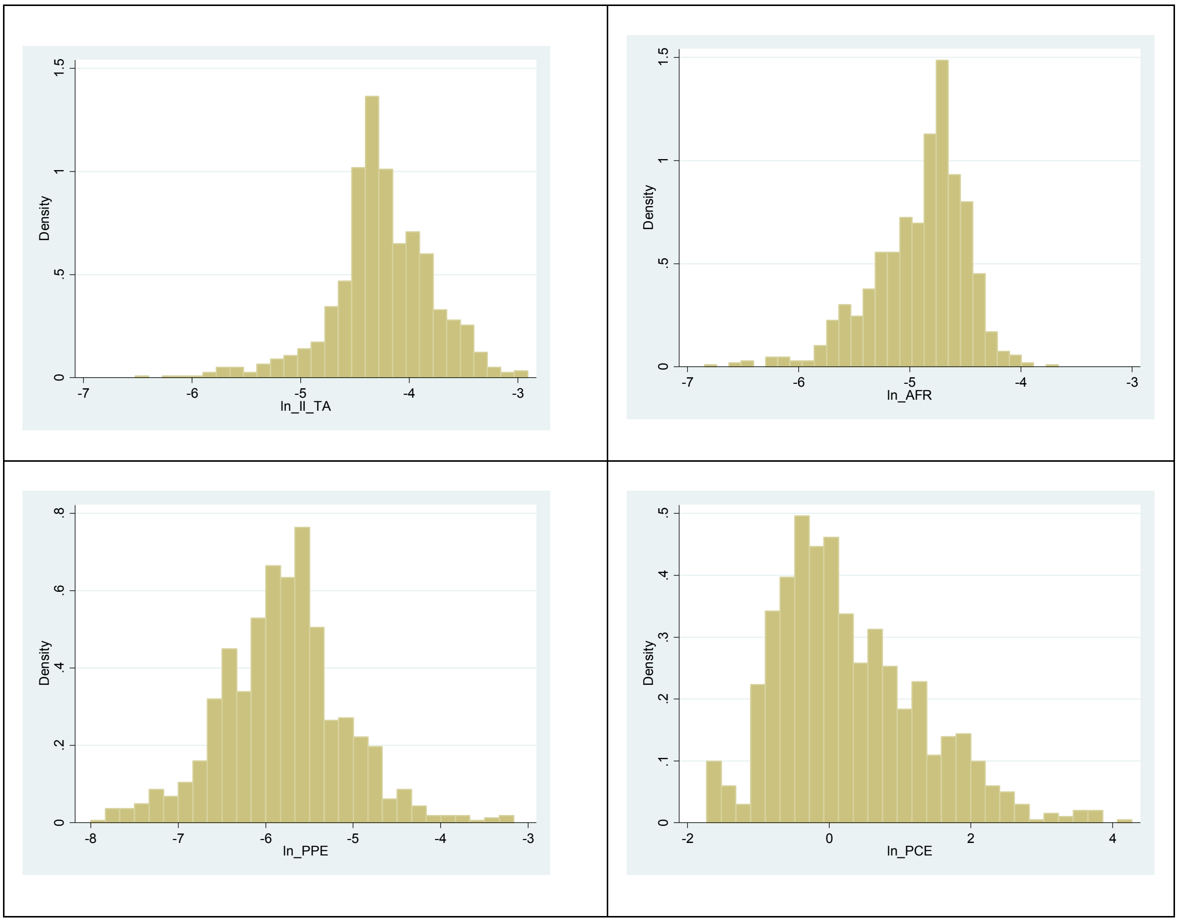
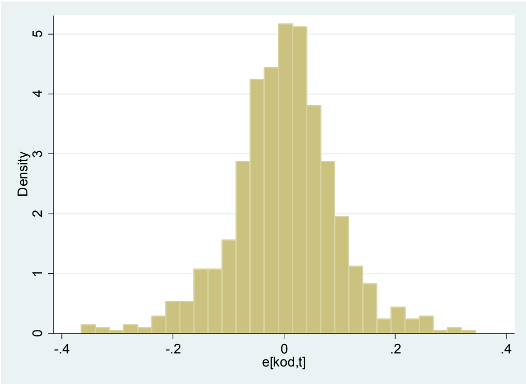
7. APPENDICES

