Filip Świtała, Małgorzata Olszak,
Iwona Kowalska

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

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Filip Świtała*, Małgorzata Olszak*, Iwona Kowalska*

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

Keywords: competition intensity, marginal costs, contestability, banking industry.

JEL: G21, G28, L1, L16

Konkurencja w sektorze bankowym w Polsce – analiza statystyki H Panzara-Rosse'a

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Celem artykułu jest określenie stopnia nasilenia konkurencji na rynku kredytowym banków komercyjnych w Polsce. Na podstawie wartości statystyki H Panzara-Rosse'a oszacowanej przy zastosowaniu kilku technik estymacji (GLS, one-step GMM and two-step GMM) identyfikujemy, że uzyskane wnioski co do stopnia nasilenia konkurencji są wrażliwe na metodę estymacji. Na podstawie analizy w poszczególnych latach w okresie 2008–2012 zauważyć można zróżnicowanie nasilenia konkurencji. W niektórych latach konkurencja jest relatywnie wysoka, gdyż wartość statystyki H wynosi 0,75 – co wskazuje na konkurencję bliską doskonałej. W innych latach poziom statystyki H jest niższy, co prowadzi do wniosku, że konkurencja ta ma cechy modelu konkurencji monopolistycznej.

Słowa kluczowe: nasilenie konkurencji, koszty krańcowe, konkurencyjność, sektor bankowy.

* **Iwona Kowalska** – PhD, University of Warsaw, Faculty of Management.
Małgorzata Olszak – PhD, University of Warsaw, Faculty of Management.
Filip Świtała – PhD, University of Warsaw, Faculty of Management.

Corresponding author at: Faculty of Management, University of Warsaw, Szturmowa Str. 1/3, 02-678 Warsaw; e-mail: ikowalska@wz.uw.edu.pl; molszak@wz.uw.edu.pl; fswitala@wz.uw.edu.pl.

1. Introduction

In the banking sector, unlike other sectors of the economy, competition policy must be designed with due consideration of the interaction between competition and bank risk-taking. On the one hand, greater competition may be good for (static) efficiency of banks (Allen and Gale, 2003). On the other hand, however, it may also result in higher risk taken by banks. This excessive risk-taking, by threatening the solvency of particular institutions, may give rise to financial instability of the entire banking system at an aggregate level (Jimenez et al., 2010). As 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's objective is to assess the intensity of competition in the Polish banking sector in its lending market. Previous studies which present the measures of competition include many papers in which the Polish loan market is one of many markets under investigation (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). This research gives one average measure of competition calculated for several years, based on annual financial data available in the Bankscope database. Its serious drawback is also the measurement of competition using market structure indicators (Beck et al., 2004, Agoraki et al.; Mirzaei et al., 2013). Much more detailed insight into the competition intensity is given by the research by Pawłowska (2010, 2012) as it gauges its levels using tools well grounded in the New Empirical Industrial Organization literature, such as the Lerner index or Panzar-Rosse H-statistics. The measures of competition are, however, obtained with the application of annual financial data.

In this paper we aim to measure the competition intensity in the bank loan market in Poland using a well grounded approach introduced by Panzar and Rosse (1987) and developed in many previous studies (for references see Tables 1 and 2). We hypothesize that competition in the Polish bank loan market may be described as monopolistic competition. Following a theoretical paper by Ruckes (2004), who suggests that a business cycle may affect competition, we put forward a hypothesis that competition in the banking market in Poland depends on the macroeconomic environment.

Our study is different from previous ones in several respects. First, in contrast to the previous research, which uses annual data, we apply the methodology used in the estimation of the H-statistics to a unique dataset of individual banks' quarterly financial items spanning the years 2008–2012. Second, as we use quarterly data, we are able to assess the competition intensity for each subsequent year in the period of 2008–2012. An analysis of evolution of the

Panzar-Rosse H-statistics in each of the years should give some insight into the impact of changing macroeconomic environment on competition intensity. Third, as the quantified level of competition may be sensitive to the estimation technique, we use several estimation methods – that is, besides traditional ordinary least squares, also fixed effects generalized least squares as well as dynamic methods, i.e. one-step GMM and two-step GMM. Such a methodological approach produces more precise measures of competition.

Upon the analysis of results, one can conclude that competition evolved differently across years in Poland. In some years, competition was rather high as the H-statistic reached the level of 0.75, which is relatively close to perfect competition. In other years, it gradually decreased reaching its lowest value in 2010, and showed an upward trend in 2011 and 2012. Generally, the values of our competitive environment measure indicate 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 the banking industry across the world as well as in the Polish banking market. Section 3 provides a description of methodology and data applied in the investigation. Section 4 presents the results of an empirical study. Finally, Section 5 is a conclusion.

2. Competition intensity measurement – a literature review

2.1. Measures of competition intensity

The current 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 as 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 the fact 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 Organization (NEIO) literature. Within the NEIO framework, there are two main types of econometric methodologies. One of them is the simultaneous equation method, which is represented by Bresnahan (1982) and Lau (1982). This method estimates the level of competition intensity by simultaneously considering

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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 the 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 measure 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 the 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 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 less efficient banks. This measure has gained considerable support 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; Bikker and Spierdijk, 2010). This diversity in results can be inferred from Table 1, which reviews most 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 used. Notwithstanding these discrepancies, it seems that the prevailing competition model in the banking industry is monopolistic 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 for 1983 and 1984
Shaffer and DiSalvo (1994)	1970–1986	Pennsylvania (USA)	Panzar--Rosse H-statistics	Duopoly; high competition
Molyneux (1994)	1986–1989	France, the 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).
Leuven-steijn et al. (2007)	1992–2004	The Euro Area	Boone indicator	The Boone indicator for Spain, Italy and Germany suggests comparatively competitive banking markets while the 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 UK and Switzerland. In the US there is a huge diversity of results, with Marshall market being the most competitive and Christian Market the least competitive.
Turk-Ariss (2010)	1999–2005	60 developing countries: including Africa, East/South Asia and Pacific, Eastern Europe and Central Asia, Latin America and the 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 index is as low as 17%. The

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Study by	Period	Countries	Type of approach	Results
				esti mated efficiency and funding-adjusted Lerner indices also vary across countries and regions.
Olivero et al. (2011)	1996–2006	10 Asian countries and 10 Latin American countries	Panzar--Rosse H-statistics	Most estimates are positive and less than 1, which 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, the 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 over time. As there are no available reference values for specific models of competition in the banking market, we cannot make any inferences on 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	The Czech Republic	Panzar--Rosse H-statistics	Highly competitive market in the period 2001–2005 and monopolistic competition in 2005–2009.

