EUROPEAN CENTRAL BANK
EUROSYSTEM

Working Paper Series

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A new measure of firm-level competition: an application to euro area banks

No 2925

Abstract

This paper extends Boone (2008) by introducing a competition measure at the individual firm level rather than for an entire market segment. It is based on the elasticity between profits and efficiency and called marginal relative profitability (MRP). Its intuition is that when a small change in efficiency derived from marginal costs can cause a large change in profits, a firm exercises pressure on its peers and gains profits. The MRP is embedded in the theoretical framework of Boone and measures competition vis-à-vis other market participants. We apply this extended Boone indicator to individual bank-level competition in the loan market in the four largest euro area countries and Austria. The MRP distribution is skewed to the left and many banks have a MRP below one, indicating that those banks have little incentive to enhance their efficiency to increase their profits. The MRP approach is shown to be a powerful tool to test the efficient-structure, structure-conduct performance, and 'quiet life' hypotheses and to detect comparatively weak non-competitive banks. Our new measure of firm-level competition enriches and complements other competition measures and provides a promising starting point for future market power analyses.

JEL codes: D4, L16, G21

Keywords: Competition, Firm level, Banks

Non-technical summary

Competition is a complex notion and not directly observable. Many methods to measure the degree of competition exist, with variation in complexity, reliability, and theoretical underpinning. The only measure among non-structural measures that is based on the concept of competition as a process of rivalry is the Boone (2008) indicator. We introduce a new performance measure of competition by extending the Boone indicator to the individual firm level. The original Boone indicator provides a single estimate of the extent of competition for an entire market segment, called Relative Profit Difference (RPD) indicator and is based on a robust theoretical model. Our new measure of competition at the individual firm level is called Marginal Relative Profitability (MRP) and allows to focus on the distribution of competition among firms. It measures competition vis-à-vis relevant peers. It is derived from normalized profits and normalized efficiency and the individual elasticity between these two variables. There can be concave or convex patterns in the relationship between profits and efficiency, leading to different conclusions about competition.

Our study not only relates to a vast amount of literature on the measurement of competition, but also to empirical studies that analyse or utilise bank competition. We present three applications of MRP to commercial, cooperative, and savings banks in the loan markets across Austria, Germany, Spain, France, and Italy from 2013-2020. The first application shows that individual bank-level MRP distribution is skewed to the left, indicating that many banks have little incentive to increase their profits by operating more efficiently. This is not only an important finding for the authorities dealing with market power, but also for bank analysts. The dispersion in individual bank-level MRP is found to be comparatively wide in Spain and narrow for savings banks. Our new MRP metric correlates significantly consistently with the Lerner index for all banks in all countries, but not significantly with other competition measures. i.e., net interest income-asset ratio and market share. Regressing one bank-level competition measure on a constant and the three other competition measures considered also confirm a common finding in the literature of a lack of consistency among competition measures. The latter illustrates the multifaceted nature of measuring competition. Consequently, the complementary value added of our new MRP metric is potentially large, as it is based on a competitive dimension of rivalry different from other measures. The second application uses MRP to test the relationships among profitability, competition, and efficiency by testing the efficient-structure (ESH),

structure-conduct-performance (SCPH) and 'quiet life' hypotheses (QLH). Regression estimates are supportive for the QLH in Austria and Germany. Those 'quiet life' banks exploit their efficiency advantage, e.g., due to their economies of scale, to have an easy life. They are insulated from the disciplinary competitive power of their peers, making them inactive in taking profit-enhancing efficiency measures. This finding in favour of the QLH helps in the design of antitrust or regulatory policies. The QLH implies that policies should be aimed at a combination of measures focused on the improvement of efficiency and competition. For the other countries, the estimates are on average in favour of the ESH. The same market structures are found by bank specialisation, with as main exception support for the SCPH for Spanish commercial and saving banks. For the median of highly competitive banks, classified as banks with a MRP larger than two, not only the ESH holds but also a consistent positive relationship between profits and competition. This finding suggests a 'busy life', a special case of the ESH and the opposite of a QLH. It is a situation of a high level of competitive rivalry that is profitable, as it encourages innovation and efficiency gains. The third and final application of our MRP approach shows that it helps in identifying weak non-competitive banks with low efficiency, low profits as well as low MRP. This application illustrates the usefulness of MRP as a selection tool for policymakers and analysts.

The new measure of firm-level competition proposed in this study has potential wide use for antitrust authorities, financial supervisors, central banks, analysts, and researchers to gain better insights into the degree of competition at the individual firm level. MRP provides a promising starting point for future market power analysis and research studies, especially in identifying firms with specific characteristics, such as comparatively weak non-competitive firms or "best-in-class" firms.

1. Introduction

The ability to reliably measure competition is valuable to researchers, analysts, and policymakers, especially antitrust authorities, financial supervisors, and central banks. The fact that competition is a complex notion and not directly observable has resulted in numerous methods to measure the degree of competition in markets over the years (Vickers, 1995; Northcott, 2004; Perekhozhuk et al., 2017; Syverson, 2019; OECD, 2021). Such methods vary in complexity, reliability, and theoretical underpinning. One broad category of indicators often used to measure competition are structural competition measures, such as static concentration measures, and dynamic measures, e.g., entry and exit rates. Another group to capture the intensity of competition are non-structural or performance measures of competition. They are based on firm behaviour and were established by the New Empirical Industrial Organisation literature. These measures aim to directly assess the competitive conduct of firms. The most applied performance measures are price mark-ups (Lerner index, Elzinga and Mills, 2011; Giocoli, 2012), correlations of output prices with input costs (H-statistic, Panzar and Rosse, 1982, 1987), and the Boone (2008) indicator. Out of these measures, the only measure based on the concept of competition as a process of rivalry is the Boone indicator. The other measures are based on the static concept of competition although their focus is on performance rather than structure. The Boone indicator proved to be a welcomed addition to the literature, also due to its theoretical underpinning. It is, however, a market-level measure of competition. Our analysis goes one step further by focusing on a firm-level measure of competition. It performs the analysis at the firm level and controls for firm-level characteristics.

This study introduces a new performance measure of competition by extending the Boone indicator to the individual firm level. The original Boone indicator, known as the Relative Profit Difference (RPD), provides a single estimate of the extent of competition for an entire market segment based on a robust theoretical underpinning. Our extension to a firm-level measure of competition is within the theoretical framework of Boone and we refer to it is as the Marginal Relative Profitability (MRP). It is the elasticity between normalized profits and normalized efficiency of an individual firm. It thus measures the increase in profits in percent of one percentage point increase in efficiency, with marginal costs as measure of efficiency. The practical usefulness of this new individual competition measure is illustrated for banks by an application to the loan market in the four largest euro area countries and Austria.

Our study contributes to two strands of the literature. First, our work relates to a vast amount of literature on the measurement of competition. We extend the theoretical underpinning of the measurement of competition for the entire market of Boone (2008) by a new measure of individual firm-level competition. A concern of the literature is the gap between the practical application and the theoretical framework of Boone (2008). We strengthen the link between empirics and theory. We distinguish between firms' market power at the individual level, which is based on the first derivative of the relationship between relative profits and relative efficiency, and the level of competition in the market, which is the integral of this relationship. We introduce within the same theoretical framework a new measure of competition on firm level, the MRP. It measures the relative competitiveness of firms compared to their peers by analysing the elasticity between profits and efficiency. The idea is that if this elasticity is high, the firm possess greater capacity to stir its own profits relative to its peers by changing its own efficiency and is therefore competitive. Second, our empirical application relates to an extensive literature that analyses the relationship between bank competition and financial stability, economic growth, crises, interest rate pass-through, credit constraints, and zombie lending (Bikker and Van Leuvensteijn, 2008, Van Leuvensteijn et al., 2011; Beck et al., 2013; Diallo, 2015; Huljak, 2015; Leon, 2015; Zigraiova and Havranek, 2015; Bikker and Spierdijk, 2017; Ijaz et al., 2020; Khan, 2022; Zhang and Huang, 2022; Altunbas et al., 2023). For a better understanding of these issues, it is important to measure competition not only for the entire market (for the use of the Boone indicator see, among others, Duygun et al., 2015; Glass et al., 2020) but also at the individual bank level. Altunbas et al. (2022) show that in the complex relationship between competition and systemic bank risk a distinction should be made between individual-bank market power and competition of its peers on the market level. The empirical results show that a competitive bank has less incentives to contribute to systemic risk, while at the same time in a competitive environment pressure from peer banks increases systemic risk. No consensus exists in the banking competition literature about how to appropriately measure competition (see, among many other studies, Northcott, 2004; Carbo et al., 2009; Bolt and Humphrey, 2010; Bikker et al., 2012; Gischer et al., 2015; Spierdijk and Zaouras, 2016; Xu et al., 2016; Bikker and Spierdijk, 2017; Dubovik and Kalara, 2018: Ahi and Laidroo, 2019). It is thus no surprise that the development of proper bank competition tests and methodologies remains an important area of research (Claessens and Laeven, 2004; Claessens, 2009).

