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When Measuring the Same Leads to Different Conclusions – A Critical Review of Measures Applied to Assess the Degree of Competition in Banking Systems

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Abstract

Economic studies on the degree of competition (DC) in banking systems use various measures which are subsumed under the 1) structure- (e. g. Herfindahl-Hirschman index), 2) conduct- (e. g. Boone indicator) or 3) performance-oriented approach (e. g. Lerner index). Yet, the respective empirical operationalizations of the different DC measures are expected to represent one central construct – the true DC of a banking system. We review 35 studies covering 15 European banking systems from 1998 to 2007. Contrasting the central construct hypothesis, we find substantial differences in the produced DC measures. Thus, the economic validity of derived conclusions regarding the competition intensity is challenged.

Keywords: Competition measurement; Degree of competition (DC); SCP paradigm; European banking system; Banking industry; Lerner index; Boone indicator; H statistic; CH_3; Central construct hypothesis

JEL: E43; E52; E58; L16

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I. Introduction

Over the last decade, the efficiency of the European financial system has been a central issue not only in general discussions involving corporations, practitioners and politicians but also in corresponding academic research. Accordingly, numerous recent studies in the field of industry economics, financial economics, market regulation and policy advice deal with questions regarding the stability, profitability and the resulting general economic performance. In this intense debate, the predominant fundamental underlying construct that guides the economic evaluation of the status quo in any national banking industry and the surrounding financial system is the degree of competition (referred to as DC) between the market agents.

Therefore, the DC covers a large scope of application. As a first example, when assessing the risk-bearing capacity of banks and the effects on the surrounding financial system, the controversially discussed competition-fragility and competition-stability hypotheses are by definition DC-based (see *Allen/Gale,* 2004; *Berger* et al., 2009; *Zigraiova/Havranek,* 2015; *Căpraru/Andries,* 2015).[1] Secondly, the DC is also frequently used in studies examining the profitability of particular strategic business areas of banks such as the lending business. For instance, *Koetter et al.* (2006), *Weistroffer* (2013) as well as *Schnabel* (2014) find that in the respective German market segment, over-capacities are usually accompanied by an exorbitantly high DC. Thirdly, DC measures are used to assess whether or not productivity gains can be realized. As an example, it is assumed that the (very) fragmented domestic markets along with an increased DC impede such productivity gains due to the inability to capitalize on economies of scale/scope.[2] Fourthly, whether or not the credit supply provided by private and institutional banks to private companies really satisfies equilibrated (i. e. market clearing) conditions (see *Love/Peria* 2014) significantly depends on the banks' ability to set their prices at will. Naturally, the potential market power of banks is determined by the DC. Finally, it is commonly accepted that the DC has a strong impact on the long-term dynamic efficiency of financial markets and its segments. As an example, for the former, this point of view is commonly found in reports published by regulatory institutions (e. g., *German Monopolies Commission*, Major Report 2014). As for the letter, regarding the specific investment banking market segment, *Bharat/Galetovic* (2006)

[1] As an example, *Berger* et al. (2009) administered a DC measurement study to examine the relation between market power, risk issues and fragility based on a sample of over 8,000 banks across 23 developed countries over a time span between 1999 and 2005. Using the DC measure Lerner index, they found that banks with a greater degree of market power are less susceptible to risks. They conclude that a diminished competition in a banking system makes it less fragile in the long run.

[2] In this context, see the recent works of *Feng/Zhang* (2014) and *Carvalho* (2014).

show that the degree of competition (i. e. dimensions of competition) has a substantial effect on the resulting incentives to invest in firm-specific relationships which in the end affects the market's efficiency.

Consequently, the accurate quantitative DC measurement which in turn allows for valid qualitative economic evaluations of the true competitive conditions in a given financial system (e. g., in a country or region) is a prerequisite for effectively supporting decision makers in regulatory institutions, the government or even the upper and middle bank management. To date, the academic literature has established a set of three general conceptual approaches to measure the DC based either on 1) structure- (e. g. the DC measure of Herfindahl-Hirschman index), 2) conduct- (e. g. *Boone indicator*) or 3) performance-oriented information (e. g. the *Lerner index*).

However, regardless of the specific underlying conceptual approach, the quantitative (i. e. numerical) operationalization of the specific DC measures subsumed under those approaches can be difficult due to a lack or the insufficiency of available data, among other reasons. As a consequence, even identical DC measures that follow the same conceptual approach (e. g. the performance of banks as measured by the price-cost-margin-based *Lerner index*) are calculated as indicators using different approximations for the required formula terms, such as the proxies used for the market prices and marginal costs. However, in the end, each indicator presented in academic research has been explicitly developed to measure solely one particular central construct: The true DC of the industry under examination. Therefore, despite the diversity in the conceptual approaches, measures and approximations, the produced DC indicators should in the end yield the same result, in that they allow for a valid qualitative economic evaluation of the real competitive condition in the market (i. e. 'the central construct hypothesis').