Study by	Period	Countries	Type of approach	Results
Cipol-lini and Fiordelisi (2012)	1996–2009	European countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, the United Kingdom	Lerner index	The mean value of the Lerner index suggests monopolistic competition.
Carbo-Valvedere et al. (2012)	1996–2012	23 OECD countries	Lerner index	Values of both indices are diversified over time and across countries, and suggest monopolistic 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 the 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 countries: Australia, China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, Pakistan, the Philippines, Singapore, Sri Lanka, Taiwan, Thailand	Lerner index and efficiency-adjusted Lerner index	Values of both indices are diversified over time and across countries, and suggest monopolistic 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)

Table 1. Review of empirical studies on banking competition. Source: Olszak (2014).

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

The empirical evidence on the intensity of competition in the Polish banking industry is rather scant. The available studies include cross-country analyses in which the 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 focus 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 over the years and suggest monopolistic competition in the Polish banking industry. The Panzar-Rosse H-statistics have been usually estimated within a regression analysis in which the 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 have 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 the application of the pooled OLS estimator to dynamic panel data is controversial as structural parameters so obtained are usually biased (Arellano and Bond, 1991; Greene, 2012; Baltagi, 2005).

3. Methodology

We use the Panzar-Rosse approach to assess the competitive nature of the 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 value indicates a higher degree of competition. Nathan

Study by	Type of measure of competition 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-statistics	0.77	Monopolistic 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-statistics	0.75 in years 1997–1998; 0.78 in years 1998–1999; 0.60 in years 1999–2000; 0.65 in years 2000–2001; 0.84 in years 2001–2002.	Monopolistic competition	1997–2002	Normalized interest income	n.a.
Bikker and Spierdijk (2008)	Panzar-Rosse H-statistics	0.03 in 2004	Monopolistic competition	1994–2004	Non-Normalized interest income	FE GLS, Recursive least squares
Pawłowska (2010)	Panzar-Rosse H-statistics	0.62 in years 1997–2007; 0.51 in years 1997–1998; 0.64 in years 1999–2003; 0.60 in years 2004–2007.	Monopolistic competition	1997–2007	Normalized interest income	FE GLS
Pawłowska (2012)	Panzar-Rosse H-statistics	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.	Monopolistic 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.	Monopolistic 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.	Monopolistic competition	1997–2009	Marginal cost function	FE GLS

Table 2. Review of empirical studies measuring competition in the Polish banking industry (commercial banks). Source: Olszak (2014) and papers cited in the table.

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and Neave (1989) point out that this interpretation assumes that 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 the 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):

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

where:

the subscript i denotes bank i, and the subscript t denotes quarter t;

ln_II_TA – interest revenue to total assets (this is our proxy for output price);

ln_AFR – average funding rate, i.e. the ratio of interest expenses to total assets;

ln_PPE – price of personnel expenditure is the ratio of personnel expenses to total assets (proxy for the price of labor);

ln_PCE – price of capital expenditure, 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, $H = \beta_1 + \beta_2 + \beta_3$.

We begin with a standard model that takes into consideration the panel nature of data, i.e. random effects generalized 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 theoretically – in general, the fixed effects model should be used if the differences between individual entities may be captured through different constant values in the model, and it is not always possible to assume that an 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 (authors adapting the Panzar-Rosse approach, P-R use fixed effects models);

may be verified by a statistical test (e.g. Breusch-Pagan and Hausman tests).

Bikker et al. (2007) and Bikker et al. (2012) demonstrate that taking interest income as a share of total assets, or the inclusion of scaled variables as explanatory variables, may lead to overestimated competition and distorted tests results. Instead, they suggest using unscaled variables, i.e. using interest income as the dependent variable. 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 this assumption by estimating the following equation for the banking sector in Poland:

$$\ln ROA\_TA_{it} = \mu + \beta_1 \cdot \ln AFR_{it} + \beta_2 \cdot \ln PPE_{it} + \beta_3 \cdot \ln PCE_{it} + \beta_k \cdot controls_{it} + \varepsilon_{it} \tag{2}$$

where ROA is the return on assets.

We define equilibrium E-statistics as $\beta_1 + \beta_2 + \beta_3$. We test whether $E = 0$, using F-test. If rejected, the market is assumed not to be in equilibrium. The idea behind 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 to testing whether the observations are in the 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. The 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.

$$\ln II\_TA_{it} = \mu + \alpha \cdot \ln II\_TA_{it-1} + \beta_1 \cdot \ln AFR_{it} + \beta_2 \cdot \ln PPE_{it} + \beta_3 \cdot \ln PCE_{it} + \beta_k \cdot controls_{it} + \varepsilon_{it} \tag{3}$$

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3.4. Data

We use very detailed bank level data which can be obtained mainly from the Reporting Information System of the National Bank of Poland. The System was developed based on the structure of the FINREP and COREP reports recommended by the Committee of European Banking Supervisors (currently the European Banking Authority). We use quarterly panel data for the years 2008–2012, including 53 domestic commercial banks for which our dataset was compiled. Having the aforementioned in mind, it must be noted that this source of information, in conjunction with additional information which was obtained from Monitor Polski B and from web pages of commercial banks, guarantees the highest quality and frequency of data that can be used for this kind of analysis. In Tables 3 and 4 we give summary information on data used in this research, i.e. descriptive statistics and a correlation matrix. Additionally, in Figure A included in the Appendix we depict distribution charts of the dependent variable and main independent variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
ln_II_TA	963	–4.259	0.466	–6.524	–2.906
ln_AFR	960	–4.911	0.417	–6.845	–3.664
ln_PPE	961	–5.806	0.706	–8.001	–3.161
ln_PCE	962	0.262	1.022	–1.729	4.274
ln_LNS_TA	967	–0.372	0.328	–2.155	–0.003
ln_DPS_F	957	4.002	0.427	1.895	5.503
ln_EQ_TA	963	2.100	1.352	–0.157	6.874
ln_OI_II	815	3.986	1.253	–1.542	9.603
ln_ROA	768	–0.168	1.061	–5.146	2.601

Table 3. Descriptive statistics. Source: Authors' calculations.

	ln_II_TA	ln_AFR	ln_PPE	ln_PCE	ln_LNS_TA	ln_DPS_F	ln_EQ_TA	ln_OI_II	ln_ROA
ln_II_TA	1.000								
ln_AFR	0.661	1.000							
ln_PPE	0.644	0.139	1.000						
ln_PCE	–0.128	–0.122	–0.199	1.000					
ln_LNS_TA	0.260	0.087	0.060	0.313	1.000				
ln_DPS_F	0.408	0.342	0.140	–0.262	0.370	1.000			
ln_EQ_TA	–0.371	–0.327	–0.459	0.662	0.325	–0.186	1.000		
ln_OI_II	–0.403	–0.051	–0.178	–0.099	–0.368	–0.316	–0.140	1.000	
ln_ROA	0.047	–0.134	0.058	0.132	0.107	–0.156	0.146	0.077	1.000

Table 4. Correlation matrix. Source: Authors' calculations.