Our new competition measure is appealing for policymakers. Antitrust authorities routinely employ market shares and profit margins for a first assessment of mergers and

acquisitions, a cornerstone of their operational activities. While these measures provide an initial glimpse into market power, they tell little about the competitiveness of the firms under scrutiny or their broader impact on the competitiveness of the market. Our new measure significantly augments the antitrust evaluative framework by shedding light on whether a merger results in a less competitive market. Our novel indicator focuses on firms' incentives to enhance their relative efficiency, as manifested in the elasticity between relative profits and efficiency. Consequently, the latter captures the potential repercussions of a takeover wherein a firm with little incentive to improve its efficiency get control of a more efficiency-driven peer, ultimately hindering efficiency gains and constraining competitive pressure. Another antitrust contribution relates to foreclosure of firms. Whether a foreclosure of a firm is welfare enhancing depends on the efficiency of the foreclosed firm. However, an inefficient firm that is foreclosed could be more competitive than the larger efficient firm that relies on its scale economies. The new MRP metric offers insights to the ability to influence the profitability of the firm with its efficiency and therefore provides new crucial information. Financial supervisors analyse the profitability and business models of banks as a key factor for financial stability. Unprofitable banks pose inherent risks to financial stability. Moreover, competitive banks are associated with reduced systemic risk (Altunbas et al, 2022). The elasticity between profits and efficiency emerges as a superior gauge of banks' adaptability to maintain profitability during adverse conditions, surpassing the conventional assessment based on the level of market shares and profit margins. Our new metric of competition unveils banks' ability to influence their profitability in the short term by cutting costs relative to their peers. For central bankers, which are concerned about the transmission of monetary policy, bank competitiveness is relevant for the interest rate pass-through (Van Leuvensteijn et al., 2013). The new MRP indicator provides the ability to assess the impact of individual banks' competitiveness on their interest rate-setting behaviour in loan markets. When in the loan market, a bank's elasticity between relative profits and efficiency increases, it indicates that this bank will pass on faster changes in the ECB policy rates. Consequently, this enhances the efficacy of monetary policy transmission. Incorporating this information promises a more refined understanding of the impact and timing of monetary policy rates changes on the real economy.

The paper proceeds as follows. Section 2 takes a closer look at various competition measures to put the new MRP metric into context. Section 3 introduces within the Boone (2008) theoretical framework our new measure of individual firm-level competition, including the interpretation of the MRP. Section 4 provides an application of our new

individual firm-level competition measure to the loan market. It describes the individual bank data set for the four largest euro area countries and Austria, takes a closer look at the key inputs of the MRP and reports MRP results along three applications. Section 5 concludes.

2. Competition measures

The literature on measuring competition is divided in two strands. The first strand of literature focuses on structural indicators of competition related to characteristics of the market, such as market shares, entry and exit rates, profits, and mark-ups. The Structure-Conduct-Performance paradigm (SCP) provides a traditional framework in the field of industrial organization for analysing competition behaviour in markets. The idea is that the structure of the market determines the conduct of its participants as shown in investment and price decisions, innovation and marketing strategies. Conduct, in turn, affects the performance of firms in terms of efficiency and profitability. Concentrated markets ease the possibilities to collude implicitly or explicitly and therefore concentrated markets result in higher prices and profits. However, an alternative explanation for higher profits in concentrated markets could be higher efficiency due to scale economies in production. For banking evidence, see, among many others, Smirlock (1985), Evanoff and Fortier (1988), and Berger (1995). The main disadvantage of these classical measures is that they may incorrectly signal competition changes. For example, a tougher competition setup may lead to a reallocation of market shares, potentially forcing some firms to exit the market. In this case these structural measures may increase, suggesting that competition has weakened when, in fact, the opposite occurred.

An alternative view to the SCP paradigm is the second strand of literature on strategic contestable and collusion behaviour. This approach gives firms' strategic behaviour central stage and focuses on the strategic interaction on prices and quantities, known as conjectural variation. This new empirical industrial organization literature provides non-structural measures like the divergence between price and marginal revenue or the Bresnahan measure (Bresnahan, 1982; Lau, 1982) and the mark-up of price over marginal cost or Lerner index (Genesove and Mullin, 1998; Shaffer and Spierdijk, 2020). Both measures are based on a static model under equilibrium conditions. Another measure from this strand of literature is the H-statistic developed by Panzar and Rosse (1987). It focuses on the transmission of costs to prices. The more changes in costs result in price changes, the more competitive the market is because firms have little pricing power and are seen as

price takers. In the Lerner index, it is the mark-up of price over marginal cost. The higher the mark-up, the greater the market power. The effect of competition on the Lerner index can be contrarily to intuition. In general, more competition may reduce the Lerner index as it reduces the price-cost margin. But some more efficient banks may have a higher price cost margin, skimming of part of the profits due to their lead in efficiency. Corts (1999) criticized the demand elasticity adjusted Lerner index, because efficient collusion could not be distinguished from Cournot competition.

The only competition measure from this performance literature where competition is the outcome from a process of rivalry is the Boone indicator. It is related to the efficiency hypothesis given its focus on the relationship between efficiency and profitability. The distribution of profits among efficient firms is central, without addressing the strength of the relationship. It answers the question to what extent efficiency contributes to profitability and looks at the property of the market to distribute production to the most efficient firms. A continuous and monotonically increasing relationship exists between RPD and the level of competition if firms are ranked by decreasing efficiency. The fact that this relationship is both continuous and monotonic is a main advantage of RPD over other competition measures, such as the H-statistics and Lerner index. In contrast to the Panzar-Rosse model that measures competition for the whole banking sector, the Boone indicator can be calculated for different product markets on which banks operate (Van Leuvensteijn et al. 2011). Another advantage of the RPD is that it is not dependent on assumptions about the type of competitive model and there is no strict need that the market is in equilibrium. The Boone indicator does not require that the universe of firms is observed, i.e., the estimated profit elasticity among a subset of firms conveys information for the market. Boone et al. (2013) compare the Boone indicator with the price-cost margin and conclude that the profit elasticity is a more reliable measure of competition. The price-cost margin tends to misrepresent the development of competition over time in markets with few firms and high concentration, i.e., in markets with high policy relevance. So, just when it is needed the most the price-cost margin fails whereas the profit elasticity does not.

Our proposed metric of firm-level competition introduces valuable insights by focusing on the efficiency or inefficiency incentives derived from the elasticity between profits and efficiency, the MRP. While conventional indicators, such as mark-ups and the Lerner index may suggest a high profit margin indicative of market power, they could equally denote an efficient firm skilfully extracting profits. A unequivocally signal of fiercely competition emerges from a high elasticity between efficiency and profits. This condition,

may, in turn, result in a high profit margin. Similarly, a high market share, often associated with market power, could alternatively indicate a highly competitive firm that has legitimately attained a high market share and thereby reaping high profits. The high elasticity of profits to efficiency unequivocally indicates that the high market shares and therefore high profits are due to high efficiency. The H-statistic looks at the passing-on behaviour of firms. A firm that quickly passes changes to the input prices is seen as a price taker with little market power. However, a quick passthrough of changes in input prices may also be indicative of substantial market power, enabling a firm to immediately passthrough such changes and protect its profit margin. It is therefore not surprising that Shaffer and Spierdijk (2015) main finding is that neither the sign nor the magnitude of the H-statistics can reliably identify the degree of market power. Bikker et al. (2012) show that Panzar-Rosse test yields an invalid measure of competitive conduct. To infer the degree of competition additional information about costs and market equilibrium is required. Shaffer and Spierdijk (2020) show that the single output or aggregate Lerner index may not be consistently aggregated and therefore lead to incorrect conclusions. The conditions to be met for the aggregate Lerner index are typically too restrictive.

In sum, each measure of competition contributes to a multifaceted understanding of competition, but their limitations underscore the need for a comprehensive analysis combining multiple indicators for a nuanced understanding of competition in the specific context. Indicators of competition tend to measure different phenomenon and may provide conflicting messages, as reported for European banking by Carbo et al. (2009). Our new MRP metric complements and enriches the existing measures and helps for a more accurate assessment of competition, especially at the firm level.

3. Theoretical model

3.1. Boone model

The Boone indicator, also referred to as the profit elasticity or Relative Profit Differences (RPD), is based on two notions. First, more efficient firms, i.e., firms with lower marginal costs, gain higher market shares or profits. Second, this effect is stronger in more competitive markets (Van Leuvensteijn et al., 2011). The RPD is the empirical operationalisation of this model. Boone (2008) shows that there is a continuous and monotonically increasing relationship between RPD and the level of competition if firms are ranked by decreasing efficiency. In other words, there is a negative relationship between efficiency, measured in terms of marginal costs, and profits; the more intense this

negative relationship is, the more competitive markets will be. Consequently in practice, the Boone indicator will have a negative sign when the relationship between marginal costs and profits is estimated, and it will be more negative the higher the level of competition is. The fact that this relationship is both continuous and monotonic is the main advantage of RPD over more traditional measures of competition such as the H-statistics and Lerner index. Another advantage is that the Boone indicator is not dependent on assumptions about the type of competitive model, such as whether this is Bertrand or Cournot competition.

Following Boone (2008) and Xu et al. (2016), we consider an industry where each firm *i* produces one product q_i (or portfolio of products), which faces a demand curve of the form:

$$p(q_i, q_{j\neq i}) = a - bq_i - d\sum_{j\neq i} q_j \quad (1)$$

and has constant marginal costs mc_i. This firm maximizes profits $\pi_i = (p_i - mc_i)q_i$ by choosing the optimal output level q_i. We assume that $a > mc_i$ and $0 < d \leq b$. The first-order equilibrium condition for a Cournot-Nash equilibrium can then be written as:

$$a - 2bq_i - d\sum_{j\neq i} q_j - mc_i = 0 \quad (2)$$

When *N* firm produce positive output levels, we can solve the *N* first-order conditions, yielding:

$$q_i(\eta_i) = \frac{(2b/d-1)a-(2b/d+N-1)\eta_i+\sum_j \eta_j}{(2b+d(N-1))(2b/d-1)} \quad (3)$$

We define profits π_i as variable profits excluding entry costs ε. Hence, a firm enters the industry if, and only if, $\pi_i \geq \varepsilon$ in equilibrium. Note that Eq. (3) provides a relationship between output and marginal costs. From $\pi_i(mc_i) = (p_i - mc_i)q_i$, it follows that profits depend on efficiency in a quadratic way, i.e.

$$\pi_i(\eta_i) = \frac{(2b/d-1)a-(2b/d+N-1)\eta_i+\sum_j \eta_j}{[(2b+d(N-1))(2b/d-1)]}(p_i - \eta_i) \quad (4)$$

The theoretical concept RPD is then defined as $RPD = \frac{\pi(\eta^{**})-\pi(\eta)}{\pi(\eta^{*})-\pi(\eta)}$ for any three firms with $\eta^{**} > \eta^{*} > \eta$. In this market, competition can increase in two ways. First, competition increases when the produced services of the various firms become closer substitutes, that is, *d* increases (keeping *d* below *b*). In other words, competition will increase when products become closer substitutes due to diminishing relevance for

geographical boundaries for instance due to technologies like the internet. Second, competition increases when entry costs ε decline. Boone (2008) proves that RPD is an increasing function of interaction among existing firms ($\frac{dRPD}{dd} > 0$) and a decreasing function of entry costs ($\frac{dRPD}{d\varepsilon} < 0$). In other words, RPD increases when competition intensifies, i.e., fiercer competition increases (decreases) profits of more efficient firms by larger (smaller) amounts than those of less efficient firms.