Against this background, the present work contributes to the field in that it is the first that examines the central construct hypothesis by reviewing 35 studies on DC measurements using differing approaches, DC measures and indicators. Overall, the reviewed studies cover 15 European banking systems over a period of ten years (1998–2007), hence providing a profound overall database that includes 5,784 observations.[3]

In sharp contrast to the central construct hypothesis, the analysis indicates significant (and to some degree outstanding) discrepancies in the measured DC values and the derived interpretations regarding the prevalent competitive con-

[3] As explained in a separate chapter addressing the description of the dataset, the coverage of data along those dimensions (time x country x studies [i. e. used DC measures]) is incomplete. Upon request, access to the database will be provided to interested researchers (please contact the corresponding author).

ditions in the banking systems. Specifically, in an aggregated analysis at the conceptual approach level (i. e. averaged across DC measures subsumed under each of the three general conceptual approaches at a given time), the market-performance- (vs. conduct-) oriented measures produce significantly higher (vs. lower) DC values, hence clearly indicating an intense (vs. diminished) degree of competition, whereas the structure-oriented DC values indicate a mid-level intensity of competition. Secondly, in a disaggregated analysis at the measure level (i. e. a comparison of DC measures within each of the conceptual approaches), further inconsistencies such as contradicting temporal changes of DCs both across, as well as within, national banking systems were identified. Finally, even when focusing on DC measure applications at the indicator level (i. e. operationalized through different approximations), substantial differences in the produced DC values and the derived intensity of competition as predicted for a selected point in time and country are detected.

Thus, the profound cross- and longitudinal analyses presented in this work clearly indicate that the economic validity of DC measurements at least partly comes into question: The DC measure-based qualitative evaluation of the actual state of competition seems to be rather sensitive to the application of a specific approach, measure and approximation, respectively.

The remainder of this paper is organized as follows: Chapter Two provides a brief theoretical background on DC measurements along with a literature review on prominent DC measures and indicators found to be well-established in the academic literature. Next, the general empirical background of the present work, the observed data, steps in data preprocessing and the general format of the created database (i. e. dimensions: year, country, DC measure) along with the respective sources (reviewed studies) are introduced in Chapter Three. Chapter Four presents the results of the analysis of the DC measures at several levels of aggregation, which is finally followed by concluding remarks and a brief discussion of the findings in Chapter Five.

II. Background and Literature Review on Competition Measurements

1. The Structure-Conduct-Performance Paradigm: Conceptual Approaches and Subsumed DC Measures

In industrial economics, the measurement of competition is fundamentally based on the structure-conduct-performance paradigm (SCP). The SCP paradigm was introduced to the field by *Mason* (1939) and *Bain* (1950) as an explanatory chain of reasoning, according to which a unidirectional causal relation between the market structure, the market conduct and the resulting market performance of economic agents in an industry exists (*Tirole* 1988).

In the context of banking and financial systems, leading economists reasonably suppose that diminished competition between the economic agents in a defined market as indicated by a growing market concentration strongly favors collusive behavior. Consequently, as the concentration in the market increases, the banks are motivated to capitalize on their potential pricing power on both the asset as well as the liability side, which leads to increased market prices (that is: prices above marginal costs[4]). In the end, substantial surplus profits for banks at the expense of social welfare are realized (*Bolt/Humphrey* 2015; *Fu* et al. 2014).

Admittedly, the assumption that this unidirectional, cohesive causality stringently holds along all the steps of the SCP's functional chain has been partly challenged by economists, e. g. by *Demsetz'* efficient structure hypothesis (1974) or the well-accepted theory of contestable markets (*Baumol* 1982). However, the general underlying idea of a multi-level chain configuration constitutes a proper classification framework: It incorporates indirect conceptual approaches at two preceding stages (structure and conduct approach) and one direct approach considering the market outcome (performance-oriented approach)[5], under which the various DC measures can be subsumed (see Fig. 1). The following subsections briefly introduce prevalent DC measures that have been established so far in the academic literature.

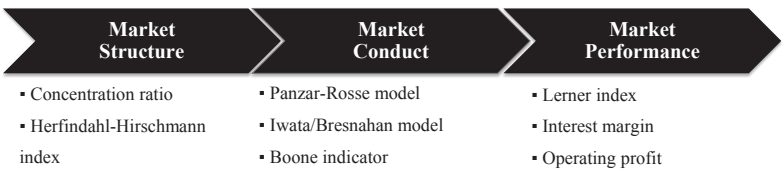

Figure 1: Conceptual Approaches and Related DC Measures

[4] For reasons of completeness, it should be noted that besides the supplier's mere pursuit of profit, other reasons may (logically) account for market price levels positioned above marginal costs (e. g. required risk premiums). However, whenever market prices exceed the marginal costs, a certain degree of price setting power of suppliers is definitely indicated.

[5] Direct DC measures are based on realized market outcomes (e. g., prices, profits) whereas indirect measures are oriented towards certain antecedents of this realized market outcome.

a) Indirect DC Measures Subsumed Under the Market Structure-Oriented Approach

The respective structure of a market can be incorporated in DC measurements either by considering the mere number of suppliers or by the distribution (i. e. the inequality) of the supplier size (*Hall/Tideman* 1967). Due to relatively low data requirements and their analytical simplicity, two DC measures have become the established standard for this market structure-oriented approach.[6] First, a mere *k*-concentration ratio (CR_k) can be calculated as the sum of all market shares of the *k*-largest companies in an industry (where *k* is usually set to 3 or 5). At the one extreme, this DC measure approaches zero when many suppliers along with small market shares fiercely compete with each other, whereas the CR_k produces a DC measure value of exactly one at the other extreme (i. e. in a monopoly).

