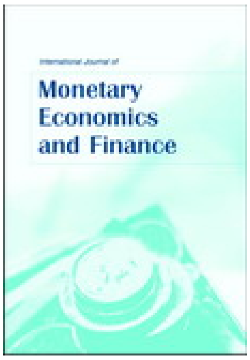

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The influence of market power on bank risk-taking in the Euro area countries during the inter-crises period

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Abstract: The European debt crisis affected the global economy, and banking stability became fragile. The economy was recovering from a difficult situation, and a new threat in the form of COVID-19 had emerged. Using a sample of 405 banks in 19 Euro area countries between 2010 and 2019, we explore the relationship between market power and bank risk-taking behaviour and verify the presence of competing paradigms. We use panel data analysis considering linear regression models and testing the potential U-shaped curve to analyse banks' market power and risk-taking behaviour. We consider various dimensions of bank risk measures (default risk, leverage risk, operational risk, liquidity risk and interest rate risk), while the market power is expressed through the Lerner index. We also examine the impact of bank-specific and macroeconomic variables on bank stability. The main findings reveal that higher market power decreases banks' risky behaviour, confirming the competition-fragility paradigm.

Keywords: Euro area; banks; stability; risk-taking behaviour; market power; Lerner index; panel data analysis; linear regression model.

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1 Introduction

In recent years, European banks have been exposed to an increasingly high risk of financial contagion, precisely because of the high degree of globalisation. One bank's 'illness', instability, and risk-taking behaviour can be passed quickly to other banks, not only within a country. Therefore, it is crucial to focus on the stability of banks and monitor how the changing competitive environment affects their risk-taking behaviour. Researchers' debate brings contrasting results whether there is a positive or negative relationship between banking stability and market power (or competition).

There is extensive literature examining the relationship between stability and competition in the banking area, and the empirical studies differ in many aspects. Some studies examine the relationship at the national level (Keeley, 1997; Jiménez et al., 2013), while others analyse several countries (Yeyati and Micco, 2003; Clark et al., 2018; Albaity et al., 2019). They also differ in the use of methods to measure competition and stability. For example, some studies focus on the stability and risk-taking behaviour of individual banks (Beck et al., 2013; Liu et al., 2013; Saif-Alyousfi et al., 2018), while others base their studies on the systemic failure of banks (Acharya and Steffen, 2012; Leroy and Lucotte, 2017). Besides, while some studies measure competition with a structural measure such as concentration indicators (Jiménez et al., 2013; Kočišová, 2017), relatively recent studies use non-structural measures (Schaeck and Cihák, 2014; Ahi and Laidroo, 2019) based on the bank-level data that reflect the behaviour of banks. However, these studies provide mixed findings and contradictory evidence. As the result of the literature review, we identify two hypotheses; the competition-fragility hypothesis claiming that less competition and a more concentrated banking environment increase stability, and the competition-stability hypothesis, which states that a more competitive and less concentrated banking environment increases stability in the financial system.

Most empirical papers have focused on the expected linear association between competition and stability. In linear models, we also apply the inclusion of the quadratic term, allowing us to set up the possibility of a potential U-shaped relationship between the indicators. The results of the analysis can help us define the optimal level of competition and point to the fact that both competition hypotheses are suitable, depending on the market power of individual banks. These results can be helpful for policymakers, as they allow us to determine the optimal turning point at which market power can increase or decrease individual banks' stability and the stability of the whole banking sector.

Since the last global crisis and before the coronavirus pandemic, there was a period when banks faced the consequences of the debt crisis, which required a consistent strategy to reinforce the banking system. The paper aims to analyse the risk-taking behaviour of Euro area banks, determine whether the changing competitive environment affects the risk-taking of these banks, and determine variables with a significant impact on their risk-taking. Furthermore, by analysing the relationship between competition and risk-taking of the bank, we want to verify the presence of competing paradigms. We explore the impact of the Lerner index, as a proxy to measure the market power, on the bank risk-taking behaviour, considering various dimensions of bank risk measures. Our sample contains 405 banks located in nineteen Euro area countries during the inter-crises period from 2010 to 2019. We find that the relationship between market power and risk measures in all models is negative. The empirical results indicate that the increasing competition leads to the bank risk-taking behaviour and overall fragility of the analysed banking sector. Additionally, considering several banks and country-related aspects, the findings indicate that capital stringency is a useful regulatory instrument in reducing bank risk-taking behaviour.

2 Theoretical background

According to Beck (2008), European financial markets have become more integrated, which led to design of regulatory frameworks and financial safety to reap maximum benefits from competition. He argues that competition is not detrimental to banking stability; however, more concentrated banking systems are less likely to suffer from systematic banking distress. He brings one of the first comprehensive studies devoted to the trade-off between competition and stability and presents competition-fragility and competition-stability hypotheses. In this section, we examine several important studies examining the observed relationship.

The competition-fragility hypothesis presents a traditional approach prevailing in the 1970s and 1980s in many emerging markets. It states that competition enhances the riskiness of the banking system. As mentioned by Mishi and Khumalo (2019), it is underpinned by the argument that bigger banks in highly concentrated markets (less competitive environment) may charge higher interest rates as they control the market, yielding higher profits. Such higher profits have a positive marginal effect acting as a buffer against loans, thereby increasing the franchise value and reducing the risk appetite of the individual banks. It transposes to a stable financial sector with cheaper monitoring and supervision costs as only a few large banks hold diversified and complex portfolios. We can state that the increase in concentration (decrease in competition) leads to bank stability increase (decrease in fragility). Their theory signals the significance of competition within the banking sector and its effect on banking stability. The study by Phan et al. (2019) strongly supports competition-fragility among East Asian banks. Their suggestion to stabilise the banking sector is to encourage and facilitate mergers of small and medium-sized banks. The competition-fragility paradigm is supported by Agoraki et al. (2011), Beck et al. (2013), Kick and Prieto (2013), Leroy and Lucotte (2017), Ghosh and Parida (2020) and Ijaz et al. (2020), who analyse the relationship between stability and competition in European banking sector (from 1998 to 2005; 2004–2013; 2001–2017), US (1994–2009), India (2007–2017), or in Germany (1994–2010).

On the contrary, the competition-stability states that bank fragility is common in the highly concentrated (less competitive) market. Boyd and De Nicoló (2005) claim that banks in a less competitive environment charge higher interest rates to companies, which induces them to expect higher risk, and the positive relationship between concentration and bank fragility. The competition-stability paradigm is also supported by Uhde and Heimeshoff (2009), Amidu and Wolfe (2013), Fiordelisi and Mare (2014), Schaeck and

Cihák (2014), Noman et al. (2018), and Ahi and Laidroo (2019), who analyse the relationship between stability and competition in European banking sector (1997–2005; 1998–2009; 2004–2014), emerging and developing countries (2000–2007), or in Asian countries (1990–2014).