Boone (2008) demonstrates how RPD can measure the level and the evolution of competition in practice. Firms are first ranked by their efficiency level. Subsequently, RPD of firm *i* are normalised by calculating its RPD against the profits of the most and the least efficient firms. This procedure yields a normalised RPD curve as a function of normalised relative efficiency differences. The level of competition is then represented by the area under the normalised RPD curve, the integral of this function. Since changes in competition move all points on the RPD curve monotonically, shifts in this function changes the surface beneath the function (the integral) and measures the evolution in competition in the market in terms of efficient product allocation (Fig. 1).

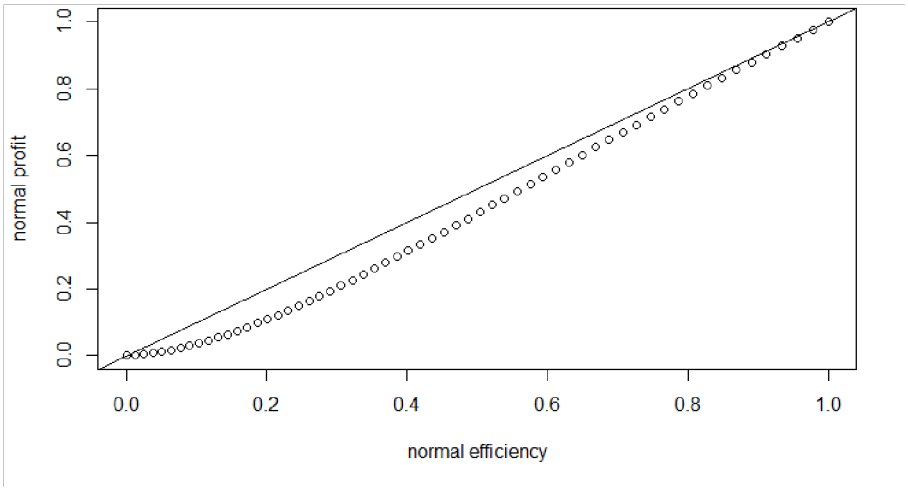

Fig. 1. The relationship between normalized profits and normalized efficiency. Note that N = 60 firms with $c_i = e^{i/100}$ and b=2, d=2. The source is authors' depiction of Boone model.

3.2. Marginal relative profitability

The theoretical underpinning of our new individual firm-level competition measure is that the market power of a specific firm can be measured by taking the first derivative of the function as plotted in Fig. 1. The idea is that the more its profitability depends on its marginal costs, the more the firm can stir its profitability relative to other firms, and the more competitive this firm is towards its peers. The first derivative between normalised profits and normalised efficiency varies for each firm. Boone (2008) shows that the

function can be concave, implying a low competitive market, but the function could also be convex. In the above example based on the model of Boone (2008) the function is convex due to four factors in the model of Boone (2008): Bertrand or Cournot competition (λ), the closeness of substitution between products (difference between *b* and *d*), and whether marginal costs are increasing or decreasing in scale (θ).

The RPD as proposed by Boone (2008) measures the general competitiveness of the market over time. In equilibrium, the relationship between relative profits and relative efficiency should be continuously rising and range between 0 and 1. For the estimation, profits are normalised so that normalised profit (NP) is $(\pi^* - \pi \ / \pi^{**} - \pi)$ and normalised efficiency (NE) is $(\eta^* - \eta \ / \eta^{**} - \eta)$. The difference between NP and RPD is that the maximum and minimum profits are not related to respectively the most efficient firm and least efficient firm, which is the case of RPD. Furthermore, NP is transformed in ln(profits) to scale the variable. The function between NP and NE is continuously rising under the condition that $\beta_1 \geq 1$ is as follows:

$$NP = NE^{\beta_1} e^{(1-NE)} \quad (5)$$

The integral of equation (5) measures overall competition by measuring the degree in which profits are allocated to the most efficient firms:

$$\int_0^1 NP = \int_0^1 NE^{\beta_1} e^{(1-NE)} dNE \quad (6)$$

To measure the individual market power of a firm in one market over time, we look at the first derivative of Eq. (5), because this reflects the ability of the firm to increase its profits relative to other firms by slight changes in its efficiency. The first derivative is MRP:

$$\text{MRP} = \frac{dNP}{dNE} = e^{(1-NE)}(\beta_1 NE^{\beta_1 - 1} - NE^{\beta_1}) \quad \text{NE/NP} \quad (7)$$

MRP is the elasticity between NP and NE of a particular firm. It measures the increase in NP in percentage of one percentage point increase in NE. Firms can influence the level of marginal costs and thus the level of efficiency, by for example digitalisation of processes and making existing processes more efficient and by innovation with the introduction of new products. A high elasticity between NP and NE indicates the ability of a firm to stir its profits relative to its peers by making processes more efficient in comparison to its peers. This elasticity could be high for example due to the successful branding of a firm or product. In other words, other parameters of competition find their expression in this

elasticity. Firm's ability to stir its own profits relative to profits of its peers indicates the level of competitiveness of a firm relative to its peers. The higher MRP, the more elastic this relationship, the more the firm can relatively stir its own profits, the more competitive it is.

The relationship between NP and NE can be both concave and convex. In a market with a concave function the allocation of profits to the most efficient firms is limited, a major part of the profits goes to the less efficient firms. This indicates that competition among firms in this market is low. In this market, the most efficient firms have the highest profits and at the same time the lowest MRP. The marginal costs could be low and efficiency high due to for example large scale economies. These firms have little incentive to become more efficient, because becoming more efficient would not change their profits. On the contrary, other firms exist that are relatively inefficient, have the lowest profits but have the highest MRP, and therefore incentives to become more efficient. These inefficient firms are the real competitors in the markets. Examples of such firms are new entrants to the market and price fighters. They can stir profits away from other competitors, mainly other inefficient firms. They still will have great difficulty to compete with the most profitable and efficient firms, because the gain of becoming more efficient diminishes with increasing relative efficiency as indicated by the concave function. This type of market will be in equilibrium, in the sense that most firms will have some profits and only a few have (temporary) losses, because inefficient firms can easily gain profits by becoming a little bit more efficient.

In a market with a convex function the distribution of profits is skewed to the most efficient firms, which is in general a sign of a highly competitive market. In this market, highly efficient firms have the highest profits and have a high MRP. They have high incentives to stay efficient and become even more competitive by becoming more efficient. These firms are very competitive as they can stir profits away from their peers by becoming slightly more efficient. This urge to stay competitive will remain with these firms, because gaining in efficiency pays out in even more profits as the MRP is above one. In this market, the most inefficient firms have the lowest profits, and the lowest MRP, which provide them little incentive to improve their relative efficiency, because the effect of an increase in relative efficiency on relative profits is limited. This could result in low profitable firms, with low efficiency, and low MRP and incentives and opportunities to become profitable again. Finally, there are firms in the middle: middle of the road efficiency and profitability and MRP. Whether these firms are competitive and can stir the profits away from their competitors depends on the nature of their efficiency (scale economies) and whether they operate in local and niche markets.

From the discussion above follows that no prior definition of the market is needed to apply the MRP approach. A market that consists out of a great number of local markets or niche markets will identify firms with low levels efficiency and high levels of profits operating with a low MRP, which indicates low competitiveness among those firms. The MRP measure does not require that the universe of firms is observed, i.e., the estimated profit-efficiency relationship among a subset of firms conveys information about the degree of competition.

4. Empirical application

Besides testing the level of relative efficiency that is needed for a viable business in the market or the overall level of competition on the market level based on Eq. (6),[1] the new measure as presented in Eq. (7) allows testing on the individual firm level. The MRP approach is demonstrated along three applications.

Application 1: Estimate the competition of firms by using the MRP. A high level of MRP means a high level of competition.

Application 2: Test the 'quiet life' and related market structure hypotheses using the MRP as competition or market structure measure.

Application 3: Identify weak non-competitive firms, defined as a combination of low efficiency, low profits and low MRP and test the market structure hypotheses for those weak non-competitive firms.

4.1. Data

Our application to individual bank-level competition in the euro area loan market uses balance sheet and income statement data from the Moody's Analytics BankFocus for the calendar years 2013-2020. The empirical analysis focuses on five countries: Austria (AT), Germany (DE), Spain (ES), France (FR) and Italy (IT). The last four rank among the most important, in terms of national GDP economies in the EMU. As such, most publications on competition in the euro area includes the largest four member states. Austria is included in this sample, because it has many banks, allowing enough observations for the model

[1] Results for competition at the market level for the countries considered are available upon request. Despite the restriction of market equilibrium is not strictly needed, we formally tested it using the Panzar-Rosse test statistics of equilibrium. Their outcomes show that market equilibrium can't be rejected at the 1% significance level in all countries apart from France. The outlier position for France can be explained by peculiarities of the French market. In contrast to the other countries, most housing loans are not backed up by collateral but by a guaranteed scheme and on the loan funding side about half of the savings products are regulated (see Box 4 and paragraph 60 in IMF, 2019).

estimates. For all other EMU countries, the number of banks, and hence observations, is too little. Our methodology requires the estimation of a series of separate country level regression analysis. Like other papers on competition, we split the sample into three bank types: commercial, savings, and cooperative banks. The applied split depends on data availability and is a mixture of ownership structures and business models. A split into business model type only is to be preferred, but due to data constraints not possible. Banks are classified as commercial if they are mainly active in retail, wholesale, and private banking (i.e., universal banks). Savings and cooperative banks are mainly active in retail banking, with the latter having a cooperative ownership structure. To exclude irrelevant and unreliable observations, banks are incorporated in our sample only if they fulfil the following conditions: a) unconsolidated data available, b) implicit loan rate should not exceed 20%, c) marginal costs should not be negative and d) equity should be positive. Due to these restrictions the database was reduced to an unbalanced panel of up to 1862 banks (depending on the year) from five euro area countries.