Secondly, the Herfindahl-Hirschman index (*HHI*) takes into account information about all the suppliers (N) in the examined relevant market. The *HHI* measure was independently developed by A. O. *Hirschman* (1945) and O. C. *Herfindahl* (1950) as a general statistical measure of concentration. Formally, the sum of the squared market shares of the economic agents is considered, thus weighing shares of larger companies much stronger than those of smaller ones. Since the *HHI* not only captures the absolute but also the relative concentration in a market, it increases with a) a decline in the number of suppliers and b) an increase in the inequality of the shares of suppliers in the defined market (see *Hirschman* 1964). The *HHI* is an inverse function of the number of banks (N) in the market and a direct function of the variance (σ2) of the market shares: $HHI = (1/N) + N\sigma 2$ (see e. g. *Bikker/Haaf* 2002, p. 2198). The *HHI* ranges between 0 and 1, respectively 0 and 10,000. In the case of perfect competition, *HHI* approaches 0 (N approaches infinity and the variance approaches zero). In contrast, in the case of a monopoly, *HHI* approaches = 1 ($N = 1$ and $\sigma 2 = 0$).

b) Indirect DC Measures Under the Market Conduct-Oriented Approach

Generally similar to the market structure-oriented approaches, the so-called non-structuralistic DC measures try to ascertain the competitive intensity in an indirect way by examining pricing- and quantity-based strategies as pursued by the economic agents in the marketplace. In the present academic research, two

[6] Moreover, *Bikker/Haaf* (2002) propose some further structural measures such as the Hall-Tideman index, Hannah-Kay index, U index or the Rosenbluth index. However, to the best of the authors' knowledge, those measures are rarely applied in contemporary academic research.

particular DC measures are considered as standard tools for this approach: The *Panzar-Rosse* model (1987) and the *Boone* indicator (2008).[7]

The Panzar-Rosse model is based on the assumption that a company's response in the form of passing on the input prices (e. g. for deposits of banks) to the demand side varies depending on the respective market configuration. Specifically, the sum of elasticities of the input prices – the so-called *H*-statistic – is measured by estimating the revenue function. The percentage change of a company's revenues as a response to an increase of input prices (or marginal costs, respectively) by one percent is negative (or equals zero) in the case of a monopoly.[8] In contrast, the value of the *H*-statistic is positive and falls in a range between > 0 and one (exactly one) in the case of intense competition (perfect competition). Specifically, in the perfectly competitive equilibrium, an increase in the input prices (and thus, the costs) reflects a mere upward shift of the average cost function and should therefore lead to a proportionate increase in prices. Consequently, since the optimum level of bank output remains unchanged, revenues change in strict correspondence to the increased input prices ($H = 1$).

The *Boone indicator* (β) deduces the degree of competition from the cost-oriented inefficiency as observed in the respective markets. *Boone's* DC measure β is based on *Demsetz*' (1974) notion that companies realize larger profits the more productive they are.[9] In the end, inefficiently operating agents suffer more (lose relatively more market share and profit) from increased competition than efficiently working firms (*Leon* 2015). Consequently, this reallocation-effect monotonically increases with competition intensity, i. e. when companies interact more aggressively and entry barriers tend to disappear (*Liu* et al. 2010). Formally, the strength of the ratio (i. e. the elasticity) between the profits and the marginal production costs at a given output level of the operating financial institution has to be determined (*Boone* 2008, 1246 p.). *Boone's* β is negative as it simply mirrors the fact that higher marginal costs are associated with lower profits. In addition, it falls within the range of [–1; 0] which is why lower values indicate more competitive market conditions. Logically, given that a bank oper-

[7] A further prominent DC measure subsumed under this indirect conduct-oriented approach has been developed and extended by *Iwata* (1974), *Bresnahan* (1982) and *Lau* (1982). Specifically, by estimating the conjectural variation of the enterprises and the price elasticities, the reactions of the competitors are herein identified. However, since very detailed and company-specific data is required for computations of this measure, it is rarely applied in academic research (as for some of the published applications, see, e. g., *Shaffer/DiSalvo* 1994; *Bikker* 2003; *Uchida/Tsutsui* 2005).

[8] For reasons of completeness: Besides monopolistic behavior, negative/zero values of *H* could also indicate perfectly collusive behavior in an oligopoly structure.

[9] Put differently, it is assumed that the efficient agents perform better and realize (relatively) higher profits at the expense of inefficient competitors, thereby further attracting a larger market share from those rivals in the long run.

ates in a strongly competitive environment, an increase of the marginal costs by one percent will lead to declining profits. Conversely, in the case of a monopolist having distinctive price-setting power, the bank can completely pass the costs on to the other market side, hence keeping the resulting profits at the initial level.[10]

c) Direct DC Measures Under the Market Performance-Oriented Approach

Direct performance-based DC measures are often reported in public or governmental statistics. Commonly, those measures are either based on mere financial statement variables (e. g. the net operating profits, earnings before interest and taxes [EBIT], etc.) or they reflect a certain type of interest-based margin (e. g. the bank-specific interest rate for a loan minus the current base rate in the lending business).

However, in academic studies, especially those addressing the banking sector, the Lerner index (*LI*) is by far the most commonly applied direct DC measure.[11] The *LI* was introduced in the seminal contribution of Abba P. *Lerner* published in 1934. The *LI* assesses the individual market power of suppliers with respect to their general capability to set their prices above the marginal costs. Specifically, in its original form, the *LI* is defined as the margin between the required output price and the marginal cost expressed as a percentage of the former. Logically, the calculated *LI* values fall within a range between zero (to be more precise: it converges to zero) in the case of perfect competition and almost one under a monopolistic market condition. In general, this means that the weaker (vs. stronger) the competitive pressure in a given market, the higher (lower) the possible price markup on the perfectly competitive price and the higher (vs. lower) the resulting Lerner index *LI*.

As a summarizing overview, Table 1 depicts formulas, terms, variables and ranges of all the above mentioned indirect and direct DC measures subsumed under the three conceptual approaches. Furthermore, some major strengths and weaknesses of each DC measure are given in the table's last column, as recently discussed in more detail by *Leon* (2015).

[10] This depicted causal relation holds under the assumption of a given specific output level only. Note that this assumption is a central pillar of Boone's model.

[11] This is indicated in Table 3 listing the studies reviewed by the authors for this contribution. As for the academic research published over the last decade, the Lerner index is the most frequently applied DC measure of all the introduced indirect and direct DC measures.