Martinez-Miera and Repullo (2010) bring extended model by Boyd and De Nicoló (2005) and propose the margin effect hypothesis. Their results show a U-shaped relationship between competition and the risk of bank failure. The risk decreases with the more competitive environment, but any additional entry above the threshold's value would increase the risk of bank failure. Concur with this study, a model of an inverted U-shaped curve by Liu et al. (2013) indicates that a moderate level of bank competition is associated with higher stability in the banking system. One of the recent studies prepared by Ahi and Laidroo (2019) confirms that if assuming a linear model between competition and stability, the competition-stability paradigm usually prevails. They examine banks from European Union countries in the period 2004–2014. The authors also observe a U-shape association between bank stability and competition.

Berger et al. (2009) point to the fact that these two paradigms do not necessarily provide conflicting predictions regarding the effects of the quality of the competitive environment on the stability of banks. Although competition in the loan market will result in riskier loan portfolios, banks' overall risk may not increase. If banks enjoy higher franchise value derived from their market position, they may protect this value from the higher loan risk with other methods. Individually, they can offset the higher risk exposure through more capitalisation, reduced interest rate risk, loans or credit derivate sales, a smaller loan portfolio, or other risk-mitigation techniques. Thus, when a bank charges higher rates for business loans and has a riskier loan portfolio, the bank may still choose a lower overall risk. This argument suggests that in studying the effect of the quality of the competitive environment on bank risk, it is crucial to select dependent variables that reflect both loan risk and overall bank risk, thereby distinguishing whether one or both theories may act simultaneously.

Comparing these approaches, the majority of the analysed studies support the competition-fragility approach and therefore, we establish the following hypothesis:

> *Hypothesis: The decrease in bank market power increases bank risk-taking behaviour (decreases the banking stability), confirming the traditional competition-fragility view.*

In pursuance of clarification of the conflicting theoretical hypotheses, there are several methods to analyse the relationship. There is a wide range of risk factors such as bank default risk, leverage risk, portfolio risk, credit risk, non-interest income risk, interest income risk, liquidity risk and operational risk, mentioned in the study by Danisman and Demirel (2019), that can be considered as an inverse measure of the stability of the banks. Being aware of the effect of risk management in banking stability is presented in studies by Ghenimi et al. (2017) showing that credit and liquidity risk influence bank stability, or Gadzo et al. (2019), who suggest that asset quality, bank leverage, the cost to income ratio and liquidity variables significantly and positively influence credit risk, operational risk as well as the financial performance of the banks.

According to Bikker and Haaf (2000), it is possible to classify competition proxies into two significant categories, structural and non-structural approaches. The structural approach uses concentration indices approximated by institutions' market share, concentration ratios and the Herfindahl-Hirschman Index. Non-structural models recognise that banks behave differently depending on the market structure in which they operate (Chun and Kim, 2004). Among them, well-known are the Lerner index, the H-statistic developed by Panzar and Rosse, the Bresnahan model or the Boone indicator. This study analyses the banking competition through the most commonly used measure, the Lerner index. Weill (2013) analyses the evolution of bank competition measured with the Lerner index for European Union banks, and many other authors use the Lerner index as a variable in an econometric model showing the nexus between bank competition and stability (Jiménez et al., 2013; Fiordelisi and Mare, 2014; Kabir and Worthington, 2017; Leroy and Lucotte, 2017). The Lerner index is an inverse proxy for competition. It means a higher value of the Lerner index, implying less market competition and higher market power. Usually, it takes values between zero and one, where zero corresponds to a perfect competition situation and the value of one to a pure monopoly. However, in the real market situation, its value can be negative, indicating the alarming trend for the specific bank in a particular year. This indicator should not be negative for long (either for a bank or a country). Spierdijk and Zaouras (2017) argue that market power is absent when the Lerner index is zero or negative.

Some studies have reported that bank-specific and macroeconomic variables can also explain bank risk-taking behaviour. The theory offers various predictions about how bank capital affects bank risk-taking and stability. These studies point to the possible negative effects of capital tightness and argue that banks' stability decreases with more stringent capital requirements (Koehn and Santomero, 1980; Kim and Santomero, 1988). It is argued that in an imperfect information environment, capital requirements reduce incentives for insiders tracking that undertake unobservable actions that maximise their welfare, but not the welfare of outside investors (Besanko and Kanatas, 1996). Nevertheless, most of the literature agrees that capital requirements are among the most critical tools of banking regulations for inducing prudent behaviour. Stricter capital requirements reduce bank risk-taking behaviour, thereby reducing the moral hazard caused by deposit insurance (Keeley and Furlong, 1990; Keeley, 1997; Barth et al., 2004; Agoraki et al., 2011; Danisman and Demirel, 2019). Another reason is that the screening of borrowers and bank risk management is enhanced by higher capitalisation (Allen et al., 2011). There is empirical literature on the impact of capitalisation on bank risk-taking behaviour, with most findings suggesting a negative relationship between capital requirements and bank risk risk-taking (Barth et al., 2004; Agoraki et al., 2011; Beck et al., 2013; Danisman and Demirel, 2019). In line with the prevailing literature, stringency in capital requirements is expected to reduce banks' risk-taking behaviour.

Within the literature review, we observe that the mentioned studies differ in obtained results, which could be affected by the different sample (bank-level data or aggregated data), by location of banks (banks only from one country, or analysis on the international level), by analysed period, by applied methodologies used as a proxy of competition or stability, but also which differ in the methods used to test the relationship between stability and competition. In some papers, authors used the Granger causality approach to determine if the competition affects the stability, or stability affects the competition, or if this relationship is reciprocal. This methodology was used, for example, in the study of Fiordelisi and Mare (2014) and Jayakumar et al. (2018). Next, linear regression was also applied to study this relationship (e.g., Berger et al., 2009; Beck et al., 2013; Schaeck and Cihák, 2014). In recent years, authors started studying linear and examining the potential U-shaped link in the relationship between competition and stability. For example, Jiménez et al. (2013) investigated the relationship using data of the Spanish banking sector, Leroy and Lucotte (2017) analysed European banks, while Cuestas et al. (2019) assessed banks in the Baltic countries.

