

# Retail banking market investigation

## Relationship between concentration and outcomes: review of empirical literature

**10 July 2015**

This is one of a series of consultative working papers which will be published during the course of the investigation. This paper should be read alongside the updated issues statement and the other working papers which accompany it. These papers do not form the inquiry group's provisional findings. The group is carrying forward its information-gathering and analysis work and will proceed to prepare its provisional findings, which are currently scheduled for publication in September 2015, taking into consideration responses to the consultation on the updated issues statement and the working papers. Parties wishing to comment on this paper should send their comments to [retailbanking@cma.gsi.gov.uk](mailto:retailbanking@cma.gsi.gov.uk) by **midday Friday 24 July 2015**.

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## **Introduction and overview**

1. Our second theory of harm concerns concentration giving rise to market power of some banks and leading to worse outcomes for customers. This working paper summarises economic literature relevant to this theory of harm, in particular literature covering the empirical link between concentration and competition in banking.
2. We have divided the literature into the following categories:
  - (a) Single-country studies focused on the UK market.
  - (b) Cross-country studies including UK.
  - (c) Other single-country studies.
  - (d) Other cross-country studies.
3. A variety of approaches are taken to measuring concentration and competition. Concentration is usually measured by a concentration ratio (combined market share of the largest firms—often the four or five largest firms) or the HHI index.<sup>1</sup> Competition may be measured by estimating a specific economic model or using some measure of market outcomes, for example: margins, profits, pass-through of costs, and the extent to which cost changes are associated with market share changes. Appendix A contains a detailed discussion of the different measures of concentration and competition.
4. The majority of papers<sup>2</sup> suggest that the structure of banking markets is important and that greater concentration leads to worse outcomes for consumers, such as lower interest rates on deposits and higher rates on loans and overdrafts – for example Degryse and Onega (2008), Scherer (2010), Bikker et al (2002, 2006a), van Leuvenstijn et al (2008) and Mulder (2014). Some papers, eg Berger and Hannan (1998) and Koetter et al (2012) find evidence in support of the ‘quiet life’ hypothesis, ie that banks with market power are prone to cost and profit inefficiencies. Finally, cross-country analysis finds significant differences across countries and different markets.
5. Most of the reviewed papers focus on the market for banking services as a whole without distinguishing between different banking sectors, such as personal current accounts (PCAs) and small and medium-sized enterprise (SME) banking. There are however several papers, eg Heffernan (2002, 2003), Heffernan and Fu (2009), Corvoisier and Groppe (2001) and Gondat-Larralde and Nier (2006), that

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<sup>1</sup> The HHI index is the sum of the squared market shares of all the firms in the market.

<sup>2</sup> Full references are provided in Appendix B.

focus on specific segments of the banking sector, such as deposits, mortgages and different types of loans, or analyse separately the markets for personal and SME customers.<sup>3</sup>

6. Several papers, eg Carbó Valverde et al (2009), Bikker (2010) and Bolt and Humphrey (2015), which focus on testing different measures of competition, report that the different measures are only weakly correlated with each other and could provide different measures of competition.<sup>4</sup>
7. Some papers, eg Heffernan and Fu (2009) and Corvoisier and Groppe (2001), investigate the relationship between market structure and performance using market power and efficient structure hypotheses. Under the market structure hypotheses it is presumed that concentration or individual market power leads to higher prices for consumers and higher profits for banks, whereas the efficient structure hypotheses argue that concentration is caused by the rapid growth of efficient banks which, in turn, may lead to more favourable prices for consumers. The findings of these papers suggest that the market power hypotheses tend to be confirmed more often, resulting in less competitive pricing by banks, although the results vary depending on the market investigated.
8. Research based on the Panzar-Rosse H-statistic measure of competition<sup>5</sup> provides conflicting results. Some papers, eg Claessens and Laeven (2004), find evidence that more concentration leads to increased competition and that it is the contestability of the market and not the market structure that really matters for competition. However, later studies, eg Bikker et al (2006a, 2006b, 2012) and Goddard and Wilson (2008) show that models based on the H-statistic suffer from misspecification, leading to biased results. Still, most of the papers applying the H-statistic find that the nature of competition can best be described as monopolistic competition and that concentration is negatively related to competition.

## Literature summary

9. The paper is structured in the following way: section (a) summarises the single-country studies focused on the UK market, section (b) summarises the cross-country studies which include the UK, and sections (c) and (d) summarise other single- and cross-country papers which do not include the UK in their analysis.

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<sup>3</sup> Although some of the papers summarised in this paper are from the early 00s or late 90s, we think that the analysis presented in them and the methods used are potentially still relevant – the approach taken is not dissimilar to that in later papers.

<sup>4</sup> The differences in the estimates provided by these measures are attributed to different indicators measuring different characteristics.

<sup>5</sup> See Appendix A for an explanation of the H-statistic and other competition measures.

### **(a) Single-country studies focused on the UK market**

*Heffernan, SA (2002), How do UK financial institutions really price their banking products?*

10. The paper analyses different types of pricing behaviour of UK banks for different products: savings accounts, interest earning current accounts (chequing), mortgages, credit cards and personal loans. Two models of imperfect competition are tested: the Salop-Stiglitz<sup>6</sup> model of monopolistic competition with 'bargains' and 'rip-offs', and Cournot behaviour.<sup>7</sup>
11. The author uses a generalised linear pricing model to estimate the price of the product using the London Interbank Offered Rate (LIBOR) as a proxy for the perfectly competitive market interest rate. The paper shows that, with the exception of mortgage products, deposit and loan interest rate setting by UK financial institutions is best described by the Salop-Stiglitz model of monopolistic competition. Perfect contestability is largely ruled out. Even in the largely competitive mortgage market the authors find signs of price discrimination. The results point to substantially lower competition for savings, current accounts (chequing), credit cards and personal loans. Heffernan concludes that financial firms exhibit different types of price-setting behaviour depending on the banking product concerned, and that firms should be required to produce information that enables consumers to compare different products for consumers, thereby helping to contain the loss of consumer surplus in imperfectly competitive markets.

*Heffernan, SA (2003), UK bank services for SMEs: are they competitively priced?*

12. The paper assesses the nature and degree of competition among UK banks in the provision of SME banking services during the period from 1996 to 2001. It applies the technique described above (Heffernan 2002) to SME banking services: business current accounts, business investment accounts, company mortgages and business loans. The paper tests for different forms of imperfect competition: Cournot behaviour and the applicability of the Salop-Stiglitz model.
13. The paper finds different<sup>8</sup> tactical pricing behaviour by financial institutions in response to a change in LIBOR, a proxy for competitive or market interest rate.

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<sup>6</sup> Under the Salop-Stiglitz model, consumers face unseen information costs. Some know the distribution of prices and others do not. The former buy only 'bargains', whereas the latter buy randomly. A firm can survive either by charging a low price ('bargain') or a high one ('rip-off'). 'Rip-off' firms stay in business as long as there are enough purchases by the inert consumers. Firms offering 'bargain' products profit from a higher volume of sales, because well-informed customers buy their cheaper products. Thus, relative 'bargains' and 'bad buys' coexist.

<sup>7</sup> The Cournot model assumes that an increase in the total number of firms should lead to lower prices, ie that deposit interest rates should go up and loan interest rates should go down as more firms enter the market.

<sup>8</sup> In a highly competitive market (or a monopoly) firms would display identical pricing behaviour.

Three types of response are observed: (i) immediate, near-complete adjustment, (ii) complete pass-through but with delay, and (iii) staggered, delayed adjustment with incomplete pass-through. The findings show that even the biggest four banks at the time (NatWest, Lloyds TSB, Barclays and HSBC) differed in the way they adjusted their rates, both within and between products.