Table 1 presents the number of banks by specialisation and country in 2020. It shows that most banks are cooperative and savings banks. About four out of the five savings banks are from Germany and about half of all cooperative banks are German. Commercial banks are more equally divided across countries, although the number of banks from Italy and France are about twice the number of banks from the other three countries. Looking across countries, more than half of all banks in our sample are from Germany. Germany has a large system of cooperative and savings banks (*Sparkassen*). Other countries with a relatively large presence in the sample are Italy and Austria with many cooperative banks. In both countries cooperative banks account for about 80% of all banks.

Table 1 Number of banks in 2020.

	Commercial	Savings	Cooperative	Total
AT	25	38	304	367
DE	23	355	661	1,039
ES	19	5	34	58
FR	53	6	55	114
IT	45	10	229	284
Total	**165**	**414**	**1,283**	**1,862**

Table 1 presents the number of banks in 2020 by country and bank specialisation. The source is authors' calculations based on BankFocus data.

Table 2 reports key model variables of banks by country. The loan market share is comparatively high in Spain and low in Germany. Regarding balance sheet structure, Spanish banks on average have a lower share of loans in total assets. The share of securities

in total assets is comparatively low in France and Austria and high in Germany and Italy. Regarding input prices, French banks have the highest average cost, which is mostly due to higher interest costs (price of funds). Banks in Austria faced comparatively expensive other expenses to fixed assets.

Table 2 Mean values of key model variables.

Country	Loans market share	Loans to assets ratio	Securities to assets	Average cost	Other expenses to fixed assets	Personnel costs to total assets	Interest expenses to total
AT	0.3%	61.1%	11.4%	2.4%	8.8%	0.8%	0.4%
DE	0.1%	61.3%	26.7%	2.7%	5.9%	0.9%	0.6%
ES	1.7%	55.3%	19.2%	2.4%	5.8%	1.1%	0.5%
FR	0.9%	69.0%	10.3%	3.2%	7.8%	0.9%	1.2%
IT	0.4%	65.1%	24.7%	2.9%	7.4%	1.1%	0.7%
Average	**0.7%**	**62.4%**	**18.5%**	**2.7%**	**7.1%**	**1.0%**	**0.7%**

Table 2 reports the average of the key model variables over the years 2013 to 2020. The source is authors' calculations based on BankFocus data.

4.2. MRP key inputs

A pivotal input for our new indicator, MRP, is marginal costs: costs associated with producing one additional unit, in our case loan. To calculate marginal costs, we estimate for each country a trans-log cost function (TCF) using individual bank observations following the same methodology as in Bikker and Van Leuvensteijn (2008) and Van Leuvensteijn et al. (2011), see Appendix. The TCF assumes that the technology of an individual bank can be described by one multiproduct production function. Under proper conditions, a dual cost function can be derived from such a production function, using output levels and factor prices as arguments. A TCF is a second-order Taylor expansion around the mean of a generic dual cost function with all variables appearing as logarithms. To acquire two standard properties of cost functions, linear homogeneity in the input prices and cost-exhaustion restrictions are imposed (Jorgenson, 1986; Beattie and Taylor, 2009). Furthermore, in line with Berger and Mester (1997), the equity ratio corrects for differences in loan portfolio risk across banks. The TCF is estimated by country, using three inputs: labour, funding, and other costs, and three outputs: loans, securities, and other services (non-interest income). The prices of inputs are defined as: personnel expenditure to number of employees, implicit rate on all liabilities and other overhead costs to fixed assets. Profits are calculated as the product of loan margin (difference between implicit interest rate and marginal cost on loans) and total gross loans.

Table 3 presents the marginal costs derived from the first derivative of the estimated TCF by country. The marginal costs differ between countries and bank specialisation;

however, with time, these differences have decreased. Across countries, German banks have on average high marginal costs compared with the other countries, suggesting lower efficiency. At the other end of the spectrum is Austria with comparatively low marginal costs. Turning to bank specialisation, marginal costs are often comparatively low for commercial banks and high for cooperative banks. Marginal costs of savings banks are compared to those of commercial and cooperative banks low in Austria and high in Germany. These differences mostly relate to scale economies as high-cost banks are often smaller institutions. Marginal costs in France hardly differ across bank specialisation.

Table 3 Marginal costs.

	Country	2013	2014	2015	2016	2017	2018	2019	2020	Average 2013-2020
Commercial	AT	1.9	1.8	1.3	1.6	1.5	2.3	1.6	1.3	1.6
	DE	2.6	2.5	2.3	1.9	2.0	2.5	2.5	1.6	2.2
	ES	3.6	2.7	2.3	2.1	1.7	1.7	1.9	1.5	2.2
	FR	3.0	2.7	2.5	2.3	1.9	1.8	1.7	1.6	2.2
	IT	2.3	1.8	1.7	1.6	1.5	1.3	1.4	1.3	1.6
Savings	AT	1.5	1.5	1.6	1.3	1.4	1.8	1.3	1.2	1.4
	DE	3.8	3.4	3.1	2.8	2.5	2.2	2.1	1.7	2.7
	ES	3.1	2.8	2.4	2.0	1.7	1.9	2.0	1.5	2.2
	FR	2.8	2.7	2.3	2.2	2.1	1.7	1.8	1.5	2.1
	IT	2.6	2.3	2.2	1.9	1.8	2.1	2.0	2.0	2.1
Cooperative	AT	2.0	1.9	2.1	2.1	2.0	2.0	2.0	2.0	2.0
	DE	3.6	3.2	2.8	2.4	2.1	1.9	1.8	1.5	2.4
	ES	5.6	4.8	3.6	3.1	2.1	1.8	1.9	1.5	3.1
	FR	2.8	2.7	2.5	2.3	2.1	1.9	1.8	1.5	2.2
	IT	2.8	2.5	2.3	2.0	2.0	2.1	1.9	1.7	2.2

Table 3 presents the marginal costs in percentage of loans by country and by year. The marginal costs are weighted by loans. The source is authors' calculations based on BankFocus data.

Figure 2 displays for individual banks by country scatter plots between the two key components of the MRP: NP and NE. Austria and France and to a lesser extent Spain show concave patterns in the relationship between profits and efficiency. In contrast, Italy has a pattern with more banks that have low profits and are inefficient. Germany does not have a clear relationship between profits and efficiency.

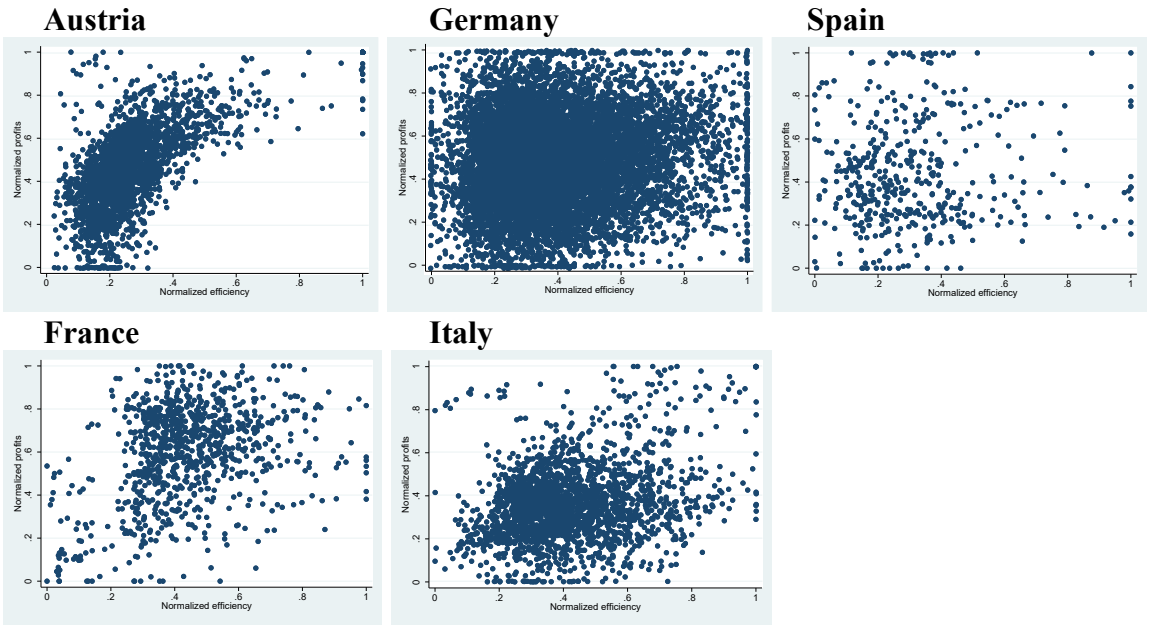

Fig. 2. MRP components scatter plots for individual banks. These figures plot the relationship between normalised profits on the vertical axis and normalised efficiency on the horizontal axis for individual banks in the five countries.