This paper focuses on the relationship between market power and risk-taking behaviour on the sample of the selected Euro area banks. In recent years, European banks have faced the risk of financial contagion. Therefore, it is essential to focus on monitoring these banks' stability and analyse how the changing competitive environment can affect their stability. We do not estimate only linear but also testing the inclusion of the quadratic term in linear models, allowing us to set up the possibility of a U-shaped relationship between stability and competition. We apply the generalised method of moments (GMM) estimator to check endogeneity problems. Analysing the potential U-shaped curved link in a regression model can signal that from a certain point, the increasing market power of individual banks may be threatening for their stability and the stability of the whole banking sector. Finding this point can support regulating the quality of the competitive environment by adjusting competition rules. To assess banks' risk-taking behaviour, we use different proxies to verify and compare different methodologies and their results.

3 Data and research methodology

We use a unique database created from the annual reports of the significant and less significant banks supervised by the European Central Bank as the primary data source. We focus on banks that operate in the countries where they were established. The dataset consists of banks' data in their financial statements or parent company data from consolidated statements, expressed in EUR. During the analysed period, three countries, Estonia in 2011, Latvia in 2014, and Lithuania in 2015, adopted the Euro as their primary currency. If banks published their statements in a different currency, we converted those data into Euro currency, using official European Central Bank exchange rates up to 31.12. of the particular year. Other data sources are the Statistical Data Warehouse database computed by the European Central Bank, Eurostat and World Bank databases proposed to enrich the dataset with more variables.

To eliminate the impact of individual banks' different sizes, most variables are expressed in ratios or the logarithm form. We excluded banks with a negative equity value and banks with the missing value of any costs or revenues from the database. After employing the filtration, we reduce the final sample to a dataset containing 405 banks in the Euro area countries from 2010 to 2019.

In the context of the data examination, we use panel data estimation techniques with choosing the fixed or random effects to analyse the relationship between competition and bank risk-taking. We follow studies that examine the competition-stability relationship (e.g., Berger et al., 2009; Fu et al., 2014; Leroy and Lucotte 2017; Cuestas et al., 2019, Danisman and Demirel, 2019; Wu et al., 2019). To solve the problem with potential endogeneity between variables, we decide to use the GMM method of Arellano and Bond (1991) for all estimations. According to this methodology, we lagged the dependent variable on the right-hand side of the equation. Several authors state (e.g., Mirzaei and Moore, 2014; Noman et al., 2018; Ahi and Laidroo, 2019; Albaity et al., 2019; Ijaz et al., 2020) that GMM manages the reverse causality, which may run from bank risk-taking to market power and other independent variables.

Firstly, bank risk measures are regressed on bank competition expressed by the Lerner index (LERNER), crisis, bank-specific, and macroeconomic variables. The econometric model takes the following form:

$$\begin{aligned} Bank\,risk_{i,t} &= \alpha + \beta_0 Bank\,risk_{i,t-1} + \beta_1 Competition_{i,t} + \beta_2 Crisis_{i,t} \\ &\quad + \sum_{k=5}^{n} \gamma_k X_{i,t} + \sum_{l=3}^{n} \delta_l Y_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{1}$$

The bank and time are represented by the indices year t and bank i, competition measure is indicated by the variable $Competition_{i,t}$; variable $Crisis_{i,t}$ indicates the crisis period; $X_{i,t}$ characterises the bank-specific variables and $Y_{i,t}$ represents the macroeconomic variables and the $Bank\,risk_{i,t-1}$ is lagged depended variable.

The presence of the U-shaped curve is tested by adding a squared term for competition measures, as in the following equation:

$$\begin{aligned} Bank\,risk_{i,t} &= \alpha + \beta_0 Bank\,risk_{i,t-1} + \beta_1 Competition_{i,t} + \beta_2 \left(Competition_{i,t}\right)^2 \\ &\quad + \beta_3 Crisis_{i,t} + \sum_{k=5}^{n} \gamma_k X_{i,t} + \sum_{l=3}^{n} \delta_l Y_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{2}$$

We include crisis variables, five bank-level variables, and three macroeconomic variables concerning control variables. The crisis variable (CRISIS) is calculated from the banking crisis data from the World Bank database and the systemic banking crisis available from the European Central Bank database. The bank-specific variables are the bank size (SIZE), the share of non-interest income on total income (NIITI), the share of fixed assets on total assets (FATA), the share of loans on total assets (LTA) and leverage (LEV). We consider the growth of gross domestic product (GDP) to capture the position of the economy in the business cycle, the harmonised index of consumer prices (HICP) data, and industry capitalisation measured as the ratio of capital to assets (CAP) in the banking sector, as macroeconomic variables in the model. Table 1 summarises the variables used in the analysis, with their descriptive statistics. The sample's descriptive statistics according to years is available in appendix 1. The calculation is done in software R and MS Excel.

To check the robustness of our model, we use five measures of bank risk-taking in our analysis. This way, we can check if the relationship between bank risk-taking and competition is the same under different risk measures. Moreover, it ables to generalise the results of our analysis. The first one is the default risk. To calculate the default risk, the Z-score is used. As a popular measure in the empirical banking literature, the Z-score reflects a bank's probability of entry into bankruptcy. With increasing index values, the bank's stability also increases, so the probability of entry into bankruptcy decreases. Initially published Z-score measure was developed by Hannan and Hanweck (1988) and Boyd and Runkle (1993), and the formula is the following:

$$Z - score_{i,t} = \frac{ROA_{i,t} + \left(E/TA\right)_{i,t}}{\sigma ROA_{i,t}} \tag{3}$$

where $ROA_{i,t}$ is the return on total assets for bank i and year t calculated as profit or loss of bank i and year t divided by its total assets, $(E/TA)_{i,t}$ is the ratio of total equity to total assets for bank i and year t, and $\sigma ROA_{i,t}$ is the standard deviation of $ROA_{i,t}$ variable. All calculated variables correspond to panel data of each year t and bank i. Since the Z-score is highly skewed, we use a natural logarithm transformation. The transformed value is multiplied by (–1) to ensure comparability with other bank risk measures. There is an inverse relationship between transformed indicator value and bank risk measures in all types of risk measures (instead of operational risk). With the higher transformed value, the bank risk measure decreases.

Leverage risk is expressed through leverage (LEV), calculated as the ratio between the bank equity and total assets and its volatility. As the leverage is highly skewed, we use a natural logarithm transformation. The multiplication by (–1) is also used as bank leverage risk decreases with increasing values of the transformed leverage indicator.

We proxy operational risk using the indicator cost to income ratio (CI) and its volatility. According to data availability, the cost to income ratio is calculated between operational costs and total income. The natural logarithm transformation is again conducted. In the case of this risk, the multiplication is not used as with the increasing value of cost to income, operational efficiency decreases, indicating increasing operational risk. Therefore, we can suppose a proportional relationship between the cost to income ratio and operational risk indicator.