14. The author finds a marked disparity in prices for particular products. Although some of the price dispersion could be attributed to non-price features, there is a residuum in the regression which the author interprets to be strongly suggestive of switching costs and imperfect information. Hence, the Salop-Stiglitz model is thought to fit well. Margin analysis shows that larger banks were offering 'rip-offs' in the deposit market, but three of the then biggest four banks were offering 'bargains' in the market for business loans. There is also some evidence supporting the Cournot model for savings accounts, current accounts and commercial mortgages.
15. The paper also investigates the effect of branches on the product price measured by deposit and loan interest rates. The results show that the deposit interest rate falls with an increase in the number of branches. This indicates that SMEs pay for the convenience of having a branch nearby. The author concludes that SMEs doing business with banks with large branch networks pay for the privilege. The results also show a negative relationship between the number of branches and business loan rates. The author suspects that this could be explained by banks with larger branch networks being able to pool the risks<sup>9</sup> and therefore offer lower interest rates.
16. The author recognises widespread SME inertia and argues that competition would increase if SMEs were encouraged to switch to other banks.

*Gondat-Larralde, C and Nier, E (2006), Switching costs in the market for personal current accounts: some evidence for the United Kingdom*

17. The paper examines how changes in market shares respond to price differentials and which model of competition<sup>10</sup> best fits the data. In order to assess the level of competition in the market for PCAs, the authors derive elasticities of bank market shares with respect to the set of PCA prices. Controlling for non-price characteristics, such as the extent of the branch network, the number of automated teller machines (ATMs) and the scope of telephone and internet banking, they find moderate sensitivity of changes in market share to differences

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<sup>9</sup> Banks with large branch networks are able to collect more information on SME risk profiles because their loan volumes are higher.

<sup>10</sup> Among the models examined are dynamic competition model with switching costs, Salop-Stiglitz model with switching costs, perfect competition and oligopoly without switching search or costs.

in the PCA interest rates (including the rate paid on positive balances, the rate of authorised overdrafts and the rate paid on individual savings accounts (ISAs)) overall across banks.

18. In addition, changes in market share were found to be sensitive to PCA rates on positive balances, but less sensitive to the rate of authorised overdraft and the rate paid on ISAs.<sup>11</sup> This suggests that a bank that offers a higher ISA rate or lower overdraft rate than its rivals offer on average would not experience any significant increase in market share for PCAs.
19. The authors also find a positive relationship between the levels of market share and price. These findings are also consistent with a moderate degree of imperfect competition with switching costs in the market for PCAs and the theory of margin enhancement, ie that the bank's current market share determines its pricing incentives: the larger the market share, the higher the incentive to raise the price of PCAs and vice versa.<sup>12</sup> The paper also predicts that the relationship between market share and price should be stronger, the lower the elasticity of demand with respect to price. Thus, the relationship between market share and price is strongest for the overdraft rate, which has the lowest elasticity of demand.

*Heffernan, SA and Fu, X (2009), The structure of retail markets: what do we learn from bank-specific rates?*

20. The paper investigates the relationship between market structure and performance in the UK retail banking market from 1993 to 2004. The authors test four major hypotheses that focus on the impact of concentration on banks' pricing behaviour:
  - (a) Market power hypotheses – concentration or individual market power leads to higher prices and bank profits:
    - (i) Structure–conduct–performance (SCP) paradigm<sup>13</sup> – bank concentration impairs competition, resulting in higher loan interest rates, lower deposit interest rates and greater profitability.
    - (ii) Relative market power (RMP) hypothesis – banks with a greater market share and well-differentiated products are able to exert market power in

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<sup>11</sup> For overdraft and ISA interest rates, coefficients are not significantly different from zero for most specifications.

<sup>12</sup> The paper finds a positive relationship between the overdraft rate and the market share and a negative relationship between the PCA interest rate and the market share. As for the ISA rate, the evidence seems to point to the market for ISAs being unrelated to the market for PCAs.

<sup>13</sup> See Appendix A for a more detailed description of the SCP paradigm.

setting prices to earn supernormal profits, independent of the degree of market concentration.

- (b) Efficient structure hypotheses – concentration is due to the rapid growth of relatively efficient banks:
- (i) X-efficiency measures the efficiency with which banks use their inputs to produce a given bundle of outputs. It can be described as the ratio of the predicted minimum costs that would be incurred if the bank were as efficient as the best-practice bank in the sample to the predicted actual costs.<sup>14</sup> X-efficient banks have lower costs, meaning that consumers face more favourable prices and firms enjoy greater market share, resulting in higher profits.
  - (ii) Scale efficiency measures whether banks operate at a scale-efficient point. Under the scale efficiency hypothesis, banks with similar management skills and production technology but producing at output levels closer to minimum average cost point (ie being more scale-efficient) will have lower costs, which may lead to more favourable prices for consumers, along with greater concentration or market share and profits.

21. The authors test the hypotheses using two measures of concentration – the Herfindahl-Hirschman Index (HHI)<sup>15</sup> and the number of firms, which serve equally well as concentration measures.
22. The authors find that the market power hypotheses seem to prevail, although the results vary depending on the market investigated.<sup>16</sup> For example, the market power hypotheses are supported for all credit products and the majority of deposit products, although there are some instances where banks' behaviour is consistent with the efficient structure hypotheses, which may be due to consumer attitudes or inertia. In 79% of the cases considered, either larger banks offered worse interest rates or higher concentration led to worse interest rates. Overall, market power is found to be present more often in the markets for credit than in those for deposit products. Although the findings suggest that in general banks tend to adopt different pricing strategies depending on the number of near substitutes and consumer attitudes, the authors do not find evidence of

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<sup>14</sup> Even though the best-practice bank itself may not be efficient when compared to banks outside the sample.

<sup>15</sup> See Appendix A for an explanation of HHI and other measures.

<sup>16</sup> The following markets were investigated: business savings, personal savings, PCAs, personal loans, credit cards and mortgages.

the top five banks<sup>17</sup> adopting different pricing strategies compared with smaller banks and building societies.

23. The notion that banks enjoy a ‘quiet life’, ie banks with market power may be less concerned about costs, meaning that larger banks are less efficient, is largely not supported.<sup>18</sup>

**(b) Cross-country analysis including UK**

24. The papers in this section are grouped as follows: (i) papers applying the Panzar-Rosse model and (ii) other cross-country studies.
25. To better understand the role of the Panzar-Rosse H-statistic, it is helpful first to note that Claessens (2009)<sup>19</sup> distinguishes between three types of approach to measuring competition:
  - (a) Market structure and associated indicators – the SCP paradigm implies that the structure of the market can directly or indirectly determine performance (eg lower concentration leads to more competitive behaviour of firms, which in turn leads to less market power and greater social efficiency). However, the SCP approach fails to take into account that structure is not necessarily exogenous, since it can itself be affected by firms’ conduct and hence by performance; and that the degree of concentration does not give straightforward answers to the level of competition: for example, even concentrated markets can be competitive and vice versa. Therefore, traditional performance measures, such as the size of banks’ net interest margins, profitability or transaction costs in stock markets, do not necessarily indicate competitiveness of a financial system.<sup>20</sup>
  - (b) Contestability and regulatory indicators to gauge contestability – the theory of contestability argues that it is the degree of entry and exit barriers, rather than actual entry, that matters for competitiveness. For example, incumbents in markets with low barriers to entry will not be able to charge prices above marginal costs, as this would induce new entry that would push the prices down. The theory recognises that competitive outcomes are possible even in concentrated markets and that above normal profits do not necessarily mean that a firm is harming consumers.

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<sup>17</sup> HSBC, RBS, HBOS, Barclays and Lloyds TSB.

<sup>18</sup> The ‘quiet life’ hypothesis held in only a few sub-markets: a third of deposit products and mortgages.

<sup>19</sup> See paragraphs 39–42 for a full description of the findings in Claessens (2009).

<sup>20</sup> These performance measures are also influenced by a variety of factors, such as a country’s macroeconomic performance and stability, the form and degree of taxation of financial intermediation, the quality of the country’s information and judicial systems, and financial institution-specific factors such as leverage, the scale of operations and risk preferences. As a result, these measures can be poor indicators of the degree of competition.

- (c) Formal competition measures – the paper distinguishes between three different empirical approaches to measuring competition:
  - (i) measuring concentration, which relies on the SCP paradigm;
  - (ii) measuring regulatory indicators and entry barriers to gauge the degree of contestability; and
  - (iii) the Panzar-Rosse H-statistic that proxies the reaction of output to input prices.