An important driver of NE as well as NP are economies of scale. The existence of the latter is a common finding for the banking sector (Huljak et al., 2022, among many others). Similarly, economies of scale can be expected to be important for profits. Regressing NE, respectively, NP, on economies of scale indeed consistently shows for all banks a significant positive impact of economies of scale, on NE as well as on NP (Table 4). For this purpose, economies of scale were calculated as the inverse of the scale elasticity defined as the ratio of marginal and average cost. The estimates confirm that scaling is important for banking. The estimated economies of scale impacts are consistently higher for efficiency than profits for all banks. The coefficient with respect to NE varies between 0.06 in Austria and 0.17 in Germany. The NP coefficient is estimated to vary between 0.01 in Austria and 0.07 in France. Looking at the economies of scale estimates by bank specialisation, a more nuanced picture emerges. There is no significant efficiency impact for French savings banks, most likely due to the regulated French market. In France most housing loans are not directly backed by real estate collateral but by a guaranteed scheme from a credit institution or an insurance company and another French peculiarity is that regulated savings products account for about half of total saving and deposit accounts (IMF, 2019). No significant profit impact is found for commercial banks in Germany, savings banks in Austria, and cooperative banks in Spain.

Table 4 Impact of economies of scale on normalised efficiency and normalised profits.

	AT	DE	ES	FR	IT	AT	DE	ES	FR	IT
	All banks					Commercial banks				
	Normalised efficiency					Normalised efficiency				
Economies of scale	0.06 **	0.17 **	0.11 **	0.13 **	0.08 **	0.04 **	0.12 **	0.08 **	0.15 **	0.07 **
	(65.6)	(50.3)	(12.0)	(7.4)	(19.4)	(20.2)	(12.7)	(6.2)	(6.2)	(11.1)
R2	0.93	0.88	0.73	0.79	0.83	0.98	0.82	0.76	0.73	0.86
	Normalised profitability					Normalised profitability				
Economies of scale	0.01 **	0.05 **	0.03 **	0.07 **	0.05 **	0.02 **	0.00	0.03 **	0.06 **	0.02 **
	(5.0)	(14.8)	(4.3)	(6.7)	(11.2)	(2.9)	(0.3)	(4.3)	(3.5)	(2.7)
R2	0.86	0.93	0.94	0.96	0.89	0.69	0.92	0.96	0.92	0.92
	Savings banks					Cooperative banks				
	Normalised efficiency					Normalised efficiency				
Economies of scale	0.10 **	0.17 **	0.54 **	-0.05	0.27 **	0.07 **	0.23 **	0.14 **	0.11 **	0.11 **
	(20.4)	(20.9)	(4.8)	(0.6)	(6.6)	(56.2)	(44.4)	(7.4)	(3.6)	(13.0)
R2	0.98	0.87	0.78	0.95	0.88	0.91	0.90	0.79	0.86	0.82
	Normalised profitability					Normalised profitability				
Economies of scale	0.00	0.05 **	0.16 **	0.15 **	0.18 **	0.01 **	0.07 **	0.01	0.14 **	0.10 **
	(0.0)	(14.8)	(2.7)	(4.1)	(3.2)	(3.1)	(17.3)	(0.4)	(8.0)	(14.7)
R2	0.92	0.93	0.95	0.99	0.84	0.83	0.94	0.91	0.95	0.87

Table 4 reports generalised least squares fixed effects estimates for NE, respectively, NP as dependent variable and as regressors a constant and economies of scale. R2 = adjusted R-squared. T-statistic in parentheses. ** denotes significance level at 1%. The source is authors' calculations based on BankFocus data.

4.3. Application 1: Measure bank competition using MRP

Looking at the distribution of the MRP for individual banks (Fig. 3), a common country finding is that this density is skewed to the left. This finding implies that in all countries most banks show a similar degree of competition compared to their peers and that only a few banks are exceptionally competitive. Many banks have little ability to increase their profits by operating more efficiently. In all countries apart from Italy most banks have a MRP lower than one, implying that in those countries most banks are uncompetitive compared to their peers. An increase in efficiency of 1% will provide those banks with less than 1% of relative profits. Banks operating with a below-one MRP have few incentives to improve efficiency, because their gains in profits is comparatively limited. Those banks have incentives to increase their profits by alleviating (systemic) risks in their investment and loan portfolios, because their ability to increase profits by efficiency is limited. It is obvious that prudential regulators should scrutinise those banks more intensively. For antitrust authorities searching for abusive behaviour of dominant banks, a MRP below one could indicate that those banks are also more likely to have anti-competitive practices like predatory pricing, tying of products and foreclosure of other firms. Finally, to ensure a level playing field among banks, market interventions by governments like subsidies that may shelter less efficient banks should be reduced. At the same time, there are also (niche) market players with a MRP above two or even much higher, such as in Italy and Spain. Those banks are far more competitive and exercise peer pressure. As regards financial stability, highly specialised niche players can play a beneficial role, being able to better

understand the specific segment of the market and therefore price the risks more adequately. On the other hand, a high level of competition across more segments might lead to margins depletion and equity optimisation that can increase banks' vulnerability.

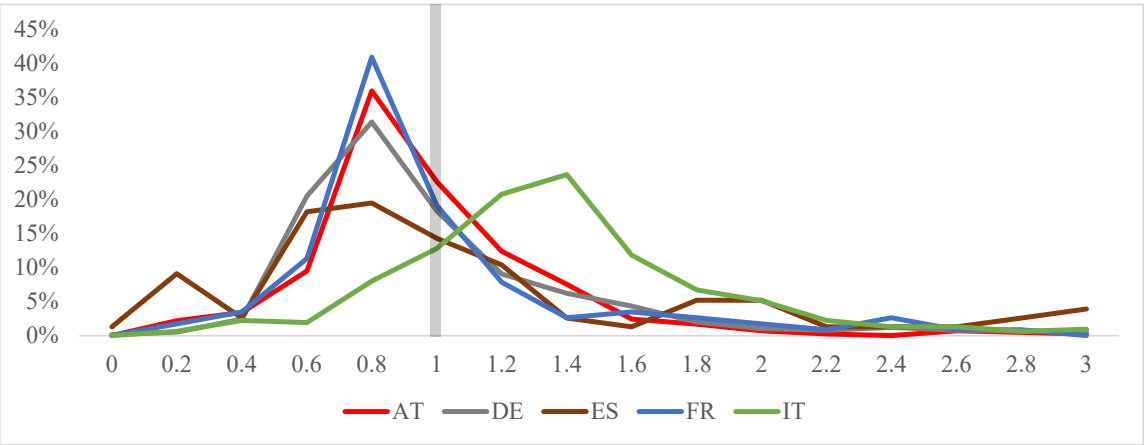

Fig. 3. Density of individual-bank MRP by country. The MRP outcomes are Winsorised at the 1% level and depicted within the 0-3 range.

Turning to MRP quartiles across countries (left-panel of Fig. 4), the median individual-bank MRP is 1.2 for Italy over the period 2013-2020, whereas it is 0.8 for the other countries. In Italy a 1% increase in NE results in a 1.2% increase in NP. With a median MRP of above one, the median Italian bank is competitive in the sense that it has an incentive to increase its efficiency relative to its peers. This finding is dominated by Italian cooperative banks as four out of the five banks in our Italian sample are co-operative banks. Presbitero and Zazzaro (2011) suggest that in markets dominated by cooperative banks, increase in competition leads to higher investments in cultivating long-lasting relationships with customers, i.e., relationship lending, and higher investments in collecting information, screening, and monitoring. Stolfi (2018) reports evidence on the connection between relationship lending and increased bank competition in Italy. In the other countries the median MRP of below one suggests that for most banks a 1% increase in NE provides less than a 1% increase in NP. The lower and higher quartile for Spain is wider than in the other countries. It shows that Spain has a lot of non-competitive inefficient banks with MRPs below one and at the same time a comparatively large number of competitive banks.

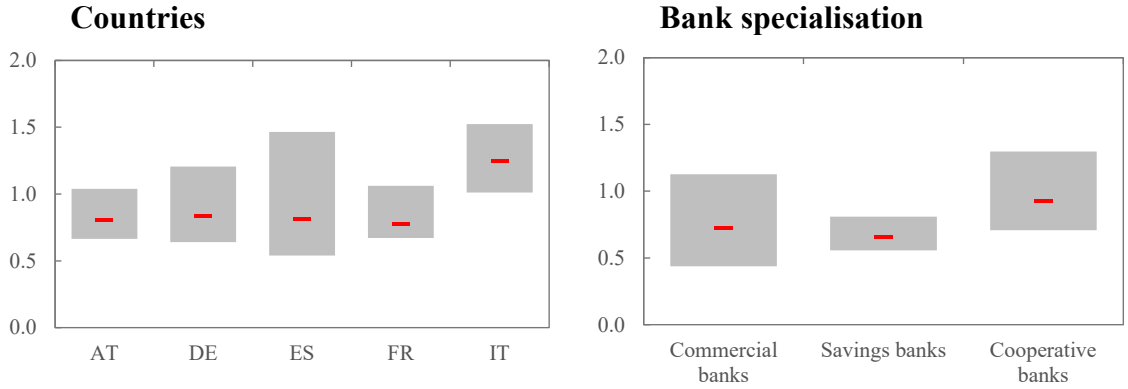

Fig. 4. Individual-bank MRP quartiles by country (left-panel) and bank specialisation (right-panel). The lower quartile is the 25th percentile in MRP, the 50th percentile is the median MRP and the 75th percentile is the upper quartile in MRP.

As regards individual-bank MRP grouped by bank specialisation, cooperative banks are found to be somewhat more competitive than commercial and savings banks (right-panel of Fig. 4). Cooperative banks, with a median MRP of 0.9, are active in local niche markets – in many cases through relationship lending – where they can stir profits away from other banks, and exercise peer pressure. This finding relates to some extent to the declining and low interest rate environment during our sample period. Traditional ordinary lending represents the backbone of cooperative banks and the significant and generalised contraction in banks' interest income over the years 2013 to 2020 has implied for cooperative banks a more significant change in the competitive environment than for other types of banks, especially compared to commercial banks (Migliorelli, 2018). The 25%-75% range of the MRP for cooperative banks varies between 0.7 and 1.3, implying quite some variation in the degree of competition among cooperative banks. The median MRP for commercial banks as well as savings banks is found to be 0.7. For savings banks the MRP range is narrow (0.6-0.8), suggesting comparatively low variation in the degree of competition. In contrast, the range is comparatively wide for commercial banks (between 0.4 and 1.1), implying that some commercial banks are far more competitive than others.