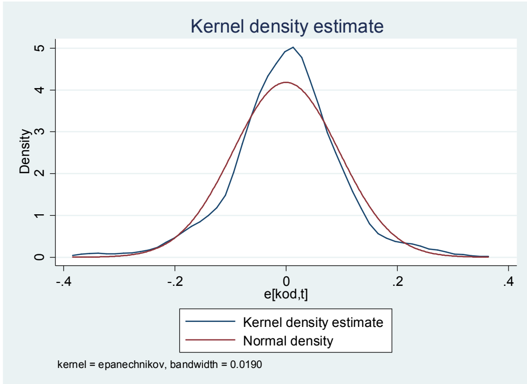
Figure A. Distribution chart of dependent and independent variables

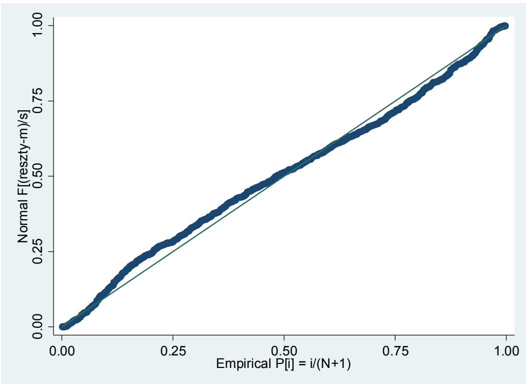


Source: Authors' analysis.

Figure B. Normality test of residuals of model.







Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)
residuals	809	0.0262	0.0000

------- joint ------

	adj chi2(2)	Prob>chi2
residuals	28.29	0.0000

Table A. Estimation of competition intensity using Random-Effects GLS regression.

Random-effects GLS regression		Number of obs =	809
Group variable: kod		Number of groups =	53
R-sq: within = 0.6785		Obs per group: min =	2
between = 0.7840		avg =	15.3
overall = 0.7551		max =	20
		Wald chi2(7) =	1778.30
corr(u_i, X) = 0 (assumed)		Prob > chi2 =	0.0000

ln_II_TA	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ln_AFR	.4861424	.0161442	30.11	0.000	.4545004	.5177845
ln_PPE	.167303	.014243	11.75	0.000	.1393872	.1952187
ln_PCE	.0552645	.0127141	4.35	0.000	.0303453	.0801838
ln_LNS_TA	.3168145	.0266261	11.90	0.000	.2646284	.3690006
ln_DPS_F	.1286282	.0188895	6.81	0.000	.0916055	.1656509
ln_EQ_TA	-.0465854	.0093586	-4.98	0.000	-.0649279	-.0282429
ln_OI_II	-.0530196	.0051466	-10.30	0.000	-.0631067	-.0429325
_cons	-.9923687	.1305376	-7.60	0.000	-1.248218	-.7365197
sigma_u	.15893638					
sigma_e	.09909347					
rho	.72008453	(fraction of variance due to u_i)				

Table B. Estimation results for long run equilibirum test.

```
------------------------------------------------------------------------------
Fixed-effects (within) regression               Number of obs      =       667
Group variable: kod                             Number of groups   =        52

R-sq:  within  = 0.0864                         Obs per group: min =         2
       between = 0.0006                                        avg =      12.8
       overall = 0.0123                                        max =        20

                                                F(7,608)           =      8.21
corr(u_i, Xb)  = -0.5255                        Prob > F           =    0.0000

------------------------------------------------------------------------------
      ln_ROA |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      ln_AFR |   .1938643   .1432847     1.35   0.177    -.0875287    .4752572
      ln_PPE |   .8708188     .15066     5.78   0.000     .5749416    1.166696
      ln_PCE |    -.24594   .1345582    -1.83   0.068    -.5101952    .0183152
   ln_LNS_TA |   .6641539   .3003268     2.21   0.027     .0743502    1.253958
    ln_DPS_F |   .2897228   .1794667     1.61   0.107    -.0627272    .6421727
    ln_EQ_TA |   .2770827   .0969971     2.86   0.004     .0865926    .4675728
    ln_OI_II |   .2003522   .0463723     4.32   0.000     .1092829    .2914216
       _cons |   3.575226   1.260256     2.84   0.005     1.100243    6.050209
-------------+----------------------------------------------------------------
     sigma_u |  .94406884
     sigma_e |  .77636536
         rho |  .59655992   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(51, 608) =     8.35             Prob > F = 0.0000
------------------------------------------------------------------------------
```