***(i) Papers applying the Panzar-Rosse model***

*Bikker, JA and Haaf, K (2002), Competition, concentration and their relationship: an empirical analysis of the banking industry*

- 26. The authors set out to test empirically the effect that concentration has on competition. First, they regress the Panzar-Rosse H-statistic on a number of banks in a sample of 23 industrialised countries (including the UK). The results show that banking markets in the industrial world are characterised by monopolistic competition. Small banks, on average, seem to operate under less competitive conditions (lower H-statistic of 0.63) than large banks (H-statistic of 0.86). The medium-sized banks occupy an intermediate position (H-statistic of 0.75). Or, to put it differently, local markets are less competitive than national and international markets. The results also show that in Europe competition seems to be stronger and that all large banks appear to operate in a very tight competitive environment. The estimates of the H-statistic over time indicate a significant increase in competition.
- 27. The authors also apply the Bresnahan conjectural variation model to deposit and loan markets in nine European Union (EU) countries (including the UK). The measure of competition from the Bresnahan model indicates for both markets that the degree of competition is high within all nine EU countries. This is in line with the results given by the Panzar-Rosse model.
- 28. Finally, the authors estimate k-firm concentration ratios and HHIs for the same 23 industrialised countries. To investigate the relationship between competition and concentration, they regress the H-statistic on various concentration indices and the absolute number of banks in these markets. The results show that the market structure has a significant effect on competition, the relationship being strongest when the 3 firm concentration ratio ( $CR_3$ ) is used. The results imply that increasing concentration decreases competition (reduces the H-statistic). This appears to confirm the observation that a few large banks can restrict

competition and that a multitude of small competitors is unable to engender competition.

*Claessens, S and Laeven, L (2004), What drives bank competition? Some international evidence*

29. Using the Panzar-Rosse H-Statistic the authors estimate competitiveness in their study of 50 countries' (including UK) banking systems. The authors find that a greater foreign bank presence and fewer activity restrictions in a country's banking sector lead to a more competitive banking system. They also find some evidence that entry restrictions on commercial banks can reduce competition, which suggests that being open to new entry is the most important competitive pressure.
30. The authors, however, find no evidence that their measure of competition decreases with increasing concentration. On the contrary, they find that more concentrated banking systems are more competitive. The results imply that it is contestability that is the most important for competition, and that market structure is not necessarily related to the degree of competition.

*Bikker, JA, Spierdijk, L and Finnie, P (2006a), The impact of bank size on market power*

31. Using a large sample of more than 18,000 banks in 101 countries (including the UK) over more than 16 years, the paper sets out to estimate the relationship between bank size and market power using the Panzar-Rosse H-statistic.<sup>21</sup> The authors find a positive relationship between market power and bank size: for example, the average H-statistic corresponding to large banks equals 0.42, whereas the H-statistic for small banks averages 0.68; monopoly is rejected less often and perfect competition is rejected more often for large banks than for small banks.
32. The authors argue that the drivers behind the market power of the large banks are bank size itself and the ability of the large banks to operate on different product and geographical submarkets.
33. The findings of this paper contradict some of the previous studies, which find that competition increases with bank size. The authors show that the latter result is due to misspecification<sup>22</sup> of the models used to derive the H-statistic in the previous literature.

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<sup>21</sup> The paper extends the traditional Panzar-Rosse model by introducing a direct role for bank size.

<sup>22</sup> See paragraph 34.

*Bikker, JA, Spierdijk, L and Finnie, P (2006b), Misspecification of the Panzar-Rosse model: assessing competition in the banking industry*

34. The paper aims to demonstrate that all the empirical papers using the H-statistic suffer from misspecification and that the level of competition in the existing Panzar-Rosse literature is systematically overestimated. The misspecification results from the dependent variable being calculated as a ratio of a bank's revenues to total assets ('the price equation') instead of being calculated as unscaled bank revenue ('the revenue equation') and introduces bias towards perfect competition (H-statistic = 1). The results show that the average value of H-statistic obtained from the Panzar-Rosse revenue equation is much smaller than the average value resulting from the Panzar-Rosse price equation (0.504 and 0.742 respectively). The authors also show that the inclusion of scale variables as explanatory variables in the estimation has a similar distorting effect.

*Bikker, JA and Spierdijk, L (2008), How banking competition changed over time*

35. The paper investigates the developments in banking competition in 101 countries during the previous 15 years using the Panzar-Rosse H-statistic approach. The authors find that competition in major Western economies has reduced over time (for example, competition decreased by almost 60% in the EU-15 over the study period) and attribute this to the process of consolidation, which generally creates larger banks with greater market power. Furthermore, the authors suggest that the continuous shift over time from traditional intermediation to more sophisticated and complex products may also have reduced competition.

*Goddard, J and Wilson, JOS (2008), Measuring competition in banking: a disequilibrium approach*

36. The paper argues that the Panzar-Rosse model suffers from a misspecification bias in the revenue equation. The standard procedure for estimating the H-statistic involves the application fixed effects estimation. Under this procedure, the correct estimation of the H-statistic relies upon an assumption that markets are in long-run equilibrium at each point in time when the data is observed.
37. The authors show that misspecification bias arises when adjustment towards market equilibrium is partial and not instantaneous, leading to H-statistic measures being severely biased towards zero. In contrast, applying an appropriate dynamic panel estimator to a correctly specified dynamic revenue equation permits virtually unbiased estimation of the H-statistic. This also eliminates the need for a market equilibrium assumption and also incorporates instantaneous adjustment as a special case. The different specifications of Panzar-Rosse H-statistic are tested using data from six developed countries (including the UK). The results confirm that dynamic panel estimator conveys

most accurate H-statistic. The paper largely focuses on methodological issues and does not provide new evidence on the relationship between concentration and pricing.

38. The authors also concur with Bikker et al (2006) that inadvertent misspecification of the revenue equation as a price equation, through either rescaling the dependent variable or including a logarithm of assets as a control variable, constitutes another form of misspecification bias affecting the estimation of the H-statistic.

*Claessens, S (2009), Competition in the financial sector: overview of competition policies*

39. The paper provides an overview of competition policies and different methods to measure competition in the financial sector. The author argues that the assessment of competition in the financial industries should be done carefully, and that the effects that competition has on financial stability and access to financial services<sup>23</sup> should be taken into account: 'The view that competition in financial services is unambiguously good is more naïve than in other industries.' When analysing competition in financial markets, the author contends that it is necessary to consider a broader set of objectives, including efficiency, access to services and financial sector stability, as well as possible trade-offs between these objectives. Factors such as entry and exit, contestability, and the fact that the provision of financial services is relying on various networks, such as the use of ATMs and credit bureaus' information, should be considered.
40. The paper argues that the traditional competition measures, such as concentration indices, have only limited applicability and that more sophisticated measures such as the H-statistic are necessary. However, the paper recognises the difficulties in applying such measures – the unclear production function for financial services, the tendency to produce and sell bundles of services, the weaker and more volatile data, the changes in ownership structure, and the presence of network properties and two-sided network effects in the markets for payment systems are some of the difficulties mentioned.
41. The paper reports significant differences between the measures in H-statistic reported by Claessens and Laeven (2004) and Bikker and Spierdijk (2008) for individual countries (the correlation is only 0.38, and the rank correlation only

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<sup>23</sup> Eg increased competition can undermine the incentives of banks to invest in information acquisition and thereby lower their lending to information-intensive borrowers.

0.29).<sup>24</sup> This is another indicator that caution must be taken in using the H-statistic to capture the degree of competition.

42. The paper also provides an overview of the findings of various cross-country or country-wide/regional studies. The studies report that making markets more contestable by reducing entry and exit barriers, increasing the flow of cross-border capital and especially inducing entry by foreign banks can have favourable competitive effects on the development of domestic banking systems. Finally, the paper provides an overview of the possible implications for competition policy.

*Bikker, JA, Shaffer, S and Spierdijk, L (2012), Assessing competition with the Panzar-Rosse model: the role of scale, costs, and equilibrium*

43. The paper is largely focussed on methodological issues and provides further evidence that the Panzar-Rosse model suffers from misspecification biases. The authors show that neither a price equation nor a scaled revenue function yield a valid measure for competitive conduct. Even when using an unscaled revenue function, additional information about costs and market equilibrium is needed in order to infer the degree of competition correctly. The results are confirmed by empirical analysis using a sample of more than 100,000 bank-year observations on more than 17,000 banks in three countries during the period from 1994 to 2004. The paper, however, does not provide any new evidence concerning the relationship between concentration and competition in banking.