Liquidity risk is calculated using the ratio of liquid assets to total assets (LATA) and its volatility. As Bourgain et al. (2012) mentioned higher liquid assets to total assets ratio leads to lower liquidity risk exposures because banks can generate cash for unexpected withdrawals through their liquid assets. The natural logarithm transformation is again conducted. The multiplication by (–1) is also used as liquidity risk decreases with increasing values of the transformed liquid assets to total assets indicator.

The last one, interest rate risk, can be expressed by using the net interest income ratio (NETIITI) and its volatility. According to data availability, the net interest income ratio is calculated as the ratio between net interest income (interest income minus interest costs) and total income. The natural logarithm transformation is again conducted. The multiplication by (–1) is also used as interest rate risk decreases with increasing values of the transformed net interest income ratio indicator.

The competition measure is expressed through the Lerner index (LERNER). Lerner (1934) uses the index to describe a firm's market power. Kabir and Worthington (2017) claim that the Lerner index is generally more suitable and informative than other competition measures because it can be calculated at the individual bank level. We decided to use the Lerner index as an indicator of competition. The Lerner index is a standard measure of competition used in many studies focused on the relationship between stability and competition. For example, in the context of our list of references, the Lerner index appears in Amidu and Wolfe (2013), Jiménez et al. (2013), Fiordelisi and Mare (2014), Kabir and Worthington (2017), Leroy and Lucotte (2017) and Albataity et al. (2019); and more. The Lerner index is an inverse proxy for competition. Its benefit is to measure the market power at the bank level directly and simultaneously during the different periods. The advantage of the Lerner index is that it provides an observation-specific estimation of market power, as opposed to country-level indicators such as conventional concentration ratios (Herfindahl-Hirschman index or Concentration ratio of 5 largest banks on the market) and the Panzar-Rosse H-statistics. Other measures can be used to analyse banks' market power or pricing behaviour in the literature, e.g., the Boone indicator. Compared to the Lerner index, the Boone indicator analyses the competition in terms of profits. The advantage is that we do not need any information on output prices in calculating the Lerner index but only on total revenues.

Table 1 Descriptive statistics of the sample

Name of the variable (Acronym)	*Description*	*Min.*	*1st Qu.*	*Mean*	*3rd Qu.*	*Max.*	*Std. dev.*
			Bank risk measures				
Default risk (DR)	(–1)*ln(Z–score)	–3.3993	–1.1109	–0.6668	–0.2490	5.9360	0.7968
Leverage risk (LER)	(–1)*ln(LEV/ St.dev(LEV))	–3.1901	–1.0537	–0.6252	–0.2064	3.0903	0.7755
Operational risk (OR)	ln(CI/ St.dev(CI))	–5.6646	–0.9816	–0.6560	–0.2180	3.4392	0.8391
Liquidity risk (LIR)	(–1)*ln(LATA/ St.dev(LATA))	–1.5869	–0.7593	–0.2168	0.1275	6.3560	0.8451
Interest rate risk (IRR)	(–1)*ln(NETIITI/ St.dev(NETIITI))	–1.2416	–0.6619	–0.1659	0.0213	7.3262	0.8613
			Competition variables				
Lerner index (LERNER)	Calculated according to formula (4)	–16.671	0.2104	0.2812	0.5025	0.9840	0.6382
			Crisis variable				
Crisis (CRISIS)	Dummy variables are from 0 to 1	0	0	0.1546	0.15	1	0.2989
			Bank-specific variables				
Bank size (SIZE)	ln(Total assets)	6.919	8.788	9.470	10.069	12.272	0.9267
Non-interest income share (NIITI)	Non-interest income/Total income	0	0.1162	0.2910	0.3952	1	0.2396
Fixed assets share (FATA)	Fixed assets/ Total assets	0	0.0008	0.0085	0.0101	0.6061	0.0208
Loans share (LTA)	Total loans/ Total assets	0.0002	0.5543	0.6641	0.8138	1.4332	0.2057
Leverage (LEV)	Total equity/ Total assets	0.0018	0.0506	0.1045	0.1181	1	0.1101
			Macroeconomic variables				
Real gross domestic product (GDP)	The annual growth rate of GDP	–0.1010	0.0080	0.0189	0.0280	0.2520	0.0241
Inflation (HICP)	The annual growth rate of the Harmonised index of consumer prices	–0.0160	0.0040	0.0131	0.0210	0.0510	0.0112
Capitalisation (CAP)	Capital in banking sector/Total assets in banking sector	0	0.0588	0.0703	0.0778	0.1486	0.0246

Source: Prepared by authors

Our estimation of the Lerner index follows the standard methodology where the Lerner index can be calculated as the difference between price and marginal costs being a derivation of the translog production function. The formulation of the Lerner index for bank i and year t is the following:

$$Lerner\,index_{i,t} = \frac{P_{i,t} - MC_{i,t}}{P_{i,t}} \tag{4}$$

where $P_{i,t}$ is the average price of bank production for bank i and year t, and $MC_{i,t}$ denotes marginal costs for bank i and year t. Following studies by Carbó et al. (2009) and Weill (2013), we substitute the price of bank production by the ratio of total revenues (interest and non-interest income) to total assets.

The formula of the Lerner index requires calculating the marginal cost function. We follow the approach provided in line with studies by Tabak et al. (2011) and Abel et al. (2017), who estimate MC_{it} based on production technology with one aggregate output and three inputs proxies described below. Following these studies, we scale total costs (TC_{it}) for bank i and year t and input prices by the price of a borrowed fund represented by w_3 to correct for heteroscedasticity. It is necessary to estimate the translog cost function based on production technology for marginal costs calculation. The cost function is expressed as follows:

$$\begin{aligned}\ln\left(\frac{TC_{i,t}}{w_{3,i,t}}\right) &= \beta_0 + \beta_1 \ln TA_{i,t} + \frac{1}{2}\beta_2 (\ln TA_{i,t})^2 + \beta_3 \ln\left(\frac{w_{1,i,t}}{w_{3,i,t}}\right) + \beta_4 \ln\left(\frac{w_{2,i,t}}{w_{3,i,t}}\right) \\ &+ \beta_5 \ln\left(\frac{w_{1,i,t}}{w_{3,i,t}}\right)\ln\left(\frac{w_{2,i,t}}{w_{3,i,t}}\right) + \frac{1}{2}\beta_6\left[\ln\left(\frac{w_{1,i,t}}{w_{3,i,t}}\right)\right]^2 + \frac{1}{2}\beta_7\left[\ln\left(\frac{w_{2,i,t}}{w_{3,i,t}}\right)\right]^2 \\ &+ \beta_8 \ln TA \ln\left(\frac{w_{1,i,t}}{w_{3,i,t}}\right) + \beta_9 \ln TA \ln\left(\frac{w_{2,i,t}}{w_{3,i,t}}\right) + \varepsilon_{i,t}\end{aligned} \tag{5}$$