Table C. Estimation of competition intensity using one-step GMM (Arellano-Bond)

```
------------------------------------------------------------------------------
System dynamic panel-data estimation         Number of obs         =       762
Group variable: kod                          Number of groups      =        53
Time variable: kw
                                             Obs per group:    min =         2
                                                               avg =  14.37736
                                                               max =        19

Number of instruments =     43               Wald chi2(7)          =   3491.58
                                             Prob > chi2           =    0.0000
One-step results
------------------------------------------------------------------------------
    ln_II_TA |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    ln_II_TA |
         L1. |   .0976505   .0239892     4.07   0.000     .0506325    .1446685
             |
      ln_AFR |   .5286487   .0165493    31.94   0.000     .4962126    .5610848
      ln_PPE |   .2014377   .0134961    14.93   0.000     .1749857    .2278896
      ln_PCE |  -.0220209   .0113382    -1.94   0.052    -.0442433    .0002015
   ln_LNS_TA |   .1569258   .0293449     5.35   0.000     .0994109    .2144406
    ln_DPS_F |   .0787877   .0213136     3.70   0.000     .0370139    .1205615
    ln_OI_II |  -.0481278   .0046601   -10.33   0.000    -.0572615   -.0389941
       _cons |  -.1267662   .1318421    -0.96   0.336     -.385172    .1316395
------------------------------------------------------------------------------
Instruments for differenced equation
        GMM-type: L(2/2).ln_II_TA
        Standard: D.ln_AFR D.ln_PPE D.ln_PCE D.ln_LNS_TA D.ln_DPS_F
                  D.ln_OI_II
Instruments for level equation
        GMM-type: LD.ln_II_TA
        Standard: _cons
------------------------------------------------------------------------------
```

Table D. Estimation of competition intensity using OLS regression – full sample results and developments of H-statistics over years 2008-2012.

ln_II_TA	2008-2012	2008	2009	2010	2011	2012
ln_AFR	.4977472 (28.28)***	.4163619 (6.86)***	.5097404 (10.88)***	.5243275 (12.04)***	.5234264 (11.92)***	.5354117 (12.08)***
ln_PPE	.2759675 (24.01)***	.241172 (10.04)***	.1879862 (7.29)***	.3236799 (11.87)***	.3339405 (13.46)***	.3693754 (13.73)***
ln_PCE	.0049034 (0.53)	.0125971 (0.67)	-.0144745 (-0.69)	.0226756 (0.97)	-.0090615 (-0.42)	-.0699899 (-3.18)***
ln_LNS_TA	.2335461 (7.94)***	.2041374 (2.91)***	.4390757 (6.54)***	.1296609 (1.79)*	.1950818 (2.97)***	.2361077 (3.36)***
ln_DPS_F	.0468171 (2.45)**	.0767887 (2.35)***	-.0170417 (-0.35)	.1180823 (2.13)**	-.0040451 (-0.07)	-.1662703 (-2.66)***
ln_EQ_TA	-.0184791 (-2.34)**	-.0186218 (-1.28)	-.0486098 (-2.68)***	.0011085 (0.05)	-.0096219 (-0.53)	.0189863 (0.99)
ln_OI_TA	-.0753027 (-13.25)***	-.0618512 (-5.53)***	-.0999108 (-7.87)***	-.0642954 (-5.23)***	-.0863154 (-6.20)***	-.089875 (-6.47)***
cons	.0364708 (0.25)	-.7211764 (-1.89)*	.0358204 (0.09)	.0506134 (0.12)	.7442485 (1.76)*	1.631984 (3.69)***
R^2	0.8004	0.7346	0.8110	0.8343	0.8385	0.8195
Wald Test [F test]	458.77 [p=0.000]	63.66 [p=0.000]	96.22 [p=0.000]	109.30 [p=0.000]	112.74 [p=0.000]	95.33 [p=0.000]
$Hfe = \beta_1 + \beta_2 + \beta_3$	**0.778618**	**0.670131**	**0.683252**	**0.870683**	**0.848305**	**0.834797**
H0: Hfe = 0 *Test F*	1391.88 [p=0.000]	113.48 [p=0.000]	163.44 [p=0.000]	297.39 [p=0.000]	341.07 [p=0.000]	343.41 [p=0.000]
H1: Hfe = 1 *Test F*	112.52 [p=0.000]	27.50 [p=0.000]	35.12 [p=0.000]	6.56 [p=0.0114]	10.91 [p=0.0012]	13.45 [p=0.0003]