*Andriesc, AM and Căpraru, B (2014), The nexus between competition and efficiency: the European banking industries experience*

44. Using the Panzar-Rosse model, the authors estimate the degree of banking competition in the EU countries for the period from 2004 to 2010. The authors find that the H-statistic used to measure competition in banking varies considerably across EU countries. The measure of H-statistic indicates that the EU banking sector operates under monopolistic competition. The authors also observe a significant increase in competition in the EU between 2004 and 2010, particularly in the Eurozone countries. The H-statistic for the UK (0.729) is just below the EU average (0.731).

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<sup>24</sup> Interestingly, the H-statistic values for the UK are similar – 0.76 in Bikker and Spierdijk and 0.74 in Claessens and Laeven – despite the fact that the two papers provide conflicting results – Claessens and Laeven report a positive relationship between concentration and the level of competition, whereas Bikker and Spierdijk contradict this finding.

45. By applying convergence tests, the authors also assess the evolution of competition in the EU member states, confirming that the convergence process occurs in banking systems with above-average competition levels.
46. Finally, the authors also find that with the exception of non-Eurozone countries<sup>25</sup> the competition–efficiency hypothesis is confirmed, showing that an increase in competition determines a significant increase in profit efficiency.<sup>26</sup>

**(ii) Other**

*van Leuvenstijn, M, Bikker, JA, van Rixtel, A and Sørensen, CK (2007), A new approach to measuring competition in the loan markets of the euro area*

47. This is the first paper that applies the Boone indicator<sup>27</sup> measure of competition to the lending markets of the five major Eurozone countries<sup>28</sup> as well as the UK, the USA and Japan. The Boone indicator measures the effect of efficiency on firms' performance using information on firms' profits and market shares, eg more efficient firms are expected to earn higher profits and have higher market shares. The Boone approach assumes that competition enhances the performance of efficient firms and impairs the performance of inefficient firms, which is reflected in their profits and market shares. The advantage of this measure compared with other applied competition measures is that it can be used to measure competition in specific market segments<sup>29</sup> and also requires relatively little data. However, specific limitations of this measure should be taken into account: for example, the Boone indicator assumes that banks generally pass on at least part of their efficiency gains to their customers and ignores differences in product quality and design, as well as attractiveness of innovations.
48. The estimation is based on the following assumptions: (i) that banks pass on at least part of their efficiency gains to their customers, eg by translating lower costs into lower output prices to gain market share; and (ii) that banks over time provide more or less similar quality levels, ignoring possible differences in product quality and design. The authors improve the original model by calculating marginal costs by using a translog cost function instead of approximating marginal costs by average variable costs.
49. The authors find that over the period from 1994 to 2004 the USA had the most competitive market for loans, whereas overall the loan markets in Germany and

<sup>25</sup> Results were insignificant for non-Eurozone countries.

<sup>26</sup> See footnote 41 for an explanation of profit (in)efficiencies.

<sup>27</sup> See Appendix A for a description of the Boone indicator.

<sup>28</sup> This includes Germany, France, Spain, Italy and the Netherlands.

<sup>29</sup> Other competition measures, eg the Panzar-Rosse model, measure competition for the entire banking sector.

Spain were among the most competitive in the EU. The UK market for loans was generally less competitive.<sup>30</sup> The paper also measures competition between specific types of bank (commercial, savings and cooperative), finding that commercial banks tend to be more competitive.

*Carbó Valverde, S, Humphrey, D, Maudos, J and Molyneux, P (2009), Cross-country comparisons of competition and pricing power in European banking*

50. The authors compare the results of five well-known indicators of banking market competition (the net interest margin/total asset ratio,<sup>31</sup> the Lerner index, the return on assets (RoA),<sup>32</sup> the H-statistic and the HHI) for a cross-section of 14 European countries (including UK) over the period from 1995 to 2001. The authors find that, despite providing consistent rankings of competition across countries at the extremes, these measures are only weakly positively correlated with each other. They are even less correlated (with only three out of 14 countries displaying a positive correlation) when within-country comparisons of different competition measures are made. The UK is consistently among the more competitive markets (ranging from second to sixth depending on the competition measure used), a finding that is different from other studies reported above.
51. The authors explain the low degree of correlation between the different indicators by the fact that these indicators are used to measure different things and are also influenced by cross-country differences in cost efficiency, fee levels, real economic growth and inflation.
52. In order to develop more consistent cross-country estimates of bank competition, the authors then propose a new, adjusted measure of bank pricing power, where they subtract the influence of country-specific effects from non-structural competition measures by using an approach from the frontier efficiency literature. The results given by this estimator imply that banking market competition in Europe may well be stronger than implied by traditional measures.

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<sup>30</sup> However, the paper reports that these results differ from other empirical studies using alternative measures of competition. For instance, Carbó et al (2006) (a more recent version of this paper was published in 2009) suggest that on average banking competition seems to be strong in the UK, followed by the Netherlands and France, and lower in Spain, Italy and Germany. The authors think that such differences are normal given the differences in methods used.

<sup>31</sup> This measure reflects the loan–deposit interest spread or interest rate mark-up after controlling for different sized banks by deflating by total asset value.

<sup>32</sup> The ratio of bank net income to the value of total assets. This is a profitability measure that considers all sources of income, not just that from traditional loan and security asset holdings.

53. The paper examines the performance of different competition measures using data on 46 countries over the period from 1996 to 2005. Various different models are compared, including the Lerner index, the SCP model (using the HHI and 3 firm concentration ratio ( $C_3$ ) as indicators),<sup>33</sup> the Cournot model (using market share as an indicator),<sup>34</sup> the Boone indicator, the Panzar-Rosse model and various models measuring efficiency costs, profit and market structure (the HHI, concentration ratios, number of banks). The analysis is based on the banking market as a whole, without regard to possible product differences.
54. The results show that the indicators, although behaving in accordance with their theoretical frameworks, are only moderately correlated with each other and differ strongly in quality. The author argues that this is due to the indicators measuring different things – competition is not the same as efficiency or profitability.
55. The results given by various competition estimates for the UK show exceptionally high cost levels, high interest margins and high profits, which are hard to reconcile with a competitive climate.

56. Using a persistence of profit approach, the paper measures the strength of bank competition in 65 countries over the period from 1997 to 2007. The persistence of bank profit approach applies a dynamic view of bank competition and is consistent with the view that potential entry is as important as actual entry in determining the intensity of competition.
57. The main hypothesis tested is that entry and exit are sufficiently free to eliminate any abnormal profits quickly, so that bank profit rates converge rapidly towards their long-run equilibrium. Alternatively, entry may be prevented by structural characteristics, specialist knowledge or regulatory advantages enjoyed by the established banks, leading to abnormal bank profits persisting from year to year.
58. The paper reports the presence of the persistence of profit, with banks in developed countries exhibiting higher persistence of profit on average than those in developing countries – the persistence of profit is relatively high in North America and Europe and relatively low in East Asia, the Pacific and sub-Saharan Africa. The authors conclude that barriers to entry and exit are sufficiently high to enable banks to retain a significant portion of their abnormal profits from year to

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<sup>33</sup> Measures the effect of concentration on profit.

<sup>34</sup> Measures the effect of market share on profit.

year. The paper also finds that the persistence of profit is stronger in those markets that are sheltered from competition by legally imposed barriers to entry.