In the model, the one aggregated output represents total assets ($TA_{i,t}$) for bank i and year t and three input prices representing the price of labour $w_{1,i,t}$, price of physical capital $w_{2,i,t}$, and price of borrowed funds $w_{3,i,t}$ for bank i and year t. We estimate the translog cost function on the whole sample of commercial banks. We use a panel regression model with fixed effects to control potential differences in technology across economies. We use the estimated coefficients of the translog function in the calculation of marginal cost, and it is specified as follows:

$$MC_{i,t} = \frac{TC_{i,t}}{TA_{i,t}}\left[\beta_1 + \beta_2 \ln TA_{i,t} + \beta_8 \ln\left(\frac{w_{1,i,t}}{w_{3,i,t}}\right) + \beta_9 \ln\left(\frac{w_{2,i,t}}{w_{3,i,t}}\right)\right] \tag{6}$$

As we mentioned above, to analyse the relationship between competition and stability, we use panel data models to estimate the fixed and random effects of banking competition on stability, resulting in the next section.

4 Research results

To examine the effects of market power on bank risk-taking behaviour expressed via different risk measures, we compare linear models without and with testing the presence of the U-shaped curve. We follow a series of steps to choose an appropriate panel model. First, we test models and use pFtest to examine whether using the fixed and random effects model is more relevant than the ordinary least squares (OLS) method. Also, we use pFtest to test the estimated fixed models and testing time and individual effects. For testing the poolability, whether it is appropriate to use the panel data structure analysis or OLS, it is also possible to provide a Chow test. To decide between fixed or random effects, we follow a Hausman test. The results show that using the fixed effects models with individual and time effects is preferred. As a part of the panel data analysis, it is crucial to focus on performing diagnostic tests. We test cross-sectional dependence with the Pesaran CD test for cross-sectional dependence in panels (CD test) to test whether the residuals are correlated across entities. We test serial correlation with Breusch-Godfrey/Wooldridge test (BPG test) and examine heteroskedasticity via Breusch-Pagan test (BP test).

Table 2 presents the empirical results about the relationship between market power (an inverse measure of competition) and bank risk-taking (an inverse measure of stability) estimated according to the formula (1). We used a panel regression model with fixed effects to allow for heterogeneity in a country and a given year. The one-year lagged independent variables are employed in the regression to reduce the possible impact of reverse causality. Columns 1–5 consider the different bank risk measures as dependent variables (default risk, leverage risk, operational risk, liquidity risk, and interest rate risk). All risk variables were transformed as presented in the methodology part. The coefficients of the Lerner index turn out to be significantly negative, which shows that the bank risk-taking, measured by different indicators, decreases with an increase in market power. In other words, an increase in competition (decrease in Lerner index) increases bank risk-taking behaviour. It is consistent with our hypothesis and the theoretical arguments in the competition-fragility paradigm. Therefore, we can argue that the banking sector's stability decreases with higher competition. The increasing competition increases the fragility of the banking sector. These effects are not only statistically but also economically significant. The coefficients' absolute value varies between 0.0391 and 0.3759 with one standard deviation increase in Lerner index (which equals 0.6382 as displayed in Table 1), leading to a decrease in bank risk by 2.5% and 24%, respectively.

The results pointed out that bank risk-taking behaviour is significantly influenced by the development of risk in the previous year. We could see that lag values always had a statistically significant impact on banks' risk-taking behaviour, which was always positive. It means that increased risk in the previous year led to increased bank risk-taking behaviour in the following year.

We can argue that most bank-specific and macroeconomic variables can explain bank risk-taking behaviour. In the case of default risk, leverage risk and interest rate risk, the crisis period seems to increase bank risk significantly. It could be influenced by the fact that the interest rate set up by the European central bank during the last crisis years significantly decreased, which led to a decrease in interest rates connected with loans and deposit products provided by banks. The faster decline can be seen in interest rates associated with loans, which led to a quicker decrease in interest income than interest costs, negatively influencing the net interest income and bank profitability. Also, during the crisis years, the probability of clients' default increased, negatively affecting commercial banks' interest income and profitability, as they were forced to create provisions for non-performing loans.

Table 2 Bank market power and bank risk-taking – linear panel regression with fixed effects

	Bank risk				
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Dependent variable	*Default risk*	*Leverage risk*	*Operational risk*	*Liquidity risk*	*Interest rate risk*
Lag(Risk measure)	0.1709 (0.0169)***	0.2567 (0.0144)***	0.3419 (0.0158)***	0.1599 (0.0135)***	0.4563 (0.0173)***
LERNER	–0.0902 (0.0208)***	–0.0712 (0.0145)***	–0.3759 (0.0183)***	–0.0391 (0.0176)**	–0.2306 (0.0269)***
CRISIS	0.0890 (0.0321)***	0.0635 (0.0224)***	–0.2595 (0.0278)***	–0.0502 (0.0271)*	0.1875 (0.0282)***
SIZE	0.1568 (0.0558)***	0.2996 (0.0393)***	–0.1977 (0.0475)***	0.0496 (0.0466)	0.0143 (0.0489)
NIITI	0.0946 (0.0917)	–0.0209 (0.0640)	0.7094 (0.0800)***	0.1027 (0.0773)	1.2204 (0.0882)***
FATA	–2.3499 (0.4149)***	–1.8626 (0.2898)***	0.4366 (0.3570)	3.5777 (0.5742)***	0.1245 (0.2638)
LTA	–0.0063 (0.0601)	–0.0423 (0.0419)	–0.1236 (0.0517)**	3.1154 (0.0579)***	–0.2444 (0.0540)***
LEV	–5.5679 (0.1653)***	–4.1347 (0.1189)***	0.5549 (0.1405)***	–0.1153 (0.1379)	–0.7232 (0.1446)***
GDP	–0.3312 (0.3455)	0.1616 (0.2411)	1.6147 (0.2972)***	0.0763 (0.2924)	–0.5445 (0.2974)*
HICP	0.7059 (0.4814)	0.2626 (0.4056)	–0.4446 (0.5009)	1.0516 (0.4920)**	1.3750 (0.5013)***
CAP	–1.8454 (0.3805)***	–1.1894 (0.2657)***	–0.4583 (0.3281)	–0.3802 (0.3261)	0.1153 (0.3285)
Individual effects	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	No	No
CD test	Yes	Yes	Yes	Yes	Yes
BPG test	No	Yes	Yes	Yes	No
BP test	No	No	No	No	No
R-Squared	0.5375	0.6552	0.5191	0.7036	0.4157
Adj. R-Squared	0.4440	0.5856	0.4219	0.6434	0.2938
Unbalanced panel	$n = 405$, $T = 1–9$, $N = 2470$				

Robust standard errors appear in parentheses below estimated coefficients. CD test – Pesaran CD test for cross-sectional dependence in panels, BPG test – Breusch-Godfrey/Wooldridge test for serial correlation in panel models, BP test – Studentised Breusch-Pagan test for heteroscedasticity. Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1.