4. Estimation results

4.1. Full sample estimation

In this section, we present a full sample estimation of our model specified following Eq. (1)-(3). In the first step, we show the results of the GLS fixed effects estimation. Next, we proceed to an analysis of the long-run equilibrium. And in the last step, we show the results of the 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 based on OLS are biased, we include these results – just for informative purposes, in a table in the Appendix.

4.1.1. GLS full sample estimation

In order to select an appropriate version of the GLS model (i.e. 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 random effects are important and that a model of pooled regression should not be built.

The Hausman test assumes that individual effects are independent of explanatory variables. If this hypothesis holds, both fixed effect and random effect estimators are unbiased but the random effect estimator is considered more efficient. In contrast, the rejection of the null hypothesis in favor of an alternative means that the fixed effect estimator is consistent or an error in the model specification occurred. The 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.

Test	H_0	Result	Probability
Breusch and Pagan Lagrangian multiplier test for random effects	Var(u) = 0	chibar2(01) = 2292.41	Prob > chibar2 = 0.000
Hausman test	difference in coefficients not systematic	chi2(7) = 29.41	Prob > chi2 = 0.000

Table 5. Breusch and Pagan Lagrangian multiplier test and Hausman test. Source: Authors' calculations.

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

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Among the results of estimation, we should focus on the following coefficients – R^2: within = 0.68 means that 68% of the intragroup diversification has been explained by the explanatory variables; between = 0.76 means that 76% of the differentiation of the endogenous variable between banks has been explained by the explanatory variables; overall = 0.74 means that 74% of the overall differentiation of the endogenous variable has been explained by the explanatory variables. The explanation of differentiation can be considered satisfactory.

The coefficients in the 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 the coefficient.

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

	Coef.	**Std. Err.**	**t**	**P > |t|**	**[95% Conf. Interval]**	
ln_AFR	0.490	0.016	29.790	0.000	0.458	0.522
ln_PPE	0.148	0.015	9.780	0.000	0.118	0.178
ln_PCE	0.065	0.014	4.560	0.000	0.037	0.093
ln_LNS_TA	0.315	0.027	11.590	0.000	0.262	0.368
ln_DPS_F	0.129	0.020	6.550	0.000	0.090	0.167
ln_EQ_TA	–0.043	0.010	–4.380	0.000	–0.063	–0.024
ln_OI_II	–0.050	0.005	–9.410	0.000	–0.060	–0.039
_cons	–1.104	0.134	–8.240	0.000	–1.368	–0.841
F(7,749) = 227.12		Prob > F = 0.000				
F test that all u_i = 0 F(52, 749) = 34.59		Prob > F = 0.000				

Table 6. Estimation of competition intensity using fixed-effects GLS regression. Source: Authors' calculations.

We have also tested the H-statistic for the 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 the banking sector in Poland can be described as monopolistic competition – the H-statistic is between 0 and 1.

The summed values of beta coefficients (i.e. $\beta_1 = 0.49$, $\beta_2 = 0.148$, $\beta_3 = 0.065$) give the H-statistic equal to 0.703, suggesting monopolistic competition.

4.1.2. Testing for long-run equilibrium

As mentioned 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 the dependent variable 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 the 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 argued by Matthews et al. (2007), the restriction 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).

Year	Test	Probability
2008	$F(1, 92) = 0.61$	prob = 0.435
2009	$F(1, 69) = 0.86$	prob = 0.358
2010	$F(1, 86) = 0.23$	prob = 0.635
2011	$F(1, 89) = 0.21$	prob = 0.651
2012	$F(1, 85) = 4.70$	prob = 0.033

Table 7. Equilibrium test for sub-periods. Source: Authors' calculations.

4.1.3. Dynamic estimation

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

As the quality of estimators in the dynamic GMM model depends on several tests, we conduct such testing (see Table 9). The first is the Arellano-Bond test regarding autocorrelation of residuals. We find that there

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is no reason to reject the null hypothesis of absence of autocorrelation. The other is the Sargan test of overidentifying restrictions, which checks whether orthogonality conditions have been sufficiently met. The Sargan test suggests proper application of the instruments.

	Coef.	Std. Err.	t	P > |t|	[95% Conf. Interval]	
ln_II_TA L1.	0.081	0.023	3.550	0.000	0.036	0.125
ln_AFR	0.534	0.021	25.440	0.000	0.492	0.575
ln_PPE	0.211	0.013	16.790	0.000	0.187	0.236
ln_PCE	–0.015	0.008	–1.760	0.078	–0.031	0.002
ln_LNS_TA	0.140	0.020	6.990	0.000	0.100	0.179
ln_DPS_F	0.054	0.025	2.150	0.032	0.005	0.103
ln_OI_II	–0.046	0.006	–7.600	0.000	–0.058	–0.034
_cons	–0.027	0.183	–0.150	0.882	–0.386	0.332
Wald chi2(7) = 4521.51		Prob > chi2 = 0.000				

Table 8. Estimation of competition intensity using two-step GMM (Arellano-Bond / Blundell-Bond). Source: Authors' calculations.

Test	H_0	Result	Probability
Arellano-Bond test for zero autocorrelation in first-differenced errors	no autocorrelation	1: z = –2.445 2: z = –0.652 3: z = –0.872 4: z = 0.627	1: 0.015 2: 0.515 3: 0.383 4: 0.530
Sargan test of overidentifying restrictions	overidentifying restrictions are valid	chi2(35) = 43.106	Prob > chi2 = 0.163

Table 9. Arellano-Bond test and Sargan test. 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 following two-step and one-step methods leads to the conclusion that all used variables are statistically significant[1].

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 the banking sector in Poland can be described as monopolistic competition due to the fact that 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 of the Panzar-Rosse H-statistics estimation by year to consider the time evolution of competition. Tables 10 and 11 show the H-statistics for Polish commercial banks in the consecutive years 2008–2012, obtained using three different estimation methods (FE GLS, two-step GMM and one-step GMM).