Table 1

DC Measurement Approches, Related DC Measures, Formulae, Ranges of Values

	measurement concept/competition measure	*calculation scheme*	*definition of variables*		*range of values*	*strengths*	*weaknesses*
market structure measures	CR_3	$CR_3 = \sum_{k=1}^{3} s_k$	s_k	market share of the k = 1,…, n largest banks	$0 < CR_3 \leq 1$	simple way of calculation low data requirements cardinal interpretation possible	no recognition of changes in market shares between the k largest banks normative specification of k geographic definition of the relevant market is necessary presumed causality between oncentration and competition not necessary (Efficiency hypothesis, Contestable markets)
	CR_5	$CR_5 = \sum_{k=1}^{5} s_k$	s_k	market share of the k = 1,…, n largest banks	$0 < CR_5 \leq 1$		
	HHI	$HHI = \sum_{k=1}^{N} s_k^2$	s_k	market share of all k = 1,…, N banks	$0 < HHI \leq 1$	inclusion of all market participants consideration of relative concentration generally low data requirements	

(continue next page)

(Table 1 continued)

market conduct measures	*Panzar-Rosse model*	$H = \sum_{i=1}^{n} \frac{\partial R}{\partial w_i} \frac{w_i}{R}$	H w_i R	H statistic input price for input factor $i,\ldots,n$ aggregated revenues of a bank	$\leq 0 \rightarrow$ monopoly $\leq 1 \rightarrow$ monop. COMP $\equiv 1 \rightarrow$ perfect COMP	robust against the geographic definition of the market moderate data requirements direct measurement of the market conduct	long-term equilibrium necessary (except in the monopoly case) assumption of a single product company and perfect competition on the input market rollig estimations hamper the intertemporal analysis assumptions on elasticities and cost functions necessary short-term negative H statistic despite of a high degree of competition possible
	Boone indicator	$\beta_k = \frac{\partial \ln \pi_k}{\partial \ln mc_k}$	β_k π_k mc_k	strength of the causal connection periodized profit of bank k marginal production costs of bank k	$-1 \leq \beta_k \leq 0$	also possible to calculate for single production markets steady and monotone relation between costs and profits illustration of market dynamics over time	no consideration of reinvested productivity gains critical assumptions regarding the relevant market cost structure has to be known
market performance measures measures	*Lerner index*	$LI_k = \frac{p(Q) - mc_k(q_k)}{p(Q)}$	$p(Q)$ $mc_k(q_k)$	price level at the market marginal costs of bank k	$0 < LI_k \leq 1$	calculation possible for single companies, groups of companies and the market as a whole very good illustraion of changes over time geographic definition of the relevant market not necessary by using mark-up pricing also quantitative measurement of market power possible robust against exogeneous influential factors	knowlege on the cost function is required theoretically, the increase of the Lerner index is possible despite of an increase in thecompetitive pressure

2. *Empirical Application of DC Measures in Academic Research: Proxies and Indicator*

As the mathematical formulae depicted in Table 1 reveal, the empirical application of the proposed DC measures requires certain types of information. However, at first glance it becomes obvious that the numerical calculation of the DC measures and the respective terms/variables can be hampered by the data requirements. Specifically, this means that the needed information is either a) not available at all (e. g., because it is based on a bank's internal business data not accessible to the researcher) or b) not unambiguously defined because several types of data may be used to represent a certain construct such as the 'input prices' as a main part of the Boone indicator's formula.

As a natural solution for this obstacle, certain approximations (usage of proxies) are required and applied by researchers in competition measurements, thereby finally creating specified *indicators* for DC measures. By definition, the term *indicator* is further used in this work as a synonym for a certain DC measure that is operationalized in a distinct way by using particular proxies for required formula constructs, terms and variables. Naturally, the applied operationalizations may substantially differ in that they use quite different proxies for the terms and variables of an identical DC measure.

As an example for a proxy of marginal costs (i. e. overall), average (international/national) deposit rates could be applied to properly gauge marginal costs in a national lending business (see e. g. *Gischer* et al. 2015). Market shares are one of the requirements for determining the *k*-largest banks' cumulative share (CR_k) or the DC measure of *HHI*. It is obvious that the required shares can be calculated in different ways, e. g. based on values (monetary value) or quantities (units sold). As for the most commonly used (but by far not the only one applied) indicator CR_3, the required shares of the three largest banks are approximated in a value-oriented way by calculating the ratio between each of the three largest banks' total assets and the sum of all the banks' total assets. However, it is clear that these total assets relationships are only one specific approximation of market shares. As only one of several counterexamples, *Bertay*/*Demirgüc-Kunt* (2013) apply CR_k indicators using quantitative market shares of banks based on loan volumes and deposit volumes.[12]

Secondly, the determination of the cost functions of banks has to be considered. Specifically, banks' marginal costs are likewise required to compute, e. g., the performance-based Lerner index in DC measurements. Again, further specifications on which proxy best reflects the true marginal costs are required.

[12] Further, as commonly used in statistical reports but only infrequently applied in academic literature, market shares in the business areas of banks are calculated with respect to the number of customers (e. g. clients using a certain banks' credit cards or accounts).