To examine how our new firm-level measure of competition relates to other structural and non-structural competition measures at the bank level, we calculate pairwise correlations between different competition measures (Table 5). Looking at all banks, our new MRP metric correlates significantly consistently with the Lerner index for all banks across countries, but not always significantly with the other competition measures. The levels of the correlations between bank-level competition measures are rather low and for all banks up to 0.4 and by bank specialisation only in 6 out of 90 cases larger than 0.4. These findings are consistent with Carbo et al. (2009). They report that different competition measures don't provide similar results, especially within individual countries.

In Table 5 four times a significant sign reversal occurs. In all four cases, the net interest income-asset ratio is involved.

Table 5 Pair-wise correlations of competition measures.

	AT	DE	ES	FR	IT	AT	DE	ES	FR	IT
	All banks					Commercial banks				
MRP, Lerner index	-0.18 **	-0.06 **	-0.15 **	-0.16 **	-0.26 **	-0.30 **	-0.37 **	-0.17	-0.18 **	-0.10
MRP, net interest income-asset ratio	-0.06 **	0.00	-0.05	0.03	-0.12 **	0.17	-0.11	-0.31 **	-0.03	-0.25 **
MRP, market share	-0.05 *	-0.01	-0.09	-0.08 **	-0.05 *	-0.63 **	-0.13 *	-0.19 *	-0.06	-0.09
Lerner index, net interest income-asset ratio	0.10 **	0.09 **	0.21 **	0.21 **	0.12 **	0.07	0.12	0.37 **	0.32 **	-0.08
Lerner index, market share	0.14 **	0.03 **	-0.06	0.12 **	0.13 **	0.32 **	0.19 **	-0.10	-0.02	0.28 **
Net interest income-asset ratio, market share	-0.09 **	-0.10 **	-0.16 **	-0.36 **	-0.18 **	0.10	-0.20 **	-0.22 *	-0.26 **	-0.26 **
	Savings banks					Cooperative banks				
MRP, Lerner index	-0.17 **	-0.10 **	0.24	0.13	-0.34 **	-0.18 **	-0.08 **	-0.19 **	-0.46 **	-0.29 **
MRP, net interest income-asset ratio	-0.05	0.00	0.33 *	0.46 **	-0.02	-0.08 **	-0.01	-0.11	0.10 *	-0.13 **
MRP, market share	-0.07	-0.06 **	-0.39 **	-0.33 *	-0.17	-0.07 **	-0.03 **	-0.13 *	-0.51 **	-0.06 *
Lerner index, net interest income-asset ratio	-0.02	0.08 **	0.08	0.10	-0.25 *	0.15 **	0.00	0.07	0.25 **	0.24 **
Lerner index, market share	0.13 *	0.00	-0.24	0.09	0.09	0.17 **	0.04 **	-0.01	0.36 **	0.03
Net interest income-asset ratio, market share	-0.18 **	-0.11 **	-0.72 **	-0.87 **	-0.12	-0.25 **	-0.15 **	-0.05	-0.45 **	-0.18 **

Table 5 reports pairwise correlations between MRP and other competition measures over 2013-2020. **, * denote significance level at 1%, respectively, 5%. The marked cells denote a significant sign reversal. The source is authors' calculations based on BankFocus data.

A lack of consistency among competition measures at the bank level is further confirmed by regressing one competition measure on a constant and the other three competition measures considered (Table 6). The explained variation among competition measures is mostly below 0.4. A similar finding for the four largest euro area countries as a group is reported in Carbo et al. (2009). The explained variations are only larger than 0.4 for Austrian commercial banks explaining MRP, for savings banks in Spain and France explaining net interest income-asset ratio as well as market share and French cooperative bank explaining market share. Overall, our results confirm a common finding in the literature of a lack of consistency among competition measures, which, in turn, illustrates the multifaceted nature of measuring competition. Consequently, the complementary value added of our new MRP metric is potentially large, as it is based on a competitive dimension of rivalry different from other measures.

Table 6 Explained variation among competition measures.

	AT	DE	ES	FR	IT	AT	DE	ES	FR	IT
	All banks					Commercial banks				
Marginal relative profitability	0.03	0.00	0.03	0.03	0.08	0.45	0.13	0.14	0.03	0.08
Lerner index	0.06	0.01	0.06	0.11	0.10	0.10	0.15	0.12	0.12	0.07
Net interest income-asset ratio	0.02	0.02	0.06	0.19	0.06	0.08	0.06	0.23	0.16	0.13
Market share	0.03	0.01	0.03	0.16	0.06	0.44	0.08	0.10	0.07	0.14
	Savings banks					Cooperative banks				
Marginal relative profitability	0.02	0.01	0.13	0.18	0.11	0.04	0.01	0.06	0.34	0.09
Lerner index	0.03	0.01	0.04	0.09	0.14	0.09	0.01	0.03	0.39	0.13
Net interest income-asset ratio	0.03	0.02	0.49	0.79	0.05	0.10	0.02	0.01	0.39	0.09
Market share	0.04	0.01	0.53	0.77	0.00	0.11	0.03	0.01	0.50	0.04

Table 6 reports the adjusted R-squared from regressing one competition measure on a constant and all the other competition measures considered. The source is authors' calculations based on BankFocus data.

4.4. Application 2: Test of market structure hypotheses using MRP

Our new measure of individual-bank competition can be used to test market structure theories. MRP together with NP and NE provide insights about three market structure hypotheses, as written in Eq. (8). The efficient structure hypothesis (ESH), as proposed by Demsetz (1973), postulates that more efficient banks are better equipped to survive competitive pressure and obtain greater market share at the expense of less efficient banks and so become larger. ESH is the proposition that states that the performance of a bank, as captured by NP, is positively related to NE, i.e., $\beta > 0$. It suggests that more efficient banks will better develop and grow in scale, resulting higher profit. We view this as a weak form of the ESH. Following a strong form of the ESH, one also expects a positive relationship between bank efficiency and market power, as more efficient banks will better compete. This results in a negative relationship between NE and MRP, i.e., a negative δ in Eq. (8). An alternative hypothesis is the structure-conduct-performance hypothesis (SCPH) developed by Bain (1956) and a dominant paradigm in industrial organization from 1950 till the 1970s. It suggests that less competitive bank conduct results in higher bank profitability. According to this hypothesis, a negative relationship exists between MRP and NP, i.e., $\gamma < 0$ in Eq. (8). A third well-known hypothesis is the 'quiet life' hypothesis (QLH) of Hicks (1935), which is a specific case of the SCPH. It establishes that with reduced competitive pressure, managers do not have incentives to work hard to keep costs under control and put less effort into maximizing efficiency. The QLH implies not only a negative relationship between MRP and NP but also a positive relationship between MRP and NE, $\gamma < 0$ and $\delta > 0$. The positive relationship between competition and efficiency, i.e., the δ term, or negative between market power and inefficiency is known as the 'quiet life' effect. For tests of these hypotheses to banks, see, among others, Berger and Hannan (1998), Maudos and Fernandez de Guevara (2007), and Delis and Tsionas (2009).

$$NP = \alpha + ßNE + \gamma MRP + \delta NE * MRP \qquad (8)$$

ESH: $\beta > 0$ (weak), $\beta > 0$ and $\delta < 0$ (strong); SCPH: $\gamma < 0$; QLH: $\gamma < 0$ and $\delta > 0$.

Regression estimates of Eq. (8) by country provide support for the QLH in Austria and Germany and for the ESH in the other countries (Table 7). In Austria and Germany NP and MRP are significantly negatively related, supportive for the SCPH. At the same time, a positive relationship between NE and MRP is found, resulting that the specific case of the SCPH of a quiet life holds in these two countries. Banks operating highly competitive exploit their efficiency advantage to have a quiet life. The 'quiet life' banks are insulated

from the disciplinary competitive power of their peers, making them inactive in taking profit-enhancing efficiency measures. The finding in favour of the QLH as special form of the SCPH is in line with evidence reported for Austria by Burgstaller (2020) and Hahn (2008) and for Germany by Hackethal et al. (2012). The support in favour of the SCPH warrants that regulators in Austria and Germany are cautious in approving acquisitions and mergers. For the other countries no significant negative relationship between NP and MRP is found, whereas the NE is in all cases significantly positively. No antitrust measures appear to be required for banks in these three countries, given the support of the ESH. The latter and no support for the SCPH is consistent with Goldberg and Rai (1996) and De Jonghe and Vander Vennet (2008) for European countries. Maudos and Fernández de Guevara (2007) do not find support for the QLH for European countries and Färe et al. (2015) overall reject the QLH for Spanish banks.

Table 7 Estimation of determinants of normalised profitability to test market structure hypotheses.