*Liu, H, Molyneux, P and Wilson, JOS (2013), Competition in banking: measurement and interpretation*

59. The paper provides a detailed overview of various approaches used to measure the relationship between concentration and competition in banking: SCP-based models (ie concentration ratios and HHI) and new empirical industrial organisation (NEIO) measures, eg the Panzar-Rosse H-statistic, the Lerner index, the Boone indicator and the persistence of profits approach.
60. The persistence of profits approach argues that if entry and exit are sufficiently free, it will eliminate any abnormal profit quickly and all banks' profit rates will converge to the same long-run average value. On the other hand, if the established banks are able to delay or block entry, abnormal profits tend to persist and differences in firm-level long-run average profit rates may be sustained indefinitely.
61. The authors apply the above-mentioned measures<sup>35</sup> to test the degree of competition in nine EU banking markets, including the UK, over the period from 2000 to 2009. The results for the UK show that the UK market was one of the least competitive of the nine examined. The authors conclude that different competition measures can provide different results and that most of the competition measures do not provide consistent evidence of the competitive conditions across their sample countries.

*Tabacco, GA (2015), Market structure and intensity of price competition in EU banking*

62. The paper analyses the relationship between market structure and the intensity of price competition in the EU banking industry. The author uses John Sutton's framework to empirically measure the relationship between market size and market concentration and then, using his own recently developed framework, measures the intensity of price competition in the then 27 EU member states from 2007 to 2012.
63. Sutton's approach can be briefly described as follows. Industries are grouped into exogenous and endogenous sunk costs industries:
  - (a) Exogenous sunk cost industries are those with homogeneous products or with horizontal product differentiation, and the firms operating in such

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<sup>35</sup> For the Panzar-Rosse model, the paper uses the estimation suggested by Bikker et al (2012) which addresses possible endogeneity issues reported.

industries compete on price. The following outcomes are expected to occur in markets characterised by exogenous sunk costs: (i) negative relationship between market size and concentration; (ii) concentration converging to 0 as market size becomes large; and (iii) tougher price competition leading to a more concentrated market structure at any given market size.

- (b) Endogenous sunk cost industries are those with vertically differentiated products, for which quality becomes extremely important. The key feature in such industries is that product quality is enhanced by means of fixed sunk cost investments, such as research and development and advertising. Expansion of the market does not attract any further entry, but instead induces established banks to increase expenditure on endogenous sunk costs.
64. The results suggest that there is a null relationship between the total size of the market and concentration, in support of Sutton's endogenous sunk costs model. The author suggests that banks possibly compete on quality by investing in endogenous sunk costs such as advertising, branch network, coverage, number of employees per branch and salary per employee.
65. Furthermore, the results from the author's own newly developed measure of banking competition<sup>36</sup> suggest that price competition is rather soft in the majority of EU member states and that banks compete on service quality. In terms of price competition, the UK's banking industry is ranked as the third-lowest of the 27 countries evaluated.

**(c) Other single-country studies**

*Berger, AN and Hannan, TH (1998), The efficiency cost of market power in the banking industry: a test of the 'quiet life' and related hypotheses*

66. The paper examines whether firms in more concentrated markets show lower operating efficiencies and tries to measure the magnitude of the resultant costs to the entire banking industry.
67. To authors use the 'quiet life' hypothesis that the market power exercised by firms in concentrated markets allows them to be less concerned about minimising costs, which may result in lower cost efficiency through one or more

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<sup>36</sup> The empirical implementation of Sutton's approach requires defining a lower bound, ie the minimal level of concentration admissible, below which nothing can happen in long-run equilibrium. On and above the lower bound, any market structure is consistent with the theory. To evaluate the degree of price competition the author then measures the distance of the lower bound to concentration, which ranges from -1 to 1. The higher the value, the greater the intensity of price competition.

of several mechanisms – shirking by managers; the pursuit of objectives other than profit maximisation; political or other activities to defend or gain market power; or simple incompetence.

68. Based on the data from over 5,000 US banks and measures of local market concentration (using the HHI), the authors find strong evidence in support of the ‘quiet life’ hypothesis – the results show that banks in more concentrated markets show poorer cost efficiency.
69. The authors also estimate the costs resulting from concentration-induced losses in bank efficiency and compare them with estimates of the social loss associated with the misallocation of resources from non-competitive pricing as measured by the welfare triangle. They find that the additional operating costs attributable to market concentration appear to be substantially larger than the social loss due to the non-competitive pricing of bank outputs, suggesting that anticompetitive mergers entail large social costs.

*Tregenna, F (2009), The fat years: the structure and profitability of the US banking sector in the pre-crisis period*

70. The paper analyses the effects of structure on bank profitability in the US in the pre-crisis period from 1994 to 2005. The results show that concentration led to increased bank profitability. This finding holds even when the largest banks are excluded from the sample, suggesting that the relationship between concentration and profitability acts in a generalised structural way, not merely through channels such as economies of scale.<sup>37</sup> Part of banks’ very high profits in the pre-crisis period can thus be regarded as deriving from the increasingly concentrated structure of the industry.
71. The author finds that the overall positive relationship between concentration and profitability is not just a reflection of the positive effects of concentration on the profitability of the largest banks, but that concentration positively affects the profitability of the rest of the banking sector. The results also suggest that the effects of bank concentration on bank profitability come at the expense of non-bank entities and could be detrimental to the rest of the economy.
72. The results do not support the X-efficiency hypothesis, suggesting that the very high profits during the pre-crisis period should not be attributed to the banks being run more efficiently.

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<sup>37</sup> In fact, the author finds that the largest banks are above a size which would appear to be ‘optimal’ in terms of economies of scale.

*Hannan, TH and Adams, RM (2011), Consumer switching costs and firm pricing: evidence from bank pricing of deposit accounts*

73. The paper assumes that competition is local for deposit markets and that pricing of deposit accounts varies by geographical area. Using data measuring migration level into and out of the local US markets, the authors test banks' pricing strategies in areas experiencing different levels of migration into and out of these local markets.
74. The paper explores the pricing relationships implied by existence of switching costs in deposit markets. Because of these switching costs, the banks face a trade-off between attracting new customers and exploiting old ones.
75. The authors predict that in addressing this trade-off, all else being equal, the banks will offer higher deposit interest rates in the areas (and during periods) experiencing more inward migration, and lower deposit rates in the areas (and during periods) experiencing greater outward migration.<sup>38</sup> Consistent with these predictions, regression results show a strong and robust relationship between bank deposit rates and the rates of inward and outward migration: deposit rates are found to increase with the rate of migration into a market and decline with the rate of migration out of the market, with the rate of outward migration having a more negative effect on deposit rates when the rate of inward migration is higher. The results imply that switching costs are very important in explaining bank deposit rates, and the negative relationship between bank deposit rates and the rate of outward migration implies, in particular, that banks take into account the future profitability of locked-in depositors in choosing current deposit rates.
76. The authors also find a negative relationship between HHI and deposit interest rates, a result consistent with the assumption that more concentrated markets lead to a greater exercise of market power.

*Bolt, W and Humphrey, D (2012), A frontier measure of U.S. banking competition*

77. The authors find that the three main measures of competition, the HHI, the Lerner index and the Panzar-Rosse H-statistic, are uncorrelated with each other for US banks.<sup>39</sup> This could be explained by the fact that these three standard measures focus on traditional bank loan and deposit activities, while neglecting increasingly important fee-based services, and incompletely adjust for input productivity differences among banks.

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<sup>38</sup> Because greater outward migration implies that a locked-in customer will not stay with the bank for many temporal periods.

<sup>39</sup> The paper also reports that the measures are only very weakly correlated for European banks, where banking concentration is considerably greater.

78. To correct this, the paper proposes an efficient frontier measure of competition similar to the one developed by Boone.<sup>40</sup> The authors use available separate revenue data for traditional banking products (consumer and business loans) along with securities and two fee-based services (payments and investment banking activities). Bank retail prices and pricing revenues are assumed to be essentially determined by the level of underlying costs and market interest rates, the productivity of the banks in producing their services and the degree of market competition, which may permit revenues to exceed a normal return on invested capital or equity.
79. This model is then applied to five major bank service lines listed above using data for the period from 2008 to 2010. The authors find that these banking activities can be ranked by their degree of relative competition in the following order (most competitive first): business loans, security operations, payment activities, consumer loans, and investment banking and related services.