Among others, assumptions have to be made on whether costs for physical capital dispositions or labor costs shall be included in or excluded from marginal costs. As an example for the latter proxy, average (international/national) deposit rates could be applied to properly gauge marginal costs in a national lending business (see e. g. *Gischer* et al. 2015). By contrast, *Liu* et al. (2010) computed the marginal cost (of total assets) from a standard translog function with a single output (total assets) and three input prices (deposits, labor and physical capital). The same issue of varying cost approximations applies to empirical applications of the conduct-oriented indirect Boone indicator β. For instance, *Delis* (2012) employs the 'true' marginal cost based on modified interest rates in the denominator of β. By contrast, other researchers suppose the (easier to determine) long-term average costs to be proper proxies for long-term marginal costs (*Schaeck/Cihák* 2013).[13]

Third, as an established standard, market prices as required for calculations of the widely used Lerner index are usually approximated as the aggregated ratio of a bank's total revenues and total assets (e. g. *Weill* 2013; *Beck* et al. 2013; *Coccorese* 2014; *Anginer* et al. 2014; *Carbò-Valverde* et al. 2016; *Delis* et al. 2016). This notion is based on the idea that banks are providers of only one single (aggregated) output good (*Berg/Kim* 1994). However, as recently discussed in research, especially in the case of studies examining the market power in a particular business segment (e. g. the lending business), those aggregated approaches are subject to several major flaws (*Gischer* et al. 2015). Therefore, instead of utilizing data on the total income, the bank's true output price could alternatively be approximated for that business segment as a modified lending interest rate (averaged across all loan categories but weighted by volume).

A major problem of DC measurements becomes obvious that has, to date, surprisingly been neglected to some degree in academic research. Banks operate, in fact, almost always as multi-product companies in diverse markets/market segments (i. e. strategic business areas) which may exhibit different competitive levels – mostly regional and at the product level. Consequently, the correct definition of the relevant product and geographic markets would be necessary prior to any DC measurement and the selection of proper approximations of required terms and variables, respectively. However, as emphasized by *Plearsikas* (2001), it is exactly the practical application of correctly defining the true relevant market[14] that still constitutes a fundamental obstacle, especially in the field of industrial economics.

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[13] Further, as a modification of the Boone indicator, the bank's market share rather than its profits can be used to calculate the indicator β (*Van Leuvensteijn* et al. 2011, 2013).

[14] In the field of strategic management, it is commonly accepted that defining the business must be seen as the starting point in the process of strategic planning (see ABELL).

Finally, another fundamental problem that emerges, especially in DC measurements in the banking industry and which inevitably leads to the application of different approximations, is that no consensus among academics exists regarding the actual production function of banks. Specifically, two contradictory points of view are prevalent, namely the intermediation vs. the production view. Intermediation was introduced by *Sealey/Lindley* (1977) and classifies the deposits of a bank as mere input goods that are required to provide loans. Consequently, banks take on the role of an intermediary institution procuring deposits and loans (*Bencivenga/Smith* 1991). Contrary to this notion, *Benston* (1965) introduced the production view, according to which deposits are considered output goods produced by the bank. The immanent dilemma of these differing production function concepts regarding DC measurements becomes obvious: Depending on the underlying point of view, only specific approximations can be considered valid. As an example, the Panzar-Rosse model along with the *H* statistic assumes that a company's behavior of passing the banks' input prices on to the demand side depends on the competitive pressure. Formally, the percentage change of revenue as a response to an increase of input prices is estimated. Following the intermediation view, the company's input price-revenue function has to be formulated exclusive of deposits on the dependent variable side (revenue) and inclusive of deposits on the independent side (input prices). In sharp contrast, under the production view deposits must be exclusively considered as an output, thereby effectively influencing revenues, but not the input prices or costs. Obviously, differing approximations (and thus: varying indicators), with respect to the content and the drivers of revenue functions, output prices, input prices, marginal cost or even revenue-oriented market shares, can emerge for the DC measures under these competing production function views.

To sum up the considerations so far, the competition measurement can be realized using different ways. On the one hand, researchers widely agree on the fact that the introduced DC measures and applied indicators are not perfect substitutes (see e. g. *Leon* 2015). On the other hand, regardless of the applied approaches, DC measures and approximations, the resulting indicators are meant to be valid in that they avoid misjudgments and reflect the actual degree of competition in a given, thoroughly defined market (i. e. central construct hypothesis).

The empirical work described in the following chapters has been conducted to examine this hypothesis in the context of the European financial system.

III. The Dataset

1. Sources (Studies), Dimensions, Data Points of the Database

To examine the question of to what extent the discussed DC measures and indicators produce consistent results, thereby confirming the central construct hypothesis, a profound secondary research study (i. e. meta-study) was carried out. Specifically, 35 studies published for the most part in highly-ranked academic journals[15] were reviewed to collect the empirically determined values of applied DC measures. As for the respective dimensions of the compiled original database, a 'country x time x DC measure' structure was established. By doing so, both longitudinal analyses (i. e. changes over time) as well as cross-sectional analyses (object-related comparisons with respect to the applied indicators of DC measures at different levels of aggregation, as well as countries, at a given time [i. e. year]) could be realized.

Regarding the first dimension of countries included in this investigation, the following 15 developed members of the European Union were considered: Austria (AT), Belgium (BE), Germany (DE), Denmark (DK), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), Luxembourg (LU), the Netherlands (NL), Portugal (PT), Sweden (SE) and the United Kingdom (UK). This selection focused on the actual importance of those countries' national banking systems for the overall European economy. Specifically, regarding the GDP realized in 2016, the respective countries ranged from the largest national economy Germany (GDP_{2016}: 3.1 trillion €) to Greece, ranked 15th (GDP_{2016}: 176 billion €). Note that as the one and only exception, Poland was deliberately substituted by Luxembourg in the sample of this investigation as the latter's capital city contains the headquarters of numerous European institutions (e. g. European Court of Justice, European Commission). Moreover, Luxembourg is considered to be among the wealthiest nations of the world with one of the highest GDP per capita.