Country	Banks																	
	All				Commercial				Savings				Cooperative					
	NE: β	MRP: γ	NE*MRP:δ	R2	NE: β	MRP: γ	NE*MRP:δ	R2	NE: β	MRP: γ	NE*MRP:δ	R2	NE: β	MRP: γ	NE*MRP:δ	R2		
AT	0.25 **	-0.017 **	0.050 **	0.89	-0.05	-0.81 **	0.98 **	0.84	0.004	-0.09 **	0.22 *	0.95	0.31 **	-0.014 **	0.04 *	0.86		
	(10.6)	(4.7)	(2.7)	QLH	(0.4)	(5.1)	(2.8)	QLH	(0.1)	(5.0)	(2.0)	QLH	(10.9)	(3.9)	(2.0)	QLH		
DE	0.71 **	-0.001 **	0.003 **	0.94	-0.06	-0.06 **	0.07 *	0.95	0.52 **	0.000	-0.01	0.88	0.26 **	-0.001 **	0.002 **	0.95		
	(40.9)	(7.1)	(3.5)	QLH	(1.6)	(4.4)	(2.0)	QLH	(27.1)	(0.0)	(0.9)	*ESH*	(32.8)	(7.2)	(3.0)	QLH		
ES	0.17 **	-0.004	-0.02	0.97	0.07	-0.17 **	0.05	0.97	-0.04	-0.20 *	0.45	0.97	0.14 **	0.000	-0.03	0.94		
	(7.1)	(0.7)	(0.7)	*ESH*	(1.5)	(4.4)	(0.6)	SCP	(0.2)	(2.2)	(1.6)	SCP	(4.4)	(0.1)	(1.3)	*ESH*		
FR	0.11 **	0.007	-0.03 **	0.97	0.10 **	0.007	-0.03	0.93	0.29 *	0.03 *	-0.45 **	0.99	0.16 **	-0.13 **	-0.06	0.96		
	(5.6)	(1.8)	(2.7)	ESH	(3.1)	(0.3)	(1.6)	*ESH*	(2.1)	(2.7)	(2.8)	ESH	(4.5)	(4.3)	(1.5)	*E/S*		
IT	0.27 **	0.006 **	-0.04 **	0.92	0.53 **	0.006	-0.19 **	0.95	0.27	-0.09	0.05	0.93	0.28 **	0.008 **	-0.04 **	0.89		
	(15.5)	(2.8)	(7.7)	ESH	(10.1)	(1.1)	(7.9)	ESH	(1.4)	(1.6)	(0.3)		(14.5)	(3.2)	(7.2)	ESH		

Table 7 reports fixed effects generalised least squares panel estimates of regressing NP on a constant, NE, MRP, and the interaction between NE and MRP for all banks and by bank specialisation. NP = normalised profitability; NE = normalised efficiency; MRP = Marginal relative profitability; R2 = adjusted R-squared. Absolute t-statistic in parentheses. Absolute t-statistics in parentheses. **, * denote significance level at 1%, respectively, 5%. ESH = efficient structure hypothesis: $\beta > 0$ (weak), $\beta > 0$ and $\delta < 0$ (strong); SCP = Structure-conduct-performance hypothesis: $\gamma < 0$; QLH = Quiet life hypothesis: $\gamma < 0$ and $\delta > 0$; E/S = ESH and SCP. The source is authors' calculation and BankFocus data.

The MRP approach can also be used to focus for instance on highly competitive banks. The latter are defined as banks with a MRP larger than two. Are the market structures different for highly competitive banks? Yes, quantile regression estimates for the median of highly competitive banks support the ESH for all countries (Table 8). For Spain and France, the estimates even indicate a significant positive impact of competition on profitability, showing exactly the opposite signs as for the QLH, suggesting than those banks have a 'busy life'. Rivalry is known to increase motivation and performance, as it encourages innovation and efficiency gains. A high level of competitive rivalry drives banks to do their best and to offer innovative products and services, resulting in higher sales and profits. Given the support of the ESH, no antitrust measures appear to be required

for those banks, but antitrust authorities should be vigilant against possible killer acquisitions of those banks by non-competitive banks to ensure the enhancement of innovation in the market.

Table 8 Estimation of determinants of profitability to test market structure hypotheses for the median of highly competitive banks.

Country	AT	DE	ES	FR	IT
NE: β	0.53 **	0.26 **	0.60 **	0.49 **	0.54 **
	(4.3)	(7.7)	(3.1)	(4.1)	(4.8)
MRP: γ	0.001	0.003	0.040 *	0.032 *	0.003
	(0.3)	(1.7)	(2.2)	(2.0)	(0.1)
NE*MRP:δ	-0.02	-0.02	-0.17 *	-0.10 *	-0.05
	(1.4)	(1.8)	(2.4)	(2.0)	(1.2)
R2	0.21 *ESH*	0.18 *ESH*	0.43 ESH	0.29 ESH	0.51 *ESH*

Table 8 reports the quantile regression estimates of regressing NP on a constant, NE, MRP and the interaction between NE and MRP for the median of banks with an MRP > 2. NP = normalised profitability; NE = normalised efficiency; MRP = Marginal relative profitability; R2 = adjusted R-squared. Absolute t-statistic in parentheses. Absolute t-statistics in parentheses. **, * denote significance level at 1%, respectively, 5%. ESH = efficient structure hypothesis: $\beta > 0$ (weak), $\beta > 0$ and $\delta < 0$ (strong). The source is authors' calculation and BankFocus data.

4.5. Application 3: Identify weak non-competitive banks using MRP

Table 9 reports the MRP by bank specialisation and country for weak banks, i.e., for banks with the lowest quartile of NE and lowest quartile of NP compared to the MRP of the whole sample. Across bank specialisations, the identified shares of weak banks in the total bank-type market ranges between up to 2.8% for commercial banks in Austria and Germany and cooperative banks in Spain and 28.6% for French savings banks. Savings banks in all countries record a double-digit weak banks' share, with a comparatively high share in France. The level playing field of the French savings bank market is heavily impacted by state-subsidised saving accounts like Livret A and other regulated savings accounts (Euromoney, 2017; IMF, 2019). The highest country shares of weak banks among commercial and cooperative banks are found for Italy, at 10.8%, respectively, 12.7%. All three bank specialisations with low NE and low NP in Italy have been consistently non-competitive in relative terms. The MRP is for all three bank specialisations below those of the whole sample. To a lesser extent, commercial weak banks in Germany, Austria and Spain were non-competitive. In all cases the lower MRP than the MRP of the whole sample is driven by low efficiency rather than low profits. This finding illustrates that the major issue of weak non-competitive banks relates to a lack of efficiency and therefore a too high cost-structure, but also no incentives to become more

efficient given the low MRP. This in contrast to France, where the weak banks have overall above average MRP and are therefore competitive, except for low efficient commercial banks. A gradual reduction of subsidies to subsidised saving schemes would be a first step in providing incentives to French banks to become more efficient, more competitive, and more profitable. Furthermore, weak banks in these countries should be allowed to be taken over by more competitive banks.

Typically, the same market structure as for all banks holds for weak non-competitive banks, i.e., the QLH for Austria and Germany and the ESH for the other countries (Table 10). It thus appears that not so much different market structures make these banks 'special'. What is key is that they hardly improve efficiency over time. Table 11 reports the NE for the identified weak non-competitive banks for a two-year period, to see whether those banks indeed do not improve NE over time. For the first part of the sample the improvements over time are limited, if any, but in the second part of the sample the NE of non-competitive banks have improved.

Table 9 MRP of weak banks compared with the MRP of the whole sample by bank specialisation and country.

Country			Commercial	Savings	Cooperative
			Compared with the whole sample		
AT	Low efficiency	diff.	-0.3	0.0	-0.1
	Low profitability	diff.	0.2	0.2	0.4
	Both	diff.	-0.3	0.1	0.2
	Count	%	1.0	14.4	10.3
DE	Low efficiency	diff.	-0.6	0.0	0.1
	Low profitability	diff.	1.3	0.3	0.8
	Both	diff.	-0.5	0.3	0.7
	Count	%	2.8	10.5	10.3
ES	Low efficiency	diff.	-0.4	0.0	-0.5
	Low profitability	diff.	0.3	0.2	1.2
	Both	diff.	-0.3	0.0	0.6
	Count	%	7.0	14.6	2.2
FR	Low efficiency	diff.	-0.3	0.5	0.0
	Low profitability	diff.	1.2	0.6	0.2
	Both	diff.	0.5	0.6	0.2
	Count	%	7.0	28.6	11.4
IT	Low efficiency	diff.	-0.5	-0.2	-0.3
	Low profitability	diff.	0.2	0.2	0.2
	Both	diff.	-0.4	-0.2	-0.2
	Count	%	10.8	16.7	12.7

Table 9 reports individual-bank MRP for weak banks by bank specialisation and by country. The whole sample refers to all banks of the same specialisation from the same country. Weak banks are banks with the lowest quartile of normalised profits and lowest quartile of normalised efficiency. The source is authors' calculation and BankFocus data.

Table 10 Estimation of market structure hypotheses for weak non-competitive banks and by bank specialisation.

Country	Banks																
	All				Commercial				Savings				Cooperative				
	NE: β	MRP: γ	NE*MRP:δ	R2	NE: β	MRP: γ	NE*MRP:δ	R2	NE: β	MRP: γ	NE*MRP:δ	R2	NE: β	MRP: γ	NE*MRP:δ	R2	
AT	0.33 **	-0.52 **	0.67 **	0.52	0.05	-0.81 **	1.00 **	0.49	0.16 **	-0.70 **	0.87 **	0.52	0.26 **	-0.50 **	0.75 **	0.51	
	(20.7)	(27.7)	(21.5)	QLH	(0.7)	(6.2)	(4.2)	QLH	(3.1)	(12.4)	(10.0)	QLH	(8.9)	(25.7)	(17.6)	QLH	
DE	0.21 **	-0.36 **	0.21 **	0.19	0.36 *	-0.08	-0.40	0.05	0.30 **	-0.51 **	0.17 *	0.29	0.27 **	-0.22 **	0.13 **	0.19	
	(8.6)	(18.3)	(5.8)	QLH	(2.1)	(0.8)	(1.4)	*ESH*	(6.1)	(19.9)	(2.3)	QLH	(8.2)	(10.9)	(2.6)	QLH	
ES	0.29 **	-0.27 **	0.11	0.11	0.42 *	0.06	-0.72	0.03	2.95 *	0.08	-3.31	0.41	0.28 *	-0.19	0.14	0.08	
	(3.0)	(4.3)	(0.7)	*E* /S	(2.2)	(0.8)	(1.6)	*ESH*	(2.3)	(0.3)	(1.8)	*ESH*	(2.0)	(1.6)	(0.4)	*ESH*	
FR	0.97 **	0.09	-1.10 **	0.26	0.75 **	0.20 **	-0.80 **	0.22	2.38	-0.05	-1.85 **	0.60	-0.36 **	-0.99 **	0.59 **	0.52	
	(7.5)	(0.9)	(6.5)	ESH	(7.9)	(3.1)	(6.4)	ESH	(1.4)	(0.3)	(0.8)		(5.3)	(16.9)	(6.0)	QLH	
IT	1.91 **	-0.11 **	-0.80 **	0.54	1.21 **	0.04	-0.60	0.47	3.58 **	0.25 *	-2.63 **	0.82	2.92 **	-0.06 **	-1.55 **	0.76	
	(6.7)	(3.2)	(2.7)	E/S	(4.7)	(0.4)	(1.6)	*ESH*	(12.5)	(2.1)	(7.8)	ESH	(41.2)	(3.7)	(19.5)	E/S	