Note: this table presents Panzar-Rosse H-statistics that depends on time and is calculated with application of OLS estimator. Under monopoly, the H-statistic should be smaller than or equal to zero; in the models of monopolistic competition and perfect competition, the H-statistic should lie between 0 and 1; under perfect competition, the H-statistic is equal to 1. Overall, a larger H-statistic indicates a higher degree of competition. Hfe denotes the Panzar-Rosse H-statistics calculated for consecutive years 2008-2012. The β1, β2, and β3 are elasticity coefficients of input prices, i.e. price of deposits, labor and capital, respectively. This table reports coefficients and t–statistics (in parentheses), with *,**,*** representing significance at the 10%,5% and 1%, respectively.

Table E. Test for long-run equilibrium.

```
------------------------------------------------------------------------------
      Source |       SS       df       MS              Number of obs =     667
-------------+------------------------------           F(  7,   659) =    9.30
       Model |  61.5233837     7  8.78905482           Prob > F      =  0.0000
    Residual |  623.125784   659  .945562646           R-squared     =  0.0899
-------------+------------------------------           Adj R-squared =  0.0802
       Total |  684.649167   666  1.02800175           Root MSE      =   .9724

------------------------------------------------------------------------------
      ln_ROA |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      ln_AFR |  -.1600596   .1040341    -1.54   0.124    -.3643378    .0442186
      ln_PPE |   .2859496   .0760662     3.76   0.000     .1365883    .4353109
      ln_PCE |  -.0232463   .0564896    -0.41   0.681    -.1341675    .0876749
   ln_LNS_TA |   .6575154   .1890942     3.48   0.001     .2862157    1.028815
    ln_DPS_F |  -.3615469   .1126508    -3.21   0.001    -.5827446   -.1403492
    ln_EQ_TA |   .1176192   .0477069     2.47   0.014     .0239433    .2112951
    ln_OI_II |    .110613   .0345371     3.20   0.001     .0427969     .178429
       _cons |    1.66139   .8889757     1.87   0.062    -.0841766    3.406956
------------------------------------------------------------------------------
```

Table F. Robustness test – GLS FE estimation of model in which control variable is bank size (ln_TA).

ln_II	2008-2012	2008	2009	2010	2011	2012
ln_AFR	.4900888 (29.77)***	.5591607 (14.68)***	.5936586 (12.25)***	.2733253 (5.38)***	.592725 (14.38)***	.6180466 (11.50)***
ln_PPE	.1417392 (7.84)***	-.0149183 (-0.49)	-.0907387 (-1.35)	.0362019 (1.12)	.0294857 (0.92)	.1171257 (3.17)***
ln_PCE	.0674123 (4.55)***	.0311811 (1.34)	.0777534 (1.46)	.044142 (1.62)	.0504847 (1.84)*	-.0176835 (-0.57)
ln_LNS_TA	.3135659 (11.49)***	.0722257 (1.45)	.3807187 (4.59)***	.2923217 (4.56)***	.2916342 (4.05)***	.2227959 (2.90)***
ln_DPS_F	.131287 (6.54)***	.035194 (0.94)	.0349559 (0.45)	.5801783 (5.06)***	.1118387 (0.99)	-.0582737 (-0.47)
ln_EQ_TA	-.0434754 (-4.37)***	.0973151 (2.27)**	.1875775 (2.44)**	.100341 (1.72)*	.0409185 (1.02)	-.0060491 (-0.19)
ln_OI_TA	-.0494425 (-9.38)***	-.0199044 (-2.96)***	-.062547 (-5.36)***	-.0120398 (-1.47)	-.0317703 (-3.15)***	-.0437449 (-5.44)***
ln_TA	.9883704 (54.16)***	.6693715 (17.87)***	.7408202 (7.27)***	.7419477 (9.99)***	.8482461 (22.30)***	1.014704 (22.30)***
cons	-.8865232 (-2.41)**	5.71875 (6.87)***	3.906071 (1.82)*	.77071 (0.52)	2.060177 (2.39)**	-.3560421 (-0.29)
R^2						
within	0.8862	0.9165	0.7364	0.7015	0.9390	0.9054
between	0.9833	0.9217	0.8150	0.9284	0.9684	0.9823
overall	0.9819	0.9188	0.8203	0.9186	0.9656	0.9817
Wald Test [F test]	727.84 [p=0.000]	156.47 [p=0.000]	38.07 [p=0.000]	31.44 [p=0.000]	205.76 [p=0.000]	124.49 [p=0.000]
F test [of significane of individual effects]	33.39 [p=0.000]	57.59 [p=0.000]	15.69 [p=0.000]	66.86 [p=0.000]	43.54 [p=0.000]	54.14 [p=0.000]
$Hfe = \beta_1 + \beta_2 + \beta_3$	**0.69924**	**0.575424**	**0.580673**	**0.353669**	**0.672695**	**0.717489**
H0: Hfe = 0 Test F	634.47 [p=0.000]	170.85 [p=0.000]	63.84 [p=0.000]	29.48 [p=0.000]	169.91 [p=0.000]	187.04 [p=0.000]
H1: Hfe = 1 Test F	117.38 [p=0.000]	93.01 [p=0.000]	33.29 [p=0.000]	98.44 [p=0.000]	40.22 [p=0.000]	29.00 [p=0.000]