Secondly, as for the time dimension, published DC measurements addressing the years between 1998 and 2007 were included in the database. For researchers in the field of banking and finance, this ten-year period evidently covers an interesting range highly relevant for DC measurements, which is proven by the number of publications considering this span (e. g. *Liu* et al. 2010). As for the starting point of the observation period, 1998 was deliberately chosen as it represents the year preceding the introduction of the common currency euro as book money in the eurozone (date of release: 31 December 1998). As for the

[15] The reviewed studies were published in the *Journal of Finance, Journal of Money, Credit and Banking, Journal of Banking and Finance, Economic Journal, Economics Letters, Applied Economics*, among others.

endpoint of the time period, 2007 likewise marks an important cornerstone for the European financial system as it preludes the onset of the financial crisis which finally spread worldwide in 2008. This way, the increasing influence of the associated external shocks, e. g. in the form of extraordinary risk premiums which essentially affected – if not even biased – the competition measurement in 2008 and in the following years, was deliberately disregarded.

Thirdly, as for the selected items constituting the *DC* measures dimension, the applied indicators of the following list were considered, as introduced in detail in the previous chapter: 1) the common structure-oriented concentration measures CR_3, CR_5 and *HHI*, 2) the conduct-oriented *H-statistic* and Boones' β and 3) the performance-oriented Lerner index (*LI*).

As an example of the data points considered as the respective input in the original database along those three dimensions, Table 2 depicts an extract from the recent contribution of *Clerides* et al. (2015) as published in the journal *Financial Markets, Institutions & Instruments*. Specifically, the authors measure the DC for national banking systems using indicators for profit elasticities and the Lerner index from 1997 to 2010. In line with the defined limits of the three dimensions in the present database, only data points in the years 1998–2007 for the DC measure Lerner index, as calculated for the 15 selected European countries, were incorporated.

2. Data (Pre-)Processing, Missing Data and Conversions

As shown in Table 1 (DC measurement approaches, related DC measures, formulae, ranges of values), the DC measures may differ in direction, in that lower values indicate higher competition intensity for some DC measures (e. g. the Lerner index values) but a lower degree of competition for others (e. g. H-statistic). Therefore, in order to enhance transparency and facilitate comparisons as well as interpretations in the later analyses, the original DC values in the database were numerically harmonized. Specifically, the actual DC values underwent a specific transformation in order to create modified values that unisono express the actual percentage of the maximum possible degree of competition with a natural upper bound (extreme value) of 100 % or 1.00, respectively. As an example, let any given country's structure-oriented DC ratio CR_3 take on a value of 0.20. This relatively low level of bank concentration indicates a low degree of market power along with a high degree of competition in that banking system. In a perfectly competitive market (vs. monopoly) CR_3 would be exactly 0 (vs. 1). Consequently, the original value of 0.20 has to be transformed into a modified value of 0.80 (or 80 %) as the actual value of 0.20 reflects 80 % of the maximum possible competition value (0) on a scale ranging from zero to one. The same transformation was applied to any other DC measure requiring a respective counter-directional preprocessing.

Table 2

Lerner Index Values as Published in the Study by Clerides et al. (2015)[16]

Country	Code	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Austria	AT	0.09	0.11	0.12	0.11	0.12	0.15	0.16	0.16	0.18	0.16
Belgium	BE	0.10	0.13	0.14	0.15	0.13	0.16	0.15	0.13	0.15	0.07
Germany	DE	0.13	0.13	0.11	0.10	0.11	0.14	0.14	0.15	0.15	0.13
Denmark	DK	0.16	0.13	0.13	0.22	0.24	0.36	0.19	0.19	0.18	0.14
Spain	ES	0.14	0.22	0.18	0.17	0.18	0.20	0.25	0.24	0.25	0.22
Finland	FI	0.19	0.34	0.37	n.a.	n.a.	0.26	0.21	0.17	0.19	0.19
France	FR	0.10	0.12	0.10	0.12	0.14	0.15	0.19	0.20	0.21	0.18
Greece	GR	0.16	0.40	0.17	0.00	0.06	0.09	0.11	0.15	0.19	0.14
Ireland	IE	0.16	0.22	0.20	0.10	0.11	0.22	0.21	0.11	0.13	0.14
Italy	IT	0.17	0.14	0.20	0.17	0.20	0.19	0.17	0.22	0.24	0.22
Luxembourg	LU	0.09	0.11	0.13	0.11	0.13	0.15	0.19	0.20	0.20	0.18
Netherlands	NL	0.11	0.14	0.20	0.21	0.10	0.09	0.16	0.17	0.12	0.17
Portugal	PT	0.09	0.08	0.15	0.22	0.17	0.21	0.25	0.18	0.15	0.13
Sweden	SE	0.18	0.17	0.18	0.24	0.13	0.19	0.26	0.24	0.22	0.18
United Kingdom	UK	0.17	0.17	0.25	0.12	0.22	0.26	0.27	0.23	0.22	0.21

Furthermore, it has to be pointed out that the resulting database structure represents a rather incomplete, disproportional design that naturally incorporates unequally distributed cell frequencies and even some missing data. Specifically, it is clear that not all of the studies of the present database include the entire information on the totality of the six considered DC measures in the fifteen selected European countries over the ten-year time span from 1998 to

[16] Two of the 150 overall data points in Table 2 (labeled as 'n.a.' for Finland in the years 2001 and 2002) are missing in the original study due to non-given information. Chapter 3.2 provides further details on how missing values/information were generally treated in the present study.

2007. As a consequence, specific cells in the database that cover "prominent" combinations of attribute values along the dimensions and which are, therefore, in the special interest of researchers (e. g., Lerner index-based DC measurements in the German banking system in 2007) include numerous observations, whereas other cells are rather underrepresented.