Source: Prepared by authors

The opposite situation can be seen in operational and liquidity risk, where the level of risks decreased during the crisis period. It could be affected by the European Central bank's monetary policy during the last crisis period. The European Central bank started to do operations to supplement the lack of liquidity in the banking market. That is why the commercial banks did not have problems with liquidity risk during the last crisis period. During these years, we can see facts within the European banking sector that the number of employees significantly decreased, reducing commercial banks' personnel costs and reducing operational risk. Therefore, we can say that the operational risk decreased during the last crisis period.

The increase in bank size increases default and leverage risk while decreasing the operational risk. We can suppose that larger banks could manage their operational efficiency better. With increasing size, fixed costs are constant (the same for smaller and bigger banks), while variable costs do not grow as fast as the bank size. On the other hand, total revenues increase with bank size. Therefore, in the case of large banks, the level of their operational risk decreased. In the case of default and leverage risk, we can suppose that smaller banks, to ensure their stability, created a higher value of equity and preferred less risky transactions, which were, however, associated with lower profitability. This cautious behaviour helped them decrease the default and leverage risk compared to larger banks. The positive relationship between the bank size and bank risk measures is in line with Agoraki et al. (2011), Afonso et al. (2015), Noman et al. (2018) and Wu et al. (2019), who pointed to the fact that large banks may have an incentive to take more risk when they believe that the government or monetary authority would bail them out when they are in a crisis mode or even collapse, which leads to the so-called 'too-big-to-fail' proposition. As presented by Wu et al. (2019), at the same time, large banks may be better prepared for shielding themselves from increasing operational risk during challenging times by taking advantage of easy access to a variety of specific risk-hedging tools or more advanced management skills in general, which is in line with our results about the negative relationship between the operational risk and bank size.

The share of non-interest income on total income (NIITI) was significant only in the case of operational risk and interest rate risk. The coefficients are positive in both cases, indicating that the risk measures also increase with increasing non-interest income share. These effects are comparable with Agoraki et al. (2011), Amidu and Wolfe (2013), Beck et al. (2013), Leroy and Lucotte (2017), Clark et al. (2018), and Cuestas et al. (2019). They also pointed out the negative relationship between non-interest income share and bank stability. Also, Baele et al. (2007) argue that a higher proportion of non-interest income on total income positively affects the value of their shares and increases their systematic risk.

The share of fixed assets to total assets was statistically significant in default risk, leverage risk and liquidity risk. While in the case of DR and LER, the negative relationship could be seen, the relationship between FATA and risk was positive in the case of LIR. The negative relationship's findings are in line with the study of Leroy and Lucotte (2017) or Clark et al. (2018).

Increasing loan to assets ratio contributes to a decrease in operational risk and interest rate risk, which is in line with Amidu and Wolfe (2013), Kick and Prieto (2013), and Leroy and Lucotte (2017), who also pointed out the positive relationship between loan to assets ratio and bank stability. We can also see that the increasing LTA increases banks' risk-taking behaviour in the case of liquidity risk. As Bourkhis and Nabi (2013) or Abuzayed et al. (2018) mentioned, the LTA reflects bank activity's core business.

A higher value may lead to greater profits but, at the same time, may increase credit and liquidity risk.

Leverage (LEV), which reflects the core capital strength of banks, had a significant negative impact on the default risk, leverage risk and interest rate risk. As mentioned by Abuzayed et al. (2018), a higher level of equity to assets suggest greater stability, where the risk-taking behaviour of bank decrease. Also, Lepetit et al. (2008) argue that lower capital ratios reflect riskier institutions and the closer the amount of capital gets to the regulatory minimum, there is always a concern that managers may 'gamble for resurrection' by taking on a riskier business in the hope of generating higher profits that can feed through to boost capital.

Regarding macroeconomic variables, while higher GDP growth decreases interest rate risk, higher GDP growth increases operational risk. We can claim that the clients could pay their loans in a period of economic growth. In contrast, in times of decline, the probability of clients' default increased, which negatively influenced the level of interest rate risk. In the case of operational risk during the period of economic decline, we can suppose that banks reduced the number of employees and the amount of property, which reduced personnel and other operational costs of commercial banks, which could positively impact (reduce) the level of operational risk. The macroeconomic variable, inflation, increased liquidity and interest rate risk. Considering the bank regulation variables, the findings indicate that more stringent capital requirements (in the form of higher capitalisation of the banking sector) decrease the various types of bank risk. The decrease could be seen in the case of default risk, leverage risk, operational risk, and liquidity risk. With the proviso, this decrease could be considered statistically significant in the case of default risk. These results are consistent with other studies. They pointed out that banks' risk-taking behaviour decreases under more stringent capital requirements (higher value of capitalisation indicator – CAP). The absolute values of the coefficients 1.8454 and 1.1894 with one standard deviation increase in capitalisation (which equals 0.0246 as displayed in Table 1) lead to a decrease in default risk by 4.54% and leverage risk by 2.93%. It is a finding consistent with the empirical results of Barth et al. (2004), Agoraki et al. (2011) and Danisman and Demirel (2019), among others. As mentioned by these authors, capital stringency emerges as a very useful regulatory instrument in reducing bank risk-taking behaviour as a higher level of capitalisation improves risk management and monitoring.