Table 10 reports the median quantile regression estimates of regressing NP on a constant, NE, and MRP for banks with MRP < 1, low (25% quartile) NE and low (25% quartile) NP. NP = normalised profitability; NE = normalised efficiency; MRP = Marginal relative profitability; R2 = adjusted R-squared. Absolute t-statistic in parentheses. Absolute t-statistics in parentheses. **, * denote significance level at 1%, respectively, 5%. ESH = efficient structure hypothesis: $\beta > 0$ (weak), $\beta > 0$ and $\delta < 0$ (strong); SCP = Structure-conduct-performance hypothesis: $\gamma < 0$; QLH = Quiet life hypothesis: $\gamma < 0$ and $\delta > 0$; E/S = ESH and SCP. The source is authors' calculation and BankFocus data.

Table 11 Normalised efficiency for weak non-competitive banks over time

	AT	DE	ES	FR	IT
2013-2014	0.27	0.21	0.24	0.44	0.28
2015-2016	0.26	0.30	0.23	0.43	0.30
2017-2018	0.28	0.47	0.39	0.56	0.38
2019-2020	0.31	0.63	0.50	0.71	0.48

Table 11 reports NE over two-year period for weak non-competitive banks.
The source is authors' calculation and BankFocus data.

5. Conclusions

This study extends the work of Boone (2008) on RPD for the overall market by introducing a new measure of competitiveness of individual firms: MRP. With a strong theoretical underpinning this metric allows for individual market power testing. MRP is a *relative* indicator based on normalized profits and normalized efficiency and on individual elasticity between these two variables. It does not suffer from external or structural issues like the Lerner index, because it considers profits and efficiency.

The usefulness of our new individual firm-level market competition measure is illustrated by applying it to commercial, cooperative, and savings banks in the loan markets. Empirical results for Austria, Germany, Spain, France, and Italy over the years 2013-2020 show that concave, convex or inconclusive patterns in the relationship between NP and NE are possible. Conclusions about individual bank competition differ accordingly. A common country finding is that the individual bank-level MRP distribution is skewed to the left: many banks have little ability to increase their profits by operating

more efficiently. The dispersion in individual bank-level MRP is found to be comparatively wide in Spain and narrow for savings banks. A closer look how the new MRP metric relates to other bank-level competition measures reveals that it is significantly consistently correlated with the Lerner index but not with other competition measures like net interest income-asset ratio or market share. Moreover, regressing MRP on these firm-level competition measures show low explanatory power, suggesting that the MRP provides a distinctive picture of competitive rivalry. It complements existing indicators of competition measures which are known to measure different things. We also show how our new individual-bank competition measure can be used to test the QLH and related hypotheses. Regression results support the QLH for Austria and Germany, but not for the other countries. 'Quiet life' banks exploit their efficiency advantage, e.g., due to their economies of scale, to have an easy life. They are insulated from the disciplinary competitive power of their peers, making them inactive in taking profit-enhancing efficiency measures. The estimates also indicate that highly competitive banks, defined as banks with a MRP larger than two, face a 'busy life' and take actively profit-enhancing efficiency measures. Another and final application of a possible use of our MRP approach is that it helps in identifying weak non-competitive banks: banks with low efficiency and low profits as well as low MRP. Here, the insight is that Italy has weak banks with a combination of inefficiency and low profitability that are non-competitive. In Germany, Austria, and Spain, weak commercial banks are identified as non-competitive.

The new measure of firm-level competition that we propose, and empirically support, is of potential wide use. Antitrust authorities, financial supervisors, central banks and other policymakers, analysts, and researchers all benefit from better insights in the degree of competition at the individual firm level. The MRP approach is especially powerful as relative selection tool. It helps to identify firms with specific characteristics, e.g., comparatively weak non-competitive firms or "best-in-class" firms. Our new individual firm-level competition measure provides a promising starting point to improve future market power analyses and research studies.

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Appendix Trans-log cost function

To calculate marginal costs as input variable for MRP, we estimate a trans-log cost function (TCF) for each country, using individual bank observations. The TCF is a second-order Taylor expansion around the mean of a generic dual cost function with all variables appearing as logarithms. It is a flexible functional form that has proven to be effective in explaining multiproduct bank services. The TCF takes the following form:

$$ln\ c_{it}^{h} = \alpha_0 + \sum_{h=1,..,(H-1)} \alpha_h\ d_i^h + \sum_{t=1,..,(T-1)} \delta_t\ d_t + \sum_{h=1,..,H} \sum_{j=1,..,K} \beta_{jh}\ ln\ x_{ijt}\ d_i^h + \sum_{h=1,..,H} \sum_{j=1,..,K} \sum_{k=1,..,K} \gamma_{jkh}\ ln\ x_{ijt}\ ln\ x_{ikt}\ d_i^h + v_{it} \quad (1A)$$

where the dependent variable c_{it}^{h} reflects the production costs of bank i (i = 1, .., N) in year t (t = 1, .., T). The sub-index h (h = 1, .., H) refers to bank specialisation, that is, commercial, savings or cooperative bank. The variable d_i^h is a dummy variable, which is 1 if bank i is of type h and otherwise zero. The variable d_t is a dummy variable, which is 1 in year t and otherwise zero. The explanatory variables x_{ikt} represent three groups of variables (k = 1, .., K.). The first group consists of (K_1) bank output components, such as loans, securities and other services (proxied by other income). The second group consists of (K_2) input prices, such as wage rates, deposit rates (as price of funding) and the price of other expenses (proxied as the ratio of other expenses to fixed assets). The third group consists of (K-K_1-K_2) control variables (also called 'netputs'), e.g., the equity ratio. In line with Berger and Mester (1997), the equity ratio corrects for differences in loan portfolio risk across banks. The coefficients α_h, β_{jh} and γ_{jkh}, all vary with h, the bank type. The parameters δ_t are the coefficients of the time dummies and v_{it} is the error term.

Two standard properties of the cost functions are linear homogeneity in the input prices and cost exhaustion (Jorgenson, 1986; Beattie and Taylor, 2009). They imply the following restrictions on the parameters, assuming – without loss of generality – that the indices j and k of the two sum terms in Equation (1A) are equal to 1, 2 or 3, respectively, for wages, funding rates, and prices of other expenses (disregarding the sub-index h):

$$\beta_1+\beta_2+\beta_3 = 1,\ \gamma_{1,k}+\gamma_{2,k}+\gamma_{3,k} = 0 \text{ for k} = 1, 2, 3, \text{ and } \gamma_{k,1}+\gamma_{k,2}+\gamma_{k,3} = 0 \text{ for } k = 4,.., K \quad (2A)$$

From equation (2A), the first restriction stems from cost exhaustion, reflecting the fact that the sum of cost shares is equal to unity. In other words, the value of the three inputs is equal to total costs. Linear homogeneity in the input prices requires that the three linear

input price elasticities (β_i) add up to 1, whereas the squared and cross terms of all explanatory variables ($\gamma_{i,j}$) add up to zero. Again without loss of generality, we also apply the symmetry restrictions $\gamma_{j,k} = \gamma_{k,j}$ for j, k = 1, .., K, to Eq. (1A). As Eq. (1A) expresses that we assume different cost functions for each type of banks, the restrictions (2A) apply to each type of bank. The marginal costs of output category $j = l$ (of loans) for bank i of category h in year t, mc_{ilt}^h are defined as:

$$mc_{i1t}^h = \partial c_{it}^h / \partial x_{i1t} = (c_{it}^h / x_{i1t}) \, \partial \ln c_{it}^h / \partial \ln x_{ilt} \qquad (3A)$$

The term $\partial \ln c_{it}^h / \partial \ln x_{ilt}$ is the first derivative of Equation (3A) of costs to loans. We use the marginal costs of the output component 'loans' only (and not for the other K_1 components) as we investigate the loan markets. We estimate a separate TCF for each individual sector in each individual country, allowing for differences in the production structure across bank specialisation within a country. This leads to the following equation of the marginal costs for output category loans (l) for bank i in category h during year t:

$$mc_{i1t}^h = c_{it}^h / x_{i1t} \, (\beta_{1h} + 2 \, \gamma_{11h} \ln x_{ilt} + \sum_{k=1,..,K;\, k \neq l} \gamma_{1kh} \ln x_{ikt} \,) \, d_i^h \qquad (4A)$$

Acknowledgements

We thank Ruben van Oosten for his insights in the model used in Boone (2008), Andrei Dubovik for his insightful discussions of earlier versions of the paper and participants of an ECB Financial Stability seminar for their comments. We sincerely appreciate the thoughtful and constructive comments provided by an anonymous referee, which have been invaluable in enhancing the quality of the paper. The views expressed are those of the authors and do not necessarily reflect those of the ECB, Eurosystem, and affiliated institutions.

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PDF ISBN 978-92-899-6673-3 ISSN 1725-2806 doi:10.2866/937110 QB-AR-24-042-EN-N