Estimation technique: FE GLS						
Dep.var: ln_II_TA	**2008–2012**	**2008**	**2009**	**2010**	**2011**	**2012**
ln_AFR	0.490 (29.79)***	0.478 (10.01)***	0.595 (11.98)***	0.350 (7.29)***	0.548 (12.95)***	0.622 (12.03)***
ln_PPE	0.148 (9.78)***	0.146 (4.66)***	0.005 (0.09)	0.086 (2.83)***	0.075 (2.34)**	0.115 (3.19)***
ln_PCE	0.065 (4.56)***	–0.064 (–2.39)**	0.032 (0.61)	0.016 (0.59)	0.064 (2.21)**	–0.015 (–0.51)
ln_LNS_TA	0.315 (11.59)***	–0.014 (–0.22)	0.384 (4.51)***	0.319 (4.77)***	0.368 (4.97)***	0.213 (3.03)***
ln_DPS_F	0.129 (6.55)***	–0.003 (–0.06)	0.023 (0.29)	0.484 (4.15)***	–0.087 (–0.81)	–0.060 (–0.49)
ln_EQ_TA	–0.043 (–4.38)***	0.067 (1.22)	0.179 (2.27)**	0.080 (1.31)	0.041 (0.95)	–0.005 (–0.15)
ln_OI_TA	–0.050 (–9.41)***	–0.014 (–1.66)*	–0.064 (–5.39)***	–0.013 (–1.46)	–0.037 (–3.43)***	–0.044 (–5.52)***
cons	–1.104 (–8.24)***	–1.081 (–2.65)***	–1.377 (–2.54)**	–4.012 (–6.80)***	–0.538 (–0.89)	–0.009 (–0,02)
R^2 within between overall	 0.680 0.762 0.737	 0.532 0.523 0.049	 0.641 0.144 0.147	 0.519 0.476 0.476	 0.763 0.478 0.480	 0.783 0.697 0.660
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 significance 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]
$Hfe = \beta_1 + \beta_2 + \beta_3$	**0.703**	**0.560**	**0.631**	**0.452**	**0.687**	**0.722**
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]

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Estimation technique: two–step GMM						
Dep.var: ln_II_TA	**2008–2012**	**2008**	**2009**	2010	2011	2012
ln_II_TA L1.	0.0808 (3.55)***	–0.034 (–0.24)	–0.038 (–0.52)	0.322 (4.53)***	0.060 (0.66)	–0.003 (–0.04)
ln_AFR	0.534 (25.44)***	0.616 (7.87)***	0.612 (11.70)***	0.478 (11.72)***	0.567 (15.87)***	0.540 (11.22)***
ln_PPE	0.211 (16.79)***	0.164 (3.49)***	0.170 (3.41)***	0.134 (3.52)***	0.159 (4.19)***	0.156 (3.81)***
ln_PCE	–0.015 (–1.76)*	–0.015 (–0.38)	–0.020 (–0.44)	0.000 (0.01)	–0.004 (–0.14)	–0.023 (–1.09)
ln_LNS_TA	0.140 (6.99)***	0.094 (0.86)	0.176 (1.85)*	0.200 (4.22)***	0.311 (4.62)***	0.162 (2.80)***
ln_DPS_F	0.054 (–2.15)**	–0.422 (–2.13)**	–0.008 (–0.13)	–0.000 (–0.00)	–0.060 (–1.20)	–0.153 (–2.28)**
ln_OI_TA	–0.046 (–7.60)***	–0.020 (–2.12)**	–0.061 (–4.45)***	–0.003 (–0.21)	–0.002 (–0.28)	–0.052 (–4.07)***
cons	–0.027 (–0.15)	1.324 (0.93)	–0.126 (–0.13)	0.371 (0.85)	0.113 (0.20)	0.232 (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]
$H2step = \beta_1 + \beta_2 + \beta_3$	**0.730**	**0.765**	**0.761**	**0.612**	**0.722**	**0.673**
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: H2*step* = 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]

Estimation technique: one–step GMM						
Dep.var: ln_II_TA	**2008–2012**	**2008**	**2009**	**2010**	**2011**	**2012**
ln_II_TA L1.	0.098 (4.07)***	0.156 (1.06)	0.004 (0.07)	0.320 (5.68)***	0.048 (0.63)	0.042 (1.13)
ln_AFR	0.529 (31.94)***	0.690 (9.40)***	0.581 (13.71)***	0.529 (10.23)***	0.554 (16.56)***	0.546 (15.30)***
ln_PPE	0.201 (14.93)***	0.247 (5.18)***	0.178 (4.51)***	0.135 (3.90)***	0.119 (5.72)***	0.167 (6.61)***
ln_PCE	–0.022 (–1.94)*	–0.011 (–0.27)	–0.095 (–3.07)***	0.012 (0.29)	–0.009 (–0.46)	–0.025 (–1.15)
ln_LNS_TA	0.157 (5.35)***	0.071 (0.73)	0.197 (2.38)**	0.152 (1.75)*	0.418 (8.26)***	0.129 (1.93)*

Estimation technique: one–step GMM						
Dep.var: ln_II_TA	**2008–2012**	**2008**	**2009**	**2010**	**2011**	**2012**
ln_DPS_F	0.079 (3.70)***	–0.217 (–1.42)	0.025 (0.39)	0.046 (0.95)	–0.050 (–1.20)	–0.203 (–3.41)***
ln_OI_TA	–0.048 (–10.33)***	–0.010 (–0.83)	–0.065 (–6.08)***	–0.018 (–1.68)*	0.012 (1.19)	–0.052 (–6.71)***
cons	–0.127 (–0.96)	2.081 (1.58)	–0.140 (–0.40)	0.479 (1.47)	–0.276 (–0.75)	0.686 (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]
$H1step = \beta_1 + \beta_2 + \beta_3$	**0.708**	**0.925**	**0.663**	**0.675**	**0.664**	**0.688**
$H0$: $H1step = 0$ 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 depend on time and are calculated with application of FE-GLS, two-step GMM and one-step Arellano and Bond GMM estimators. Under monopoly, the H-statistic should be smaller than or equal to zero; in the models of monopolistic 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 value indicates a higher degree of competition. H2step denotes the Panzar-Rosse H-statistics calculated for consecutive years 2008–2012. β_1, β_2, and β_3 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 10%, 5% and 1%, respectively.

Table 10. Developments of the Panzar-Rosse H-statistics over time.

Since each of those estimation techniques has some specific advantages and disadvantages, we take the average of the three estimates as our measure of competition intensity in Poland (see Table 11). Such a procedure has also been applied by Claessens and Laeven (2004:571). Upon the analysis of these results, one can conclude that competition evolved differently over the years in Poland. In some years, competition was rather high as the H-statistic reached the level of 0.75, which is relatively close to perfect competition (in 2008). Then it gradually decreased reaching its lowest value in 2010, and slightly increased since then. Generally, the values of our competitive environment measure indicate 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).