*Koetter, M, Kolari, JW and Spierdijk, L (2012), Enjoying the quiet life under deregulation? Evidence from adjusted Lerner indices for U.S. banks*

80. Using a sample of approximately 350,000 observations containing annual data for all insured US commercial banks from 1976 to 2007, the authors test for the 'quiet life' hypothesis, ie that firms with market power are prone to cost and profit inefficiencies.<sup>41</sup>
81. To test for potential cost and profit inefficiencies the authors use efficiency-adjusted Lerner indices.<sup>42</sup> The findings show that adjusted Lerner indices are on average about 30% higher than conventional Lerner indices suggesting an increase in market power in the US banking industry from 1998 to 2007. The authors also investigate the causal relation between market power and inefficiency, finding evidence in support of the 'quiet life' hypothesis.<sup>43</sup>
82. The paper also estimates the effects of deregulation on the 'quiet life' hypothesis. The findings again are in support of the 'quiet life' hypothesis in terms of profit efficiency. The effect of deregulation on efficiency is found to be generally positive, though fairly small.

<sup>40</sup> See Appendix A for a description of the Boone indicator.

<sup>41</sup> The profit inefficiencies arise when firms do not fully exploit their pricing opportunities, for example requiring too little collateral and charging too low interest rates when lending.

<sup>42</sup> The Lerner indices are adjusted to account for the possibility of forgone rents, avoiding the assumption of full efficiency. A better description of a conventional Lerner index is given in Appendix A.

<sup>43</sup> The paper reports a significant negative relationship between adjusted Lerner indices and profit efficiency, showing that profit efficiency declines with the increase of market power. With regard to cost efficiencies, neither conventional nor adjusted Lerner indices provide any evidence supporting the 'quiet life' hypothesis. In general, the results show that profit and cost efficiencies are often different for adjusted versus unadjusted Lerner indices.

*Overvest, B and Tezel, G (2014), Notes on the margin: an overview of NMA's mortgage market study*

83. The paper provides an overview of a sector study conducted by the Netherlands Competition Authority (NMA) on the Dutch mortgage market. The NMA's study analysed various aspects of the market, including the changes in concentration, barriers to entry and exit, consumer preferences, switching costs and the likelihood of (tacit) collusion. The paper is focused on the findings concerning the developments relating to bank margins.
84. The authors find that following the financial crisis, average bank margins increased significantly, reaching historically high levels, and then fell back to pre-crisis levels in early 2011. The authors conclude that these developments can be explained by changes in market structure: (i) the increase in margins was preceded by a merger between two major banks, thus reducing the competitive pressure exerted by challenger banks; and (ii) stabilisation of financial markets and increase in the sales of challengers led to a decrease in concentration levels and margins. The study finds no indication that the changes in margins were driven by collusive conduct.

*Mulder, M (2014), The impact of concentration and regulation on competition in the Dutch mortgage market*

85. The paper investigates the effects of industry structure and regulatory pricing constraints on competition in the Dutch mortgage market during the financial crisis. The author estimates the effect of the changes in concentration levels (estimated by the four firm concentration ratio<sup>44</sup> (CR<sub>4</sub>) and the HHI) on the Lerner index over the period from 2005 to 2010.
86. The paper finds that the increase in concentration levels has a negative effect on competition. It links this to the decline in competitive pressure from fringe suppliers, thus enabling the larger banks to charge higher interest rates. It also finds indications that the regulatory pricing constraints imposed by the European Commission have negatively influenced competition, with the less aggressive pricing policy of the state-supported banks resulting in less intensive competition.

*Bolt, W and Humphrey, D (2015), Assessing bank competition for consumer loans*

87. The paper analyses and compares the performance of several competition indicators, including the HHI, the Panzar-Rosse H-statistic, the Lerner index,

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<sup>44</sup> A broader description of concentration ratios and other measures is given in Appendix A.

mark-up<sup>45</sup> and two newer measures based on frontier analysis,<sup>46</sup> in measuring the competitiveness of banks in the provision of consumer loans.

88. Looking at a sample of 2,644 banks in the US over the period from 2008 to 2010, the paper finds that the competition measures are only weakly correlated to each other, showing that the assessment of competition largely depends on the measure used.
89. Using each competition measure the authors rank the banks from most to least competitive and then match the findings with banks having the lowest to highest average price of consumer loans. The authors find that the best matches are given by the Lerner index, the mark-up and the competition efficiency frontier measure, and conclude that these measures can be considered as the ‘best’ in identifying the price conduct aspect of the SCP paradigm. HHI provides no matches that are significant.

#### **(d) Other cross-country studies**

*Corvoisier, S and Groppe, R (2001), Bank concentration and retail interest rates*

90. The authors maintain that the impact of concentration on the pricing behaviour of banks can be summarised by two opposing hypotheses: (i) banks will collude and use market power to extract rents (the ‘structure–performance’ hypothesis) and (ii) concentration will increase the overall efficiency in the sector. According to the latter hypothesis, concentration is due to more efficient banks growing more rapidly than less efficient banks, or more efficient banks taking over less efficient ones. If this were the case, banks would price their services more competitively (the ‘efficient structure hypothesis’). The authors also raise a further possibility that higher contestability can lead to an overall increase in competition, irrespective of the level of concentration.
91. The authors construct HHIs for selected euro area countries for different bank products, including overall, short-term and long-term customer loans, mortgages, and demand, fixed-maturity and saving deposits, covering the period from 1993 to 1999. They then estimate a country-specific, product-specific Cournot model where banks are assumed to behave as price setters in the loan market, while

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<sup>45</sup> Measured as the difference between the average price of consumer loans and average cost of deposits, divided by the average price of consumer loans.

<sup>46</sup> These include an efficiency-adjusted Lerner index as proposed by Koetter, Kolari and Spierdijk (2012) and a competition efficiency frontier measure similar to the Boone indicator.

they face a given deposit rate on their liabilities.<sup>47</sup> They regress banks' margins on HHIs, parameters for risk and costs and other variables.

92. The authors find that increasing concentration in a sample of EU countries (the UK not included) may have resulted in less competitive pricing by banks for loans and demand deposits. However, for savings and time deposits, evidence that concentration affects interest rates is not found.

*Berger, AN, Demirguc-Kunt, A, Levine, R and Haubrich, JG (2004), Bank concentration and competition: an evolution in the making*

93. The paper provides an overview of the economic literature dealing with the impact of bank concentration and competition on bank performance. The paper is mainly based on studies of the US markets.
94. The authors note that new research is moving away from the traditional concentration measures, such as HHI or concentration ratios, in order to test the SCP paradigm, and starting to apply alternative models, such as the efficient structure hypothesis, the Bresnahan conjectural variation model, the Panzar-Rosse model and structural demand models based on consumer choice under product differentiation.
95. The new research distinguishes between concentration and competition and generally finds that bank competition is 'good' from a social perspective. However, the papers report only weak evidence of concentration effects on pricing – while greater concentration is generally associated with less favourable prices for consumers, higher profitability and reduced access to credit, these findings are frequently not robust when other measures of bank competition, such as regulation or foreign bank entry, are included.
96. The findings of studies based on the measures of competition other than concentration are generally robust, showing that policies that restrict bank competition – regulation, barriers to foreign bank participation, and direct state control of banking resources – tend to be associated with 'bad' outcomes, such as higher prices, less access to credit, reduced stability of the financial system and diminishing overall economic performance.

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<sup>47</sup> The authors assume that banks behave as Cournot competitors in the sense that the loan rate of one bank does not affect the behaviour of any of its competitors in the loan market.

*van Leuvensteijn, M, Sørensen, CK, Bikker, JA and van Rixtel, A (2008), Impact of bank competition on the interest rate pass-through in the euro area*

97. Using the Boone indicator, the paper investigates the impact of loan market competition on the interest rates applied by the euro area banks to loans and deposits during the period from 1994 to 2004.
98. Three outcomes are tested:
  - (a) the effect of loan market competition on the level of bank loan and deposit rates;
  - (b) the effect of loan market competition on the long-run equilibrium pass-through of bank interest rates to changes in corresponding market interest rates; and
  - (c) the effect of loan market competition on the immediate adjustment of bank interest rates to changes in market interest rates.
99. The results provide evidence that stronger competition implies significantly lower spreads between bank and market interest rates for most loan market products, ie stronger competition leads to lower interest rates and stronger pass-through of market interest rates.
100. Furthermore, the authors observe higher bank spreads (ie lower bank interest rates) on current account and time deposits when loan market competition is stronger. This suggests that bank competition is heavier in the loan market, so that banks compensate for their reduction in loan market income by lowering their deposit rates.