Table 3 Bank market power and bank risk-taking – linear panel regression model with fixed effects and the inclusion of the quadratic term

	Bank risk				
	Model 6	*Model 7*	*Model 8*	*Model 9*	*Model 10*
Dependent variable	*Default risk*	*Leverage risk*	*Operational risk*	*Liquidity risk*	*Interest rate risk*
Lag(Risk measure)	0.1711 (0.0169)***	0.2578 (0.0144)***	0.3242 (0.01554)***	0.1598 (0.0135)***	0.4278 (0.0170)***
LERNER	–0.1856 (0.0331)***	–0.1443 (0.0231)***	–0.5993 (0.0286)***	–0.0321 (0.02811)	–0.5125 (0.0362)***
LERNER^2	–0.0239 (0.0065)***	–0.0183 (0.0045)***	–0.0550 (0.0055)***	0.0017 (0.0055)	–0.1255 (0.0111)***

Table 3 Bank market power and bank risk-taking – linear panel regression model with fixed effects and the inclusion of the quadratic term (continued)

	Bank risk				
	Model 6	*Model 7*	*Model 8*	*Model 9*	*Model 10*
Dependent variable	*Default risk*	*Leverage risk*	*Operational risk*	*Liquidity risk*	*Interest rate risk*
CRISIS	0.0817 (0.0320)**	0.0576 (0.0224)**	–0.2821 (0.0272)***	–0.0496 (0.0271)*	0.1749 (0.0274)***
SIZE	0.1685 (0.0557)***	0.3079 (0.0391)***	–0.1752 (0.0464)***	0.0487 (0.0466)	0.0385 (0.0474)
NIITI	0.1211 (0.0917)	–0.0007 (0.0640)	0.7854 (0.0785)***	0.1007 (0.0776)	1.3334 (0.0860)***
FATA	–2.4324 (0.4142)***	–1.9247 (0.2891)***	0.2601 (0.3492)	3.5832 (0.5746)***	–0.0819 (0.3531)
LTA	0.0085 (0.0601)	–0.0311 (0.0419)	–0.0906 (0.0507)**	3.1145 (0.0579)***	–0.1828 (0.0527)***
LEV	–5.6126 (0.1653)***	–4.1659 (0.1187)***	0.4756 (0.1374)***	–0.1118 (0.1383)	–0.7283 (0.1402)***
GDP	–0.3552 (0.3444)	0.1432 (0.2402)	1.5561 (0.2903)***	0.0780 (0.2925)	–0.4894 (0.2883)*
HICP	0.6279 (0.5800)	0.2039 (0.4043)	–0.5844 (0.4895)	1.0572 (0.4924)**	1.1177 (0.4864)**
CAP	–1.7882 (0.3797)***	–1.1452 (0.2650)***	–0.3053 (0.3208)	–0.3837 (0.3263)	0.2266 (0.3186)
Individual effects	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	No	No
CD test	Yes	Yes	Yes	Yes	Yes
BPG test	No	Yes	Yes	Yes	No
BP test	No	No	No	No	No
R-Squared	0.5405	0.6579	0.5414	0.7036	0.4513
Adj. R-Squared	0.4474	0.5886	0.4485	0.6432	0.3366
Unbalanced Panel	n = 405, T = 1 – 9, N = 2470				
Turning point	-3.8796	-3.9354	-5.4464	X	-2.0422
% over TP	99.59%	99.62%	99.76%	X	99.04%
% under TP	0.41%	0.38%	0.24%	X	0.96%
Shape	Inverse U-shape	Inverse U-shape	Inverse U-shape	X	Inverse U-shape

Robust standard errors appear in parentheses below estimated coefficients. CD test – Pesaran CD test for cross-sectional dependence in panels, BPG test – Breusch-Godfrey/Wooldridge test for serial correlation in panel models, BP test – Studentised Breusch-Pagan test for heteroscedasticity. Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1.

Source: Prepared by authors

The recent literature reports evidence of a turning point that represents an optimal threshold of competition (Martinez-Miera and Repullo, 2010; Jiménez et al., 2013; Leroy and Lucotte, 2017; Cuestas et al., 2019; Danisman and Demirel, 2019). Therefore, we also tested the relationship between market power and bank risk-taking by including the squared Lerner index in the regression as presented in equation (2). Table 3 shows the results of the linear panel regression model with fixed effects and the inclusion of the quadratic term. It is clear from Table 3 that almost all of the coefficients of the squared terms appear to be statistically significant. Only in the case of Model 9, where the dependent variable was liquidity risk, the linear and also quadratic term of the Lerner index were not statistically significant. In the case of other risks, the quadratic term was statistically significant. Therefore, we could calculate the turning point and set up the shape of the relationship between the Lerner index and bank risk measures. As the Lerner index's linear and quadratic term was negative, we can conclude that the curve's shape is an inverse U-shape. After calculating turning points, we can see that only a maximal 1% of values are under the turning points, and more than 99% of values are above the turning points. It means that most of the Lerner index values are in the part of the curve, where with the increasing value of the Lerner index, the bank risk measures also increase. It also confirmed our findings from the linear regression, which are in line with our hypothesis and the theoretical arguments in the competition-fragility paradigm. We can claim that the banking sectors' stability decreases with higher competition, or the increasing competition increases the fragility of the banking sector.

5 Conclusions

The impact of the risk-taking behaviour of a bank can be passed to other banks or the whole country. Therefore, banking stability in the Euro area countries, which represent an essential part of the world economy, cannot be ignored. The motivation to explore competition-stability and competition-fragility hypotheses came from the broad range of existing studies about the topic and their contradictory findings. This paper examines the relationship between banking market power, as an inverse measure of competition, and stability through risk-taking behaviour of the banks, using bank-level panel data of 405 banks across nineteen Euro area countries from 2010 to 2019, since the last global crisis and before the coronavirus pandemic economic consequences.

As the paper aims to verify the relationship between competition and stability of the banking system and the presence of competing paradigms, we explore the impact of market power on the bank risk-taking behaviour in the case of Euro area banks. We utilise five dimensions of bank risk exposures: default risk, leverage risk, operational risk, liquidity risk, and interest rate risk. As an inverse proxy for competition, we expressed the market power through the Lerner index. Examining this relationship, we established the hypothesis that states an expectation that a decrease in bank market power increases bank risk-taking behaviour (decreases the stability in banking), confirming the traditional competition-fragility view. For the analysis, we established a unique dataset from individual financial statements of banks to compute variables and bring a resultant assessment of these variables.

Examining this relationship, we established the hypothesis that states an expectation that a decrease in bank market power increases bank risk-taking behaviour (decreases the stability in banking), confirming the traditional competition-fragility view.

Overall, the study's main findings in analysed models results show that the relationship between market power and risk measures is negative, indicating that the competition-fragility argument prevails. These results are in line with Agoraki et al. (2011), Beck et al. (2013), Kick and Prieto (2013), Leroy and Lucotte (2017), and Ijaz et al. (2020). They also found a negative relationship between competition and stability. This result may be a signal for policymakers. Some barriers to interlinking banks by establishing new subsidiaries and branches in different countries should be prepared internationally. These barriers can help to maintain the stability of the banking sector. Policymakers, in general, ensure all banks' stability, credibility, and solvency. The competition policy should set up the optimal competition level and ensure that increased competition does not lead to the frag of the European banks. In transition countries, the regulators should accelerate the consolidation process among existing banks through mergers and acquisitions. These findings suggest that the banking system's consolidation could strengthen smaller banks' market power and ensure their stability in the global competitive environment.