If we look at macroeconomic background in Poland in 2008–2012, we find that the values of the H-statistic are affected by GDP growth – but with a one year lag. In particular, they have the highest level in 2008, a year after 2007, when the Polish economy was booming (i.e. GDP growth was

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Type of H-statistics	2008	2009	2010	2011	2012
$Hfe = \beta_1 + \beta_2 + \beta_3$	0.560	0.631	0.452	0.687	0.722
$H2step = \beta_1 + \beta_2 + \beta_3$	0.765	0.761	0.612	0.722	0.673
$H1step = \beta_1 + \beta_2 + \beta_3$	0.925	0.663	0.675	0.664	0.688
H-average	***0.750***	***0.685***	***0.580***	***0.691***	***0.694***

Note: this table presents Panzar-Rosse H-statistics that depend on time and are 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 value indicates a higher degree of competition. Hfe denotes the Panzar-Rosse H-statistics calculated for consecutive years 2008–2012. β_1, β_2, and β_3 are elasticity coefficients of input prices, i.e. price of deposits, labor and capital, respectively.

Table 11. Developments of the Panzar-Rosse H-statistics over time – average competition indicator.

as high as 7.2). The H-statistic reached its borderline in 2010, a year after GDP growth was the lowest. It started to increase 2011 with a one year lag in comparison to GDP. As the GDP was growing in 2011, the competition intensity also increased in 2012, with the H-statistic reaching the value of 0.694. Overall, the correlation coefficient between lagged GDP growth and H-statistics is around 0.87. This linear relationship indicates that, on the one hand, competition may be affected by GDP growth, increasing as GDP increases. On the other hand, the GDP growth may also be influenced by the competition intensity. One might say that increased competition in a given year results in decreased GDP growth in the subsequent year (see Table 12).

	Year						
	2007	2008	2009	2010	2011	2012	2013
GDP growth	7.2	3.90	2.60	3.70	4.80	1.80	1.7
H-statistics		0.75	0.69	0.58	0.69	0.69	
Correlation coefficient (GDP lagged and H-statistics)	0.869						
Correlation coefficient (GDP and H-statistics lagged)	–0.723						

Table 12. Annual real GDP growth in Poland in 2007–2013 and correlations between lagged GDP and H-statistics. Source: Polish Central Statistical Office and authors' calculations.

5. Conclusions and discussion

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

Upon the analysis of results, one can conclude that competition evolved differently over the years in Poland. Our study finds that quantitative estimation of competition is sensitive to the econometric specification technique in consecutive years 2008–2012. However, on average, the competition intensity in 2008–2012 may be described as monopolistic competition.

Our results further show that competition may be affected by macroeconomic environment. This impact is visible with a lag as GDP growth in a given year is positively correlated with the H-statistic in the subsequent year. Thus our result is in line with the stylized fact that favorable macroeconomic conditions stimulate competition in the bank loan market.

As increasing competition may be related with excessive bank risk taking, with its negative consequences for financial stability, this highly competitive banking market might endanger economic growth in the years that follow. The analysis of the correlation coefficient between lagged H-statistics and GDP growth seems to support this view as it leads to the conclusion that increased competition in the banking sector in a given year is associated with decreased economic growth in the subsequent year. This result, as well as the result given in the previous paragraph, should be interpreted with caution due to the correlation method applied. In particular, to make inferences about the structural relationship between bank competition and economic growth, further research should apply a regression analysis, preferably with the application of a data set covering at least a full business cycle for a larger sample of countries.

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1 Detailed estimation results for one-step estimation can be found in Świtała et al. (2013).

References

Agoraki, M-E., Delis, M. D. and Pasiouras, F. (2011). Regulations, competition and bank risk-taking in transitions countries. *Journal of Financial Stability*, 7(2011), 38–48.

Alawode, A. A. and Al Sadek, M. (2008). What is financial stability? *Financial Stability Paper Series*, No. 1/March 2008.

Allen, F. and Gale, D. (2000). *Comparing Financial Systems*. Cambridge, MA: MIT Press.

Allen, F. and Gale, D. (2004). Competition and financial stability. *Journal of Money, Credit and Banking, 36*(2), 453–480.

 DOI 10.7172/1644-9584.48.4

Allen, W. and Wood, G. (2006). Defining and achieving financial stability. *Journal of Financial Stability,* 2, issue 2, 152–172.

Arellano, M. and Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies,* 58, 277–297.

Ashcraft, A. (2008). Does the market discipline banks? New evidence from the regulatory capital mix. *Journal of Financial Intermediation,* 17, 543–561.

Baltagi, B. H. (2005). *Econometric Analysis of Panel Data*. Chichester: John Wiley & Sons, Ltd.

Beck, T. (2008). Bank competition and financial stability: Friends or foes? *Policy Research Working Paper Series,* 4656. The World Bank.

Beck, T., De Jonghe, O. and Schepens, G. (2013). Bank competition and stability: cross-country heterogeneity. *Journal of Financial Intermediation,* 22, 218–244.

Beck, T., Demirguc-Kunt, A. and Maksimovic, V. (2004). Bank Competition and Access to Finance: International Evidence. *Journal of Money, Credit and Banking, 36*(3), 627–648.

Beck, T., Demirguc-Kunt, A. and Levine, R. (2006). Bank concentration, competition, and crises: First results. *Journal of Banking & Finance*, 30, 1581–1603.

Beck, T., De Jonghe, O. and Shepens, G. (2011). Bank Competition and Stability: Crosscountry Heterogeneity. *Working Paper* 2011-080, CentER.

Berger, A. N., Klapper, L. F. and Turk-Ariss, R. (2009). Bank competition and financial stability. *Journal of Financial Services Research,* 35, 99–118.

Berger, A., Demiguc-Kunt, A., Levine R. and Haubrich, J. (2004). Bank concentration and competition: An evolution in the making. *Journal of Money, Credit and Banking, 36*(3), June, part 2, 433–451.

Berger, A., Herrig, R. J. and Szegö, G. P. (1995). The role of capital in financial institutions. *Journal of Banking and Finance*, 19, 393 – 430.

Berger, A. N., Klapper, L. F. and Turk-Ariss, R. (2009). Bank competition and financial stability. *Journal of Financial Services Research,* 35, 99–118.

Besanko, D. and Thakor, A. (1993). Relationship banking, deposit insurance and bank portfolio choice. In: C. Mayer and X. Vives (eds.), *Capital markets and financial intermediation*, Cambridge University Press.

Besar, D., Booth, P., Chan, K. K., Milne, A. and Pickles J. (2009). *Systemic Risk in Financial Services*. Cass Business School, July, mimeo.