Note: this table presents Panzar-Rosse H-statistics that depends on time and is calculated with application of FE GLS estimator. Under monopoly, the H-statistic should be smaller than or equal to zero; in the models of monopolistic competition and perfect competition, the H-statistic should lie between 0 and 1; under perfect competition, the H-statistic is equal to 1. Overall, a larger H-statistic indicates a higher degree of competition. Hfe denotes the Panzar-Rosse H-statistics calculated for consecutive years 2008-2012. The β1, β2, and β3 are elasticity coefficients of input prices, i.e. price of deposits, labor and capital, respectively. This table reports coefficients and t–statistics (in parentheses), with *,**,*** representing significance at the 10%,5% and 1%, respectively.

Table H. Developments of the Panzar-Rosse H-statistics over time (estimation – FE GLS)

ln_II_TA	2008-2012	2008	2009	2010	2011	2012
ln_AFR	.4901799 (29.79)***	.4780416 (10.01)***	.5947568 (11.98)***	.3500564 (7.29)***	.5476668 (12.95)***	.6224614 (12.03)***
ln_PPE	.14803 (9.78)***	.1462696 (4.66)***	.0050466 (0.09)	.086183 (2.83)***	.0750668 (2.34)**	.1147065 (3.19)***
ln_PCE	.0646951 (4.56)***	-.063967 (-2.39)**	.0316218 (0.61)	.0162228 (0.59)	.0642331 (2.21)**	-.0152293 (-0.51)
ln_LNS_TA	.3150666 (11.59)***	-.0138012 (-0.22)	.3835976 (4.51)***	.3188393 (4.77)***	.3682678 (4.97)***	.2130149 (3.03)***
ln_DPS_F	.1287467 (6.55)***	-.0031216 (-0.06)	.0231212 (0.29)	.4839481 (4.15)***	-.0871584 (-0.81)	-.059755 (-0.49)
ln_EQ_TA	-.0434595 (-4.38)***	.0672184 (1.22)	.1786788 (2.27)**	.0799654 (1.31)	.0405267 (0.95)	-.0046189 (-0.15)
ln_OI_TA	-.0495534 (-9.41)***	-.0143315 (-1.66)*	-.064328 (-5.39)***	-.0125977 (-1.46)	-.0366521 (-3.43)***	-.0439967 (-5.52)***
cons	-1.104434 (-8.24)***	-1.080756 (-2.65)***	-1.37703 (-2.54)**	-4.011884 (-6.80)***	-.5377009 (-0.89)	-.009478 (-0,02)
R^2 within between overall	 0.6798 0.7616 0.7368	 0.5316 0.5230 0.0494	 0.6413 0.1438 0.1469	 0.5191 0.4763 0.4763	 0.7632 0.4784 0.4798	 0.7833 0.6967 0.6601
Wald Test [F test]	227.12 [p=0.000]	18.64 [p=0.000]	28.10 [p=0.000]	16.65 [p=0.000]	49.72 [p=0.000]	54.21 [p=0.000]
F test [of significane of individual effects]	34.59 [p=0.000]	33.92 [p=0.000]	15.27 [p=0.000]	62.81 [p=0.000]	38.89 [p=0.000]	54.70 [p=0.000]
$Hfe = \beta_1 + \beta_2 + \beta_3$	**0.702905**	**0.560344**	**0.631425**	**0.452462**	**0.686967**	**0.721939**
H0: Hfe = 0 *Test F*	670.43 [p=0.000]	97.25 [p=0.000]	77.76 [p=0.000]	54.04 [p=0.000]	156.44 [p=0.000]	205.13 [p=0.000]
H1: Hfe = 1 *Test F*	119.77 [p=0.000]	59.87 [p=0.000]	26.50 [p=0.000]	79.14 [p=0.000]	32.48 [p=0.000]	30.43 [p=0.000]