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Appendix 1: Descriptive statistics of the sample according to years

Variable	*Descriptive statistics*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*
DR	Mean	–0.58	–0.52	–0.57	–0.70	–0.74	–0.88	–0.95	–0.96	–0.98	–0.94
	Min.	–3.17	–3.28	–3.25	–3.33	–3.16	–3.19	–3.20	–3.19	–3.20	–3.19
	Max.	2.35	5.94	2.48	2.33	3.21	1.71	2.23	1.77	1.73	1.78
	Std. dev.	0.87	0.97	0.76	0.80	0.70	0.66	0.68	0.65	0.61	0.68
LER	Mean	–.050	–0.52	–.053	–0.65	–0.71	–0.83	–0.91	–0.92	–0.93	–0.89
	Min.	–3.14	–3.13	–3.14	–3.19	–3.13	–3.16	–3.16	–3.17	–3.17	–3.17
	Max.	2.25	2.64	3.02	2.89	1.99	2.23	2.14	1.93	1.82	1.93
	Std. dev.	0.87	0.80	0.76	0.76	0.65	0.67	0.65	0.63	0.61	0.67
OR	Mean	–0.89	–0.94	–0.95	–0.81	–0.74	–0.57	–0.52	–0.46	–0.50	–0.46
	Min.	–5.62	–5.58	–4.88	–5.66	–4.75	–3.83	–3.84	–2.82	–2.89	–3.47
	Max.	2.19	1.09	1.91	2.33	2.07	1.81	3.44	2.55	1.92	1.86
	Std. dev.	1.07	0.94	0.91	1.00	0.87	0.73	0.86	0.81	0.77	0.71
LIR	Mean	–0.05	–0.11	–0.17	–0.20	–0.22	–0.34	–0.43	–0.42	–0.47	–0.44
	Min.	–1.59	–1.55	–1.55	–1.50	–1.54	–1.51	–1.57	–1.58	–1.58	–1.56
	Max.	3.02	2.61	2.33	2.83	3.23	2.70	2.70	3.43	3.59	3.51
	Std. dev.	0.91	0.81	0.77	0.79	0.83	0.66	0.63	0.70	0.67	0.70
IRR	Mean	–0.10	–0.06	–0.10	–0.18	–0.20	–0.29	–0.27	–0.27	–0.18	–0.25
	Min.	–1.24	–1.15	–1.24	–1.24	–1.14	–1.20	–1.18	–1.21	–1.20	–1.18
	Max.	3.36	2.86	2.18	2.85	3.35	3.91	5.27	7.33	6.06	3.63
	Std. dev.	0.75	0.73	0.64	0.66	0.74	0.77	0.88	0.90	0.99	0.88
LERNER	Mean	0.22	0.28	0.27	0.26	0.31	0.31	0.17	0.20	0.27	0.30
	Min.	–3.86	–1.05	–2.97	–4.75	–3.57	–6.51	–16.7	–7.73	–5.70	–5.38
	Max.	0.82	0.88	0.85	0.98	0.92	0.93	0.91	0.92	0.93	0.89
	Std. dev.	0.52	0.26	0.33	0.48	0.41	0.58	1.47	0.96	0.67	0.53
CRISIS	Mean	0.47	0.49	0.55	0.22	0.18	0.15	0.04	0.03	0.00	0.00
	Min.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Max.	1.00	1.00	1.00	0.50	0.50	0.50	0.50	0.50	0.00	0.00
	Std. dev.	0.46	0.42	0.42	0.24	0.24	0.23	0.13	0.12	0.00	0.00
SIZE	Mean	9.50	9.48	9.57	9.51	9.42	9.,35	9.37	9.39	9.42	9.43
	Min.	6.9211	7.46	7.46	7.51	7.01	7.35	7.46	7.47	7.54	7.52
	Max.	2.21	12.27	12.24	12.14	11.75	11.60	11.83	11.79	11.78	11.79
	Std. dev.	1.01	0.97	0.96	0.95	0.91	0.88	0.90	0.91	0.90	0.92
NIITI	Mean	0.24	0.22	0.22	0.25	0.27	0.29	0.28	0.30	0.30	0.31
	Min.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Max.	0.94	0.89	0.93	1.00	0.99	0.99	1.00	1.00	1.00	1.00
	Std. dev.	0.21	0.20	0.19	0.21	0.23	0.24	0.24	0.24	0.25	0.24

Variable	*Descriptive statistics*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*
FATA	Mean	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Min.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Max.	0.16	0.14	0.05	0.14	0.47	0.61	0.13	0.33	0.15	0.15
	Std. dev.	0.02	0.01	0.01	0.01	0.03	0.04	0.02	0.03	0.01	0.01
LTA	Mean	0.70	0.70	0.69	0.68	0.67	0.65	0.62	0.62	0.60	0.61
	Min.	0.00	0.03	0.04	0.06	0.04	0.06	0.01	0.01	0.00	0.00
	Max.	1.01	1.02	1.00	1.07	1.05	1.15	1.16	1.09	1.01	1.00
	Std. dev.	0.21	0.20	0.20	0.20	0.20	0.19	0.21	0.21	0.21	0.21
LEV	Mean	0.10	0.09	0.09	0.11	0.11	0.12	0.13	0.13	0.13	0.13
	Min.	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.01
	Max.	0.96	0.94	0.95	1.00	0.94	0.97	0.97	0.98	0.98	0.98
	Std. dev.	0.12	0.10	0.09	0.13	0.10	0.12	0.13	0.13	0.13	0.12
GDP	Mean	0.02	0.02	0.00	0.01	0.02	0.04	0.03	0.04	0.03	0.03
	Min.	–0.06	–0.10	–0.07	–0.07	–0.02	0.00	–0.01	0.01	0.01	0.01
	Max.	0.06	0.07	0.04	0.06	0.09	0.25	0.06	0.09	0.09	0.06
	Std. dev.	0.03	0.03	0.03	0.02	0.02	0.04	0.01	0.02	0.01	0.01
HICP	Mean	0.02	0.03	0.03	0.01	0.00	0.00	0.00	0.02	0.02	0.02
	Min.	–0.02	0.01	0.01	–0.01	–0.01	–0.02	–0.01	0.00	0.01	0.00
	Max.	0.05	0.05	0.04	0.03	0.02	0.01	0.02	0.04	0.03	0.03
	Std. dev.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CAP	Mean	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.07
	Min.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00
	Max.	0.10	0.11	0.12	0.13	0.13	0.14	0.50	0.14	0.15	0.12
	Std. dev.	0.02	0.03	0.03	0.03	0.03	0.03	0.13	0.03	0.02	0.03

Source: Prepared by authors