Bikker, J., Shaffer, S. and Spierdijk L. (2012). Assessing competition with the Panzar-Rosse Model: The role of scale, costs and equilibrium. *Review of Economics and Statistics, 94*(4), 1025–1044.

Bikker, J. and Spierdijk, L. (2008). How banking competition changed over time. *The Nederlandsche Bank Working Paper* 167.

Bikker, J. and Spierdijk L. (2010). Measuring and explaining competition in the financial sector. *Journal of Applied Business and Economics,* 11, 11–42.

Bikker, J., Spierdijk, L. and Finnie, P. (2006). Misspecification of the Panzar–Rosse model: assessing competition in the banking industry. *DNB Working Papers,* 114, Netherlands Central Bank.

Bikker, J., van Leuvensteijn, M. (2008). Competition and efficiency in the Dutch life insurance industry. *Applied Economics, 40*(16), 2063–2084.

Blundell, R. and Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data model. *Journal of Econometrics, 87*(1), 115–143.

Boone, J. (2001). Intensity of competition and the incentive to innovate. *International Journal of Industrial Organization, 19*(5), 705–726.

Boone, J. (2008). A new way to measure competition. *The Economic Journal,* 118, 1245–1261.

Boone, J., Griffith, R. and Harrison, R. (2004). *Measuring competition.* Paper presented at the Encore Meeting 2004 "Measuring competition".

Boone, J. and van Leuvensteijn, M. (2010). Measuring competition using the profit elasticity: American sugar industry, 1890–1914. *CEPR Discussion Paper Series,* 8159.
Boone, J., van Ours, J. and van der Wiel, H. (2007). How (not) to measure competition. *Tilburg Law and Economics Center (TILEC) Discussion Paper* 2007–014.
Borio, C. and Drehmann, M. (2009). Towards an operational framework for financial stability: 'fuzzy' measurement and its consequences. *BIS Working Papers*, 284, Bank for International Settlements
Boyd, J. H. and De Nicoló, G. (2005). The theory of bank risk taking and competition revisited. *Journal of Finance,* 60, 1329–1343.
Boyd, J. H., De Nicoló, G. and Jalal, A. (2006). Bank risk taking and competition: New theory, new empirics. *IMF Working Paper* 06/297.
Boyd, J. H., De Nicoló, G. and Jalal, A. (2009a). Bank competition, risk and asset allocation. *IMF Working Papers,* WP/09/13, International Monetary Fund.]
Boyd, J. H., De Nicoló, G., Jalal, A. and Loukoianova E. (2009b). Banking Crises and Crisis Dating: Theory and Evidence. *IMF Working Papers,* 09/141, International Monetary Fund.
Bresnahan, T. F. (1982). The oligopoly solution concept is identified. *Economic Letters,* 10, 87–92.
Bretschger, L., Kappel, V. and Werner T. (2012). Market concentration and the likelihood of financial crises. *Journal of Banking and Finance, 36*(12), 3336–3345.
Carbó Valverde, S., Humphrey, D., Maudos, J. and Molyneux, P. (2009). Cross-country comparisons of competition and pricing power in European banking. *Journal of International Money and Finance, 28*(1), 115–134.
Carletti, E. and Hartmann, P. (2003). Competition and Financial Stability. What's Special about Banking? In: P. Mizen (ed.), *Monetary History, Exchange Rates and Financial Markets: Essays in Honor of Charles Goodhart,* (Vol. 2). Cheltenham, UK: Edward Elgar.
Casu, B. and Girardone, C. (2006). Bank competition, concentration and efficiency in the single European Market. *The Manchester School,* 74, 441–468
Casu, B. and Girardone, C. (2009). Does Competition lead to Efficiency? The Case of EU Commercial Banks. *Working Paper Series,* WP 01/09.
Cipollini, A. and Fiordelisi, F. (2012). Economic value, competition and financial distress in the European banking system. *Journal of Banking & Finance,* 36, 3101–3109.
Claessens, S. (2009). Competition in the Financial Sector: Overview of Competition Policies. *IMF Working Paper* WP/09/45.
Classens, S. and Laeven, L. (2004). What drives bank competition? Some international Evidence. *Journal of Money, Credit and Banking, 36*(3), June part 2, 563–583.
Craig, B. and Dinger, V. (2013). Deposit market competition, wholesale funding, and bank risk. *Journal of Banking and Finance,* 37, 3605–3622.
De Nicoló, G. and Loukoianova, E. (2007). Bank Ownership, Market Structure and Risk. *IMF Working Paper* WP/07/215.
De Nicoló, G. and Lucchetta, M. (2011). Bank Competition and Financial Stability: A General Equilibrium Exposition. *IMF Working Paper* WP/11/295.
Delis, M. (2012). Bank competition, financial reform and institutions: The importance of being developed. *Journal of Development Economics*, 97, 450–465.
Demirgüç-Kunt, A. and Detragiache E. (1998). The Determinants of Banking Crises: Evidence from Developing and Developed Countries. *IMF Staff Papers, 45*, 81–109.
Demirgüç-Kunt, A. and Detragiache, E. (2005). Cross-country empirical survey of systemic banking distress: a survey. *IMF Working Papers,* 05/96. International Monetary Fund.
Dick, A. (2006). Nationwide branching and its impact on market structure, quality and bank performance. *Journal of Business,* 79, 567–592.
Dick, A. and Lehnert, A. (2007). Personal Bankruptcy and Credit Market Competition. Staff Report, 272. Federal Reserve Bank of New York.

 DOI 10.7172/1644-9584.48.4

Dinger, V. and von Hagen, J. (2009). Does Interbank borrowing Reduce Bank Risk? *Journal of Money, Credit and Banking,* 41, 491–506.

Duygun, M., Shaban, M. and Weyman-Jones, T. (2013). Measuring Competition Using the Boone Relative Profit Difference Indicator: an application to Banking Systems in Emerging Economies. *Economics Discussion Paper Series,* WP 2013–05.

Flannery, M. J. (1998). Using Market Information in Prudential Bank Supervision: A Review of the U.S. Empirical Evidence. *Journal of Money, Credit and Banking*, *30*(3), Part 1, 273–305.

Flannery, M. J. (2001). The faces of "market discipline". *Journal of Financial Services Research,* 20: 2/3, 107 – 119.

Flannery, M. J. and Sorescu, S. M. (1996). Evidence of Bank Market Discipline in Subordinated Debenture Yields: 1983–1991. *The Journal of Finance*, *51*(4), 1347–1377.

Flannery, M. J., Kwanb, S. H. and Nimalendrana, M. (2004). Market evidence on the opaqueness of banking firms' assets. *Journal of Financial Economics,* 71, 419–460.