*Degryse, H and Ongena, S (2008), Competition and regulation in the banking sector: a review of the empirical evidence on the sources of bank rents*

101. The paper provides an overview of findings from empirical banking literature. This includes a review of 12 papers on the effect of concentration on deposit markets and 18 on the effect of concentration on loan markets. The authors find that increased concentration tends to lead to higher loan interest rates, but that the magnitude of this result varies widely depending on the study. For deposit rates, they find that overall most papers report a negative impact of an increase in concentration on time<sup>48</sup> and savings deposit rates. However, demand deposits<sup>49</sup> seem less affected by market concentration.

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<sup>48</sup> Time deposits are those that cannot be withdrawn for a specific period of time without incurring a penalty.

<sup>49</sup> Accounts from which deposited funds can be withdrawn at any time without any advance notice.

102. The paper provides a short summary of previous analysis of structure–performance relationships in retail banking. The literature indicates that higher levels of local bank market concentration lead to lower interest rates for depositors and, with some complex exceptions, higher interest rates for borrowers. One study also find that young (ie newly established) borrowers tend to pay lower interest rates for their loans, which can be described as 'bargains'. Once such consumers are locked in, the loan interest rates are increased.
103. The literature reviewed also finds definite economies of scale and scope in banking, but in most cases these are exhausted at relatively low thresholds. The paper also finds evidence of a positive relationship between an increase in market concentration (usually, following a merger) and new entry, suggesting that market forces may mitigate at least some of the anticompetitive effects associated with high concentration.

## **Appendix A: Overview of different methods used to measure competition in banking**

1. The most common methods used to measure competition in banking can be summarised as follows:
  - (a) Structural and related methods, such as various concentration indices, entry analysis and the Lerner index, which often have low data requirements, but exhibit weaknesses in theoretical foundations, eg concentration levels do not necessarily reflect the level of competition in the market.
  - (b) The Panzar-Rosse H-statistic, which has low data requirements, but is mainly used to test the competitiveness of the banking system as a whole, rather than focusing on specific product markets. This is the most widely applied model; however, serious misspecification issues were reported by several studies,<sup>50</sup> resulting in biased estimates.
  - (c) The Boone indicator, which has low data requirements and can be used to test the competitiveness of specific banking sectors. However, it faces identification issues if firms compete on quality and design.
  - (d) Other measures, eg conjectural variation models, profit margins, persistence of profits approach and measures based on frontier analysis.
2. A more detailed description of these methods is given in Léon (2014).
3. This paper provides an overview of the most frequently used structural and non-structural measures of competition in banking, providing a detailed description of the advantages and disadvantages of each method.
4. It divides the approaches used to estimate competition into two main groups:
  - (a) Structural models are based on traditional industrial organisation and focus on the linkages between market structure and performance (the SCP paradigm). Under the SCP paradigm, high concentration increases market power and incentives to collude, which, in turn, leads to higher prices and profitability. The paper outlines the following structural measures used to measure competition:
    - (i) There are various concentration measures: the number of firms, concentration ratios and the HHI:

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<sup>50</sup> See for example Bikker et al (2006a, 2006b, 2012), Goddard and Wilson (2008).

- i. The number of firms is the simplest of the concentration measures and is calculated as the sum of firms in the market. The different market shares of each firm are not taken into account.
- ii. The  $k$ -firm concentration ratio measures the market share of top  $k$  firms in the market and can be described as the sum of the market shares of the  $k$  largest firms. The most commonly used  $k$  values are 3, 5 and 10.

$$CR_k = \sum_{i=1}^K s_i$$

The concentration ratio focuses on the market share of the top  $k$  firms only and does not take into account the size distribution of the remaining firms.

- iii. The HHI is the concentration measure most frequently used by national competition authorities and researchers and is computed by summing the square market shares of all  $N$  firms on the market.

$$HHI = \sum_{i=1}^N s_i^2$$

The HHI assigns greater values to higher market shares, thus giving more importance to larger firms.

<i>Advantages</i>	<i>Shortcomings</i>
Have low data requirements Do not require firm-level variables	Have weaknesses in theoretical foundations – alternative theories show that concentrated markets can be competitive (eg Bertrand duopoly, market contestability) and collusion can also be sustained in the presence of many firms Are not exogenous and may reflect differences in firms' efficiency Require relevant markets to be defined; are subject to data availability issues

- (ii) Contestability theory focuses on regulatory and supervisory frameworks, entry and exit conditions.

<i>Advantages</i>	<i>Shortcomings</i>
Data available for a large number of countries Does not require firm-level variables	Omits non-regulatory barriers and sunk costs Entry and exit in banking industry can be influenced by non-legal (eg technological and informational) barriers, especially in developing countries

- (b) New empirical industrial organisation models focus on non-structural measures of competition, and were developed as a response to deficiencies

in the SCP paradigm. These models try to assess directly the competitive conduct of firms. The paper outlines the following measures:

- (i) The Lerner index provides a firm-specific measure of market power which is simple and straightforward to interpret and does not pose stringent data requirements, with a possibility to study evolution of pricing over time. This method does not require defining the relevant market.

<i>Advantages</i>	<i>Shortcomings</i>
Offers a firm-specific measure of market power Have low data requirements Is simple and straightforward to implement Offers flexibility Market definition not required	Has weaknesses in theoretical foundations (measuring market power is not the same as measuring competition), eg it is theoretically possible that market power increases with more intense competition; fails to take into account reallocation effect from inefficient to efficient firms Cannot capture degree of product substitutability Requires firm-level variables and information on prices Can be distorted by spending on other activities and inefficiency

- (ii) Conjectural variation (Iwata and Bresnahan-Lau) models aim to control for changes in the Lerner index due to demand changes and to isolate firms' competitive behaviour. The conjectural variation model can be described as an elasticity-adjusted Lerner index.

$$L_i = \frac{P - C'_{q_i}}{P} = -\frac{(1 + \lambda_i)s_i}{\varepsilon_i}$$

The conjectural variation parameter  $\lambda_i$  measures firm  $i$ 's expectations about the reactions of its rivals and ranges from  $-1$  to  $N - 1$  (where  $N$  is the number of firms). In a collusive situation if firm  $i$  chooses to increase its production by 1, all firms will do the same. Hence, the full exploitation of market power exercised by firm  $i$  coincides with  $\lambda_i = N - 1$  and the total output increases by  $N$  unities.  $\lambda = -1$  implies that firms are competing under perfect competition and  $\lambda = 0$  – under Cournot.

The value of demand elasticity  $\varepsilon$  can be obtained from the demand equation and the conjectural variation parameter  $\lambda$  – from the modified supply equation.

<i>Advantages</i>	<i>Shortcomings</i>
Gives direct estimate of firm's conduct that is continuous and maps all oligopoly solution concepts Remains valid if regulatory restrictions apply or firms do not maximise profits Can cope with monopsony power in deposit market	Structural model requires specifying of functional forms for demand and supply equations and requires a large number of observations, including prices Small sample issues – identification and instability Is sensitive to market definition – results are biased if sample fails to span the complete market Has same limitations as Lerner index Unable to take into account interest rate regulations

- (iii) The Panzar-Rosse model is the most widely applied competition assessment technique in the banking literature. This indicator captures the influence of input prices on firms' revenues – weak influence (low values) is interpreted as indicating market power whereas strong influence (high values) indicate a higher degree of competition. The model is estimated by using a reduced form revenue equation which regresses revenue (in logarithm) on input prices (in logarithm) and other control variables.

$$\ln(Rev_i) = \alpha + \sum_{l=1}^L \beta_l \ln(w_{l,i}) + \sum_{k=1}^K \gamma_k Z_{k,i} + \varepsilon_i$$

The H-statistic, the parameter measuring the degree of competition, is calculated as the sum of the elasticities of the bank's total revenue with respect to that bank's input prices, and ranges from  $-\infty$  to +1.

$$H = \sum_{l=1}^L \beta_l$$

Under perfect competition, input prices and total revenues increase by the same percentage and the H-statistic = 1. The H-statistic  $\leq 0$  indicates a monopoly, and the H-statistic in a range from 0 to 1 indicates monopolistic competition.