As for a further necessary conversion, some of the included studies have reported DC measures in a certain country as mean values over a specific time span rather than yearly observations. As an example, in the laudable empirical comparison of DC measures (*LI vs. HHI vs. H-statistic*) published by *Carbó-Valverde* and colleagues (2009) in the *Journal of International Money and Finance*, a mean *H-statistic* value is reported in European financial systems (e. g. Germany) over an observation period from 1995 to 2001. As a result of the conversion applied in the present work, the reported mean value was divided, thereby creating four estimated data points for Germany (i. e. for 1998, 1999, 2000, 2001) falling in the considered time span between 1998–2007.

In the end, the final database created for the present analysis contains a total of 5,784 data points. Table 3 gives a summarizing overview of the considered 35 studies sorted by the DC measures (in rows) as well as countries (columns) as reported therein.

IV. Empirical Analysis

The following section reports the results of the comparison of DC measurements with respect to the central construct hypothesis. In line with the structure of Table 1 and the chain of reasoning presented in Chapter 2, the steps in analysis are oriented towards three different levels of aggregation along the database dimension of DC measures. Specifically, at the aggregated approach level, Chapter 4.1 examines whether or not the DC measures subsumed under the market structure- (S), market conduct- (C) and the market performance-oriented approaches (P) produce on average comparable results. Next, Chapter 4.2 follows a medium disaggregated analysis path at the level of the six DC measures under examination. Finally, Chapter 4.3 is focused on specific approximations of the applied DC measures at the indicator level. In each of the subchapters, cross sectional analyses for a given point of time (e. g. 1998 as the starting point of the observation period) as well as longitudinal analyses (such as developments over the time span 1998–2007) are carried out. The results are further differentiated along the database's third dimension as averages across all the 15 countries or country-specific DC measurement values. Figure 2 provides examples for the resulting "slice & dice" procedures as known from online analytical processing (OLAP) in data mining in databases.

Table 3

Studies Included in the Present Analysis of DC Measurements

	AT	*BE*	*DE*	*DK*	*ES*	*FI*	*FR*	*GR*	*IE*	*IT*	*LU*	*NL*	*PT*	*SE*	*UK*
CR_3															
Alegria/Schaeck (2008)	x	x	x		x		x			x	x	x		x	x
Casu/Girardone (2006)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hempell (2002)			x												
CR_5															
Casu/Girardone (2006)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
European Central Bank (2015)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Fernández de Guevara et al. (2005)	x	x	x	x		x	x	x	x	x	x	x	x	x	x
Hempell (2002)			x												
Matthews et al. (2007)															x
Staikouras/Koutsomanoli-Fillipaki (2006)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
HHI															
Alegria/Schaeck (2008)	x	x	x		x		x	x		x	x	x		x	
Carbó et al. (2009)	x	x	x	x	x		x	x	x	x	x	x	x	x	x
Casu/Girardone (2006)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
European Central Bank (2015)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Fernández de Guevara/Maudos (2007)					x										
Hempell (2002)			x												
Liu et al. (2010)	x	x	x	x		x	x			x		x		x	x
Matthews et al. (2007)															x
Weill (2013)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

H-Statistic															
Bikker et al. (2012)	x	x	x	x	x		x	x	x	x	x	x	x	x	x
Carbó et al. (2009)	x	x	x	x	x		x	x	x	x	x	x	x	x	x
Casu/Girardone (2006)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Claessens/Laeven (2004)	x	x	x	x	x		x	x		x	x	x	x		x
Coccorese (2004)										x					
Delis et al. (2008)					x			x							
Gischer/Stiele (2008)			x												
Hempell (2002)			x												
Liu et al. (2010)	x	x	x	x		x	x			x		x		x	x
Matthews et al. (2007)															x
Schaeck et al. (2009)	x	x	x	x			x	x	x	x		x	x	x	x
Weill (2004)	x	x	x	x	x		x	x		x	x	x	x		x
Weill (2013)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Boone-Indicator															
Brissimis et al. (2014)	x	x	x		x	x	x	x	x	x	x	x	x		
Delis (2012)	x	x	x	x	x	x	x	x	x	x		x	x	x	x
Schaeck/Čihák (2010)	x	x	x	x			x			x	x	x			x
van Leuvensteijn et al. (2011)			x		x		x			x		x			x
van Leuvensteijn et al. (2013)	x	x	x		x		x			x	x		x		

(continue next page)

(Table 3 continued)

	AT	*BE*	*DE*	*DK*	*ES*	*FI*	*FR*	*GR*	*IE*	*IT*	*LU*	*NL*	*PT*	*SE*	*UK*
Lerner-Index															
Ayadi et al. (2009)	x	x	x		x					x					
Beck et al. (2013)	x	x	x	x	x		x	x	x	x	x	x	x	x	x
Brissimis et al. (2014)	x	x	x		x	x	x	x	x	x	x	x	x		
Carbó et al. (2009)	x	x	x	x	x		x	x	x	x	x	x	x	x	x
Clerides et al. (2015)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Coccorese (2014)	x	x	x	x	x		x	x	x	x	x	x	x	x	x
Coccorese/Pellecchia (2010)										x					
Fernández de Guevara et al. (2007)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Fernández de Guevara/Maudos (2004)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Fischer/Hempell (2005)			x												
Gischer et al. (2015)	x	x	x		x	x	x	x	x	x	x	x	x		
Koetter/Vins (2008)			x												
Liu et al. (2010)	x	x	x	x		x	x			x		x		x	x
Maudos/Fernández de Guevara (2007)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Maudos/Fernández de Guevara (2004)			x		x		x			x					
Weill (2013)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