Foos, D., Norden, L. and Weber, M. (2010). Loan growth and riskiness of banks. *Journal of Banking and Finance,* 34, 2929–2940.

Fu, X. (M.), Lin, Y. (R.) and Molyneux, P. (2014). Bank competition and financial stability in Asia Pacific. *Journal of Banking and Finance,* 38, 64–77.

Greene, W. H. (2012). Econometric Analysis. New York: Prentice Hall.

Haq, M. and Heaney, R. (2012). Factors determining European bank risk. *Journal of International Financial Markets, Institutions & Money,* 22, 696–718.

Hellmann, T., Murdock, K. and Stiglitz, J. (2000). Liberalization, moral hazard in banking and prudential regulation: are capital requirements enough? *American Economic Review,* 90, 147–165.

Jimenez, G., Lopez, J. and Salas, J. S. (2010). How Competition Impacts Bank Risk Taking. *Banco de Espana Working Paper* 1005.

Keeley, M. C. (1990). Deposit insurance, risk and market power in banking. *American Economic Review,* 80, 1183–1200.

Lau, L. (1982). On identifying the degree of competitiveness from industry price and output data. *Economic Letters,* 10, 93–99.

Lerner, A.P. (1934). The Concept of Monopoly and the Measurement of Monopoly Power. *The Review of Economic Studies, 1*(3), 157–175.

Leuvensteijn, M., van Kok-Sørensen, C., Bikker, J. and van Rixtel, A. (2013). Impact of bank competition on the interest rate pass-through in the euro area. *Applied Economics, 7*(48), 1359–1380.

Leuvensteijn, M., Bikker, J., van Rixtel, A. and Kok-Sørensen, C. (2011). A new approach to measuring competition in the loan markets of the euro area. *Applied Economics, 43*(23), 3155–3167. Earlier published as: Leuvensteijn, M., Bikker, J., van Rixtel, A. and Kok-Sørensen, C. (2007). A new approach to measure competition in the loan markets of the euro area. *ECB Working Paper* 768.

Liu, H., Molyneux, P. and Wilson, J. O. S. (2010). Competition and stability in European Banking – a regional analysis. *Bangor Business School Working Paper* BBSWP/10/019.

Martinez-Miera, D. and Repullo, R. (2010). Does competition reduce the risk of bank failure? *Review of Financial Studies, 23*(10), 3638–3664.

Matthews, K., Murinde, V. and Zhao, T. (2007). Competitive conditions among the major British banks. *Journal of Banking and Finance*, *31*, 2025–2042.

Mikłaszewska, E. (ed.). (2010). *Bank na rynku finansowym: Problemy skali, efektywności i nadzoru*. Wydawnictwo Wolters Kluwer Polska Sp. z o.o.

Milne, A. (2009). Macroprudential Policy: what can it achieve? *Oxford Review of Economic Policy*, *25*(4), 608–269.

Molyneux, P., Thornton, J. and Lloyd-Williams, D. M. (1996). Competition and Market Contestability in Japanese Commercial Banking. *Journal of Economics and Business,* 48, 33–45.

Nathan, A. and Edwin, H. N. (1989). Competition and Contestability in Canada's Financial System: Empirical Results. *Canadian Journal of Economics,* 22, 576–594.

Noth, F. (2011). *Banking Competition and Real Sector Stability: Does the Risk Shifting Channel Exist?* Goethe University Frankfurt

Olivero, M. P., Li, Y. and Jeon, B. N.(2011). Competition in banking and the lending channel: Evidence from bank-level data in Asia and Latin America. *Journal of Banking & Finance,* 35, 560–571.

Olszak, M. (2014). Zależność między konkurencją w sektorze bankowym i stabilnością finansową banków – przegląd badań teoretycznych i empirycznych. *Internetowy Kwartalnik Antymonopolowy i Regulacyjny* 2014, 5(3), 8–34.

Panzar, J. C. and Rosse, J. N. (1982). Structure, Conduct and Comparative Statistics. *Bell Laboratories Economics Discussion Paper.*

Panzar, J. C. and Rosse, J. N. (1987). Testing for 'Monopoly' Equilibrium. *Journal of Industrial Economics,* 35, 443–456.

Pawłowska, M. (2005). Competition, Concentration, Efficiency, and their Relationship in the Polish Banking Sector. *Materiały i Studia,* Paper No. 32.

Pawłowska, M. (2010). Competition in the Polish Banking Sector. *Gospodarka Narodowa* 5/6/2012, 91–119.

Pawłowska, M. (2012). Competition, concentration and foreign capital in the Polish banking sector (prior and during the financial crisis). *National Bank of Poland Working Paper* 130.

Repullo, R. (2004). Capital requirements, market power, and risk-taking in banking. *Journal of Financial Intermediation,* 13, 156–182.

Ruckes, M. (2004). Bank Competition and Credit Standards. *The Review of Financial Studies, 17*(4), 1073–1102.

Salas, V. and Saurina, J. (2003). Deregulation, market power and risk behavior in Spanish banks. *European Economic Review,* 47, 1061–1075.

Schaeck, K. and Cihák, M. (2010). Competition, efficiency and soundness in banking: An industrial organization perspective. *Tilburg University European Banking Center Discussion Paper* 2010–20S.

Schaeck, K., Cihak, M. and Wolfe, S. (2006). Are More Competitive Banking Systems More Stable? *IMF Working paper* WP/06/143.

Schaeck, K., Cihak, M. and Wolfe, S. (2009). Are competitive banking systems more stable? *Journal of Money, Credit, and Banking,* 41, 711–734.

Schierch, A., Schmidt-Ehmcke, J. (2010). Empiricism Meets Theory – Is the Boone-Indicator Applicable. *DIW Discussion Papers* 1030, Berlin.

Shaffer, S. (1982). A Non-structural Test for Competition in Financial Markets. In: *Bank Structure and Competition. Conference Proceedings,* 225–243. Federal Reserve Bank of Chicago.

Shaffer, S. (1983). Non-structural Measures of Competition: Toward a Synthesis of Alternatives. *Economics Letters,* 12, 349–353.

Shaffer, S. (1989). Competition in the U.S. Banking Industry. *Economics Letters* 29, 321–323.

Shaffer, S. (1993). A Test of Competition in Canadian Banking. *Journal of Money, Credit, and Banking,* 25, 49–61.

Shaffer, S. (2001). Banking Conduct before the European Single Banking License: A Cross-Country Comparison. *North American Journal of Economics and Finance,* 12, 79–104.