Note: this table presents Panzar-Rosse H-statistics that depends on time and is calculated with application of FE GLS estimator. Under monopoly, the H-statistic should be smaller than or equal to zero; in the models of monopolistic competition and perfect competition, the H-statistic should lie between 0 and 1; under perfect competition, the H-statistic is equal to 1. Overall, a larger H-statistic indicates a higher degree of competition. Hfe denotes the Panzar-Rosse H-statistics calculated for consecutive years 2008-2012. The β1, β2, and β3 are elasticity coefficients of input prices, i.e. price of deposits, labor and capital, respectively. This table reports coefficients and t–statistics (in parentheses), with *,**,*** representing significance at the 10%,5% and 1%, respectively.

Table I. Developments of the Panzar-Rosse H-statistics over time (estimation techinique – two-step GMM).

ln_II_TA	**2008-2012**	**2008**	**2009**	**2010**	**2011**	**2012**
ln_II_TA L1.	.0807785 (3.55)***	-.0343268 (-0.24)	-.0375452 (-0.52)	.3223629 (4.53)***	.060405 (0.66)	-.0031935 (-0.04)
ln_AFR	.5335559 (25.44)***	.6158809 (7.87)***	.6120927 (11.70)***	.4776826 (11.72)***	.5673053 (15.87)***	.5397294 (11.22)***
ln_PPE	.2112995 (16.79)***	.163983 (3.49)***	.1695185 (3.41)***	.134289 (3.52)***	.1588087 (4.19)***	.1562773 (3.81)***
ln_PCE	-.0148803 (-1.76)*	-.0153388 (-0.38)	-.0201352 (-0.44)	.0004338 (0.01)	-.0044383 (-0.14)	-.0232209 (-1.09)
ln_LNS_TA	.1395117 (6.99)***	.0938077 (0.86)	.1759759 (1.85)*	.2002451 (4.22)***	.3109243 (4.62)***	.1623571 (2.80)***
ln_DPS_F	.0539524 (-2.15)**	-.4219215 (-2.13)**	-.0080383 (-0.13)	-.0000678 (-0.00)	-.0604014 (-1.20)	-.1534082 (-2.28)**
ln_OI_TA	-.0464487 (-7.60)***	-.0204351 (-2.12)**	-.0611408 (-4.45)***	-.002876 (-0.21)	-.0024377 (-0.28)	-.0523264 (-4.07)***
cons	-.0271004 (-0.15)	1.323888 (0.93)	-.1259294 (-0.13)	.3709071 (0.85)	.1131545 (0.20)	.2317579 (0.54)
Wald Test [χ^2]	4521.51 [p=0.000]	135.85 [p=0.000]	328.98 [p=0.000]	594.26 [p=0.000]	1309.88 [p=0.000]	306.41 [p=0.000]
$H2step = \beta_1 + \beta_2 + \beta_3$	**0.729975**	**0.764525**	**0.761476**	**0.612405**	**0.721676**	**0.672786**
H0: H2step = 0 χ^2 *Test*	1086.45 [p=0.000]	49.51 [p=0.000]	102.33 [p=0.000]	103.51 [p=0.000]	151.30 [p=0.000]	112.19 [p=0.000]
H1: H2step = 1 χ^2 *Test*	148.66 [p=0.0302]	4.70 [p=0.0302]	10.04 [p=0.0015]	41.46 [p=0.000]	22.50 [p=0.000]	26.54 [p=0.000]