H-statistic is a good measure of competition in a static perspective; however, it requires strong assumptions that cannot always be checked.

<i>Advantages</i>	<i>Shortcomings</i>
<ul style="list-style-type: none"> <li>Can be estimated by simple, single-equation linear model</li> <li>Requires a limited number of observations</li> <li>Does not require market definition</li> </ul>	<ul style="list-style-type: none"> <li>Has identification issues: some important assumptions have to be verified, eg the market has to be in long-run equilibrium (ie the number of firms is endogenous and the bank profits are uncorrelated with input prices)</li> <li>Interpretation of the H-statistic depends on the hypotheses assumed regarding the market equilibrium, demand elasticity and cost function</li> <li>Requires information on prices</li> <li>Monopsony power could mask monopoly power</li> </ul>

- (iv) The Boone indicator takes into account the reallocation effect and is based on the presumption that more efficient firms achieve superior performance, in terms of higher profits at the expense of their less efficient rivals, and also attract greater market share. The Boone indicator uses relative differences in profit to measure the level of competition. The intensity of competition is estimated by using a simple profitability equation:

$$\ln\pi_i = \alpha + \beta \ln c_i + \varepsilon_i$$

The coefficient  $\beta$  gives the profit elasticity, ie the drop in profits caused by an increase in costs, and should be negative, reflecting the fact that higher marginal costs are associated with lower profits.

Efficient banks may choose to translate lower costs either into higher profits or into lower output prices in order to gain market share. To estimate the effect of costs on market share van Leuvenstein et al (2007) uses the following equation:

$$\ln s_i = \alpha + \beta \ln c_i + \varepsilon_i$$

In both cases, higher  $\beta$  (in absolute terms; we are expecting the relationship between costs and profits/market share to be negative) implies higher competition. Both equations can also be run by introducing fixed effects or instrumental variables in order to take into account unobserved heterogeneity.

The Boone indicator catches the dynamic aspects of competition but may sometimes fail to identify the degree of competition in the short run. It is also a recently developed tool and has not yet been properly scrutinised.

#### *Advantages*

- Has strong theoretical foundations
- Can be estimated by simple, single-equation linear model
- Requires a limited number of observations
- Gives continuous measure of competition
- Considers (partially) non-price strategies

#### *Shortcomings*

- Efficiency should be one-dimensional and observed, which is not always the case
- Efficiency gains may not be translated into lower prices or higher profits in the short run
- Different forms of competitive situation cannot be distinguished
- Requires firm-level variables and information on prices
- Has identification issues in some cases (eg if firms compete on quality), leading to positive  $\beta$

## Appendix B: Summary list of sources

- (a) Single Country studies focused on the UK market:
- Heffernan, SA (2002), ‘How do UK financial institutions really price their banking products?’, *Journal of Banking and Finance*
  - Heffernan, SA (2003), ‘UK bank services for SMEs: are they competitively priced?’, *Cass Business School working paper*
  - Gondat-Larralde, C and Nier, E (2006), ‘Switching costs in the market for personal current accounts: some evidence for the United Kingdom’, *Bank of England working paper*
  - Heffernan, SA and Fu, X (2009), ‘The structure of retail markets: what do we learn from bank-specific rates?’, *Applied Financial Economics*
- (b) Cross-country analysis including UK:
- (i) Papers applying the Panzar-Rosse model:
- Bikker, JA and Haaf, K (2002), ‘Competition, concentration and their relationship: an empirical analysis of the banking industry’, *Journal of Banking and Finance*
  - Claessens, S and Laeven, L (2004), ‘What drives bank competition? Some international evidence’, *Journal of Money, Credit and Banking*
  - Bikker, JA, Spierdijk, L and Finnie, P (2006a), ‘The impact of bank size on market power’, *DNB working paper*
  - Bikker, JA, Spierdijk, L and Finnie, P (2006b), ‘Misspecification of the Panzar-Rosse model: assessing competition in the banking industry’, *DNB working paper*
  - Bikker, JA and Spierdijk, L (2008), ‘How banking competition changed over time’, *DNB working paper*
  - Goddard, J and Wilson, JOS (2008), ‘Measuring competition in banking: a disequilibrium approach’, *EIEF working paper*
  - Claessens, S (2009), ‘Competition in the financial sector: overview of competition policies’, *International Monetary Fund working paper*

- Bikker, JA, Shaffer, S and Spierdijk, L (2012), ‘Assessing competition with the Panzar-Rosse model: the role of scale, costs, and equilibrium’, *Review of Economics and Statistics*
- Andriev, AM and Căpraru, B (2014), ‘The nexus between competition and efficiency: the European banking industries experience’, *International Business Review*

(ii) Other:

- van Leuvenstijn, M, Bikker, JA, van Rixtel, A and Sørensen, CK (2007), ‘A new approach to measuring competition in the loan markets of the euro area’, *European Central Bank (ECB) working paper*
- Carbó Valverde, S, Humphrey, D, Maudos, J and Molyneux, P (2009), ‘Cross-country comparisons of competition and pricing power in European banking’, *Journal of International Money and Finance*
- Bikker, JA (2010), ‘Measuring performance of banks: an assessment’, *Journal of Applied Business and Economics*
- Goddard, J, Liu, H, Molyneux, P and Wilson, JOS (2010), ‘The persistence of bank profit’, *Bangor Business School working paper*
- Liu, H, Molyneux, P and Wilson, JOS (2013), ‘Competition in banking: measurement and interpretation’, Handbook of research methods and applications in empirical finance, edited by Bell, A, Brooks, C and Prokopczuk, M
- Tabacco, GA (2015), ‘Market structure and intensity of price competition in EU banking’, *Journal of Competition Law and Economics*

(c) Other single country studies:

- Berger, AN and Hannan, TH (1998), ‘The efficiency cost of market power in the banking industry: a test of the “quiet life” and related hypotheses’, *Review of Economics and Statistics*
- Tregenna, F (2009), ‘The fat years: the structure and profitability of the US banking sector in the pre-crisis period’, *Cambridge Journal of Economics*
- Hannan, TH and Adams, RM (2011), ‘Consumer switching costs and firm pricing: evidence from bank pricing of deposit accounts’, *Journal of Industrial Economics*

- Bolt, W and Humphrey, D (2012), ‘A frontier measure of U.S. banking competition’, *De Nederlandsche Bank (DNB) working paper*
- Koetter, M, Kolari, JW and Spierdijk, L (2012), ‘Enjoying the quiet life under deregulation? Evidence from adjusted Lerner indices for U.S. banks’, *Review of Economics and Statistics*
- Overvest, B and Tezel, G (2014), ‘Notes on the margin: an overview of NMA’s mortgage market study’, *Journal of Competition Law and Economics*
- Mulder, M (2014), ‘The impact of concentration and regulation on competition in the Dutch mortgage market’, *Journal of Competition Law and Economics*
- Bolt, W and Humphrey, D (2015), ‘Assessing bank competition for consumer loans’, *DNB working paper*

(d) Other cross-country studies:

- Corvoisier, S and Groppe, R (2001), ‘Bank concentration and retail interest rates’, *ECB working paper*
- Berger, AN, Demirguc-Kunt, A, Levine, R and Haubrich, JG (2004), ‘Bank concentration and competition: an evolution in the making’, *Journal of Money, Credit and Banking*
- van Leuvensteijn, M, Sørensen, CK, Bikker, JA and van Rixtel, A (2008), ‘Impact of bank competition on the interest rate pass-through in the euro area’, *ECB working paper*
- Degryse, H and Ongena, S (2008), ‘Competition and regulation in the banking sector: a review of the empirical evidence on the sources of bank rents’, *Handbook of financial intermediation and banking*
- Scherer, FM (2010), ‘A perplexed economist confronts “too big to fail”’, *European Journal of Comparative Economics*

(e) Papers describing various methods used to measure competition in banking:

- Léon, F (2014), ‘Measuring competition in banking: a critical review of methods’, *Série Études et Documents du CERDI n° 12*