Shaffer, S. (2004). Comment on "What Drives Bank Competition? Some International Evidence" by Stijn Claessens and Luc Laeven. *Journal of Money, Credit, and Banking, 36*(3), 585–592.

Sironi, A. (2001). An Analysis of European Banks' SND Issues and its Implications for the Design of a Mandatory Subordinated Debt Policy. *Journal of Financial Services Research* 20: 2/3, 233–266.

 DOI 10.7172/1644-9584.48.4

Sironi, A. (2003). Testing for Market Discipline in the European Banking Industry: Evidence from Subordinated Debt Issues. *Journal of Money, Credit and Banking, 35*(3), 443–472.

Stavarek, D. and Repkova, I. (2011). Estimation of the competitive conditions in the Czech banking sector. *MPRA Paper* No. 30720.

Stiglitz, J. and Weiss A. (1981). Credit rationing with imperfect information. *American Economic Review,* 71, 393–410.

Świtała, F., Olszak, M. and Kowalska, I. (2013). Competition in commercial banks in Poland – analysis of Panzar-Rosse H-statistics. *Faculty of Management Working Papers Series,* 4/2013.

Tabak, B. M., Fazio, D. and Cajueiro, D. O. (2012). The relationship between banking market competition and risk-taking: do size and capitalization matter? *Journal of Banking and Finance, 36*(12), 3366–3381.

Tabak, B. M., Fazio, D. and Cajueiro, D. O. (2013). Systemically important banks and financial stability: The case of Latin America? *Journal of Banking and Finance, 37*(12), 3855–3866.

Turk-Ariss, R. (2010). On the Implications of Market Power in Banking: Evidence from Developing Countries. *Journal of Banking and Finance, 34*(4), 765–775.

Uhde, A. and Heimeshoff, U. (2009). Consolidation in banking and financial stability in Europe: Empirical evidence. *Journal of Banking and Finance,* 33, 1299–1311.

Xu, B., Van Rixtel, A. and Van Leuvensteijn, M. (2013). Measuring bank competition in China: a comparison of new versus conventional approaches applied to loan markets. *BIS Working Papers,* 422.

Appendix

ln_Π_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**
*H*0: *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]
*H*1: *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 depend on time and are calculated with application of the 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. β_1, β_2, and β_3 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 A. Estimation of competition intensity using OLS regression – full sample results and developments of H-statistics over years 2008–2012.

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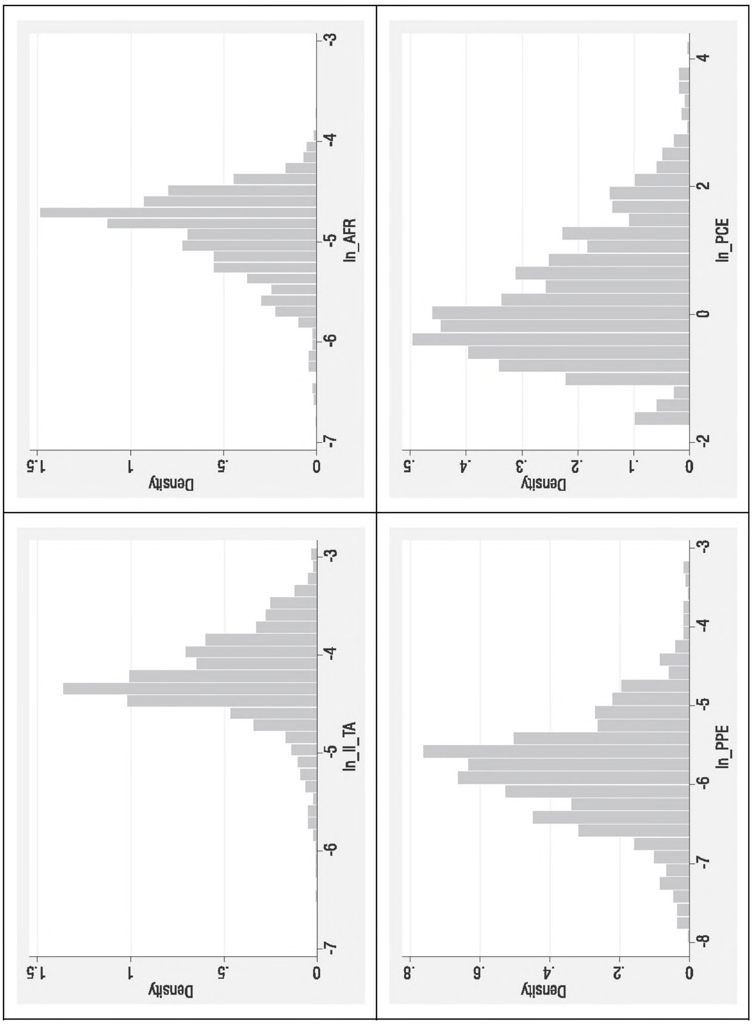
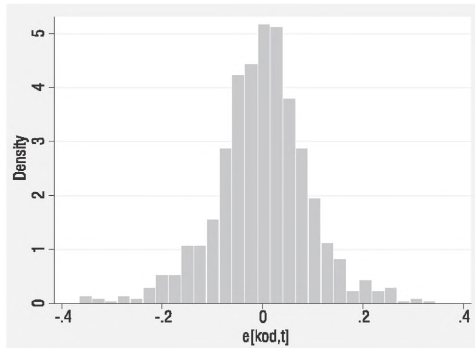
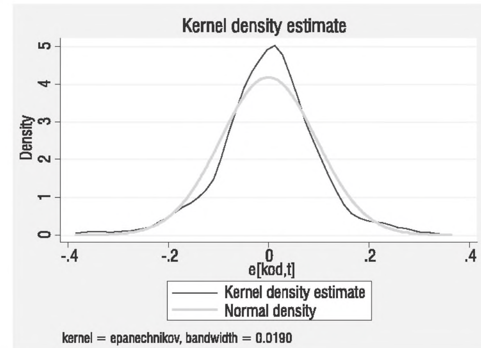
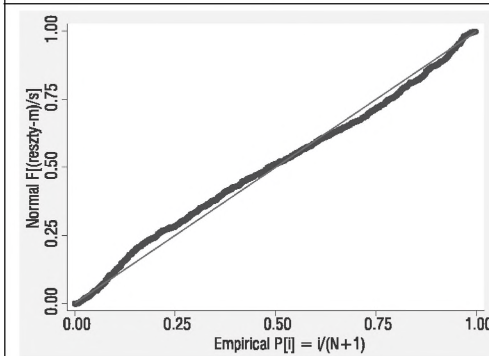


Figure A. Distribution chart of dependent and independent variables. Source: Authors' analysis.







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

Figure B. Normality test of residuals of model.

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