Note: this table presents Panzar-Rosse H-statistics that depends on time and is calculated with application of two-step Blundell and Bond GMM estimator. Under monopoly, the H-statistic should be smaller than or equal to zero; in the models of monopolistic competition and perfect competition, the H-statistic should lie between 0 and 1; under perfect competition, the H-statistic is equal to 1. Overall, a larger H-statistic indicates a higher degree of competition. H2step denotes the Panzar-Rosse H-statistics calculated for consecutive years 2008-2012. The β1, β2, and β3 are elasticity coefficients of input prices, i.e. price of deposits, labor and capital, respectively. This table reports coefficients and t–statistics (in parentheses), with *,**,*** representing significance at the 10%,5% and 1%, respectively.

Table J. Developments of the Panzar-Rosse H-statistics over time (estimation technique – one-step GMM).

ln_II_TA	**2008-2012**	**2008**	**2009**	**2010**	**2011**	**2012**
ln_II_TA L1.	.0976505 (4.07)***	.1560147 (1.06)	.0043815 (0.07)	.3202465 (5.68)***	.0481214 (0.63)	.0424213 (1.13)
ln_AFR	.5286487 (31.94)***	.6896346 (9.40)***	.5808347 (13.71)***	.5288154 (10.23)***	.5539801 (16.56)***	.5462418 (15.30)***
ln_PPE	.2014377 (14.93)***	.2470417 (5.18)***	.1778101 (4.51)***	.134556 (3.90)***	.1189704 (5.72)***	.1670227 (6.61)***
ln_PCE	-.0220209 (-1.94)*	-.0114327 (-0.27)	-.0951468 (-3.07)***	.0120749 (0.29)	-.0085705 (-0.46)	-.0253267 (-1.15)
ln_LNS_TA	.1569258 (5.35)***	.0707299 (0.73)	.1970415 (2.38)**	.1519357 (1.75)*	.4182208 (8.26)***	.1290177 (1.93)*
ln_DPS_F	.0787877 (3.70)***	-.2165083 (-1.42)	.0252634 (0.39)	.0460347 (0.95)	-.0503054 (-1.20)	-.2029104 (-3.41)***
ln_OI_TA	-.0481278 (-10.33)***	-.0097634 (-0.83)	-.0648695 (-6.08)***	-.0179511 (-1.68)*	.0124223 (1.19)	-.0516855 (-6.71)***
cons	-.1267662 (-0.96)	2.080637 (1.58)	-.1398267 (-0.40)	.4790145 (1.47)	-.2759626 (-0.75)	.6856679 (2.30)**
Wald Test [χ^2]	3491.58 [p=0.000]	203.73 [p=0.000]	688.42 [p=0.000]	845.68 [p=0.000]	625.60 [p=0.000]	561.37 [p=0.000]
$H1step = \beta_1 + \beta_2 + \beta_3$	**0.708066**	**0.925244**	**0.663498**	**0.675446**	**0.66438**	**0.687938**
H0: H1step = 0 χ^2 *Test*	910.80 [p=0.000]	139.94 [p=0.000]	88.64 [p=0.000]	81.46 [p=0.000]	374.97 [p=0.000]	285.89 [p=0.000]
H1: H1step = 1 χ^2 *Test*	154.83 [p=0.000]	0.91 [p=0.3392]	22.80 [p=0.000]	18.81 [p=0.000]	95.69 [p=0.000]	58.83 [p=0.000]

Note: this table presents Panzar-Rosse H-statistics that depends on time and is calculated with application of one-step Arellano and Bond GMM estimator. Under monopoly, the H-statistic should be smaller than or equal to zero; in the models of monopolistic competition and perfect competition, the H-statistic should lie between 0 and 1; under perfect competition, the H-statistic is equal to 1. Overall, a larger H-statistic indicates a higher degree of competition. H2step denotes the Panzar-Rosse H-statistics calculated for consecutive years 2008-2012. The β1, β2, and β3 are elasticity coefficients of input prices, i.e. price of deposits, labor and capital, respectively. This table reports coefficients and t–statistics (in parentheses), with *,**,*** representing significance at the 10%,5% and 1%, respectively.