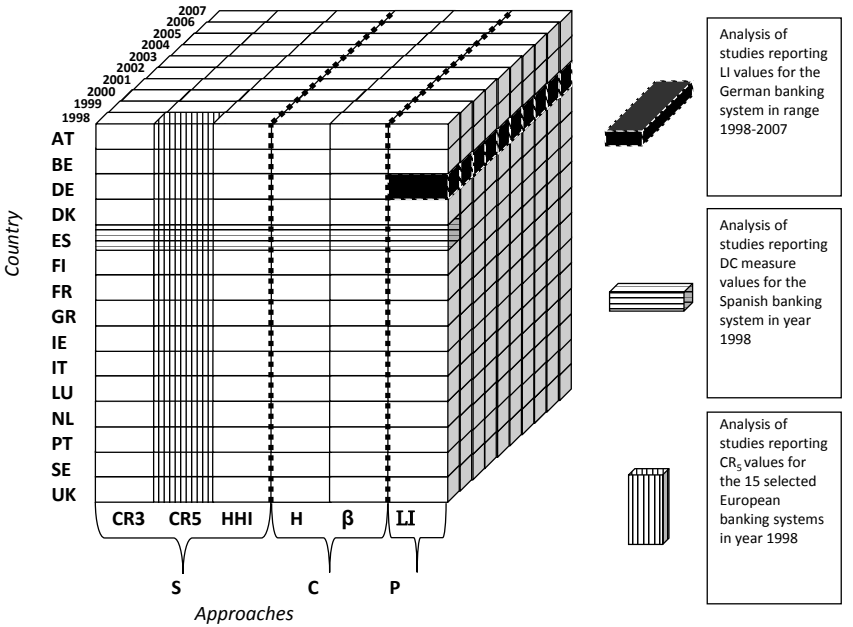

Figure 2: Database Structure and Possible Slice & Dice Procedures in the Analysis

1. Analyses at the Approach Level: Aggregated S/C/P Values in DC Measurements

The analysis at the approach level reveals substantial differences in the degree of competition under the structure-, conduct- and the performance-oriented DC measures both in a cross-sectional as well as longitudinal analysis. Specifically, Table 4 gives an overview of DC values as reported for the year 1998 as the starting point of the present observation period. Averaged across the selected 15 national banking systems, an overall mean score of 0.65 (i. e. 65 % of the maximum possible competition intensity) is indicated. However, the performance-oriented DC measures (i. e. Lerner index applications) produce a competition score of 0.87 (87 %), thereby indicating a highly competitive market environment. In contrast, the DC measures subsumed under the conduct-oriented approach imply a sound market power of banks along with a diminished competition score of only 40 %. Positioned between these two opposing values, the structure-oriented DC measures produce a mid-level intensity of competition (68 %).

In a deeper country-specific analysis, this finding of contradictory DC levels holds for most of the observed countries. As for the example of the Greek banking system, DC values under the structure-oriented approach (S) indicate a

Table 4

Approach Level Analysis of DC Values Regarding Year 1998.[17]

Approach	AVG[a]	*AT*	*BE*	*DE*	*DK*	*ES*	*FI*	*FR*	*GR*	*IE*	*IT*	*LU*	*NL*	*PT*	*SE*	*UK*
S	0.68	*0.69* (n = 8/ s = 0.19)	*0.61* (n = 7/ s = 0.27)	*0.83* (n = 9/ s = 0.18)	*0.53* (n = 6/ s = 0.3)	*0.77* (n = 7/ s = 0.23)	*0.33* (n = 4/ s = 0.31)	*0.81* (n = 9/ s = 0.18)	*0.55* (n = 5/ s = 0.29)	*0.69* (n = 5/ s = 0.24)	*0.85* (n = 8/ s = 0.14)	*0.85* (n = 7/ s = 0.11)	*0.53* (n = 8/ s = 0.31)	*0.70* (n = 5/ s = 0.21)	*0.63* (n = 8/ s = 0.28)	*0.82* (n = 7/ s = 0.12)
C	0.40	*0.36* (n = 14/ s = 0.25)	*0.49* (n = 13/ s = 0.24)	*0.41* (n = 16/ s = 0.20)	*0.32* (n = 11/ s = 0.18)	*0.38* (n = 12/ s = 0.12)	*0.37* (n = 4/ s = 0.44)	*0.35* (n = 13/ s = 0.25)	*0.25* (n = 10/ s = 0.51)	*0.53* (n = 7/ s = 0.21)	*0.41* (n = 15/ s = 0.26)	*0.58* (n = 9/ s = 0.31)	*0.43* (n = 14/ s = 0.33)	*0.46* (n = 10/ s = 0.29)	*0.29* (n = 7/ s = 0.22)	*0.40* (n = 12/ s = 0.24)
P	0.87	*0.88* (n = 10/ s = 0.07)	*0.87* (n = 10/ s = 0.08)	*0.88* (n = 13/ s = 0.08)	*0.86* (n = 8/ s = 0.06)	*0.84* (n = 12/ s = 0.06)	*0.83* (n = 4/ s = 0.10)	*0.91* (n = 10/ s = 0.06)	*0.88* (n = 8/ s = 0.06)	*0.83* (n = 7/ s = 0.02)	*0.84* (n = 13/ s = 0.09)	*0.91* (n = 8/ s = 0.06)	*0.90* (n = 9/ s = 0.07)	*0.88* (n = 8/ s = 0.05)	*0.86* (n = 8/ s = 0.07)	*0.85* (n = 8/ s = 0.03)

Notes: [a] Average across all selected countries in 1998

[17] The table's cell content explained by means of the cell positioned in last row/last column: Under the performance-oriented approach (row *P*), a total of 8 studies ($n = 8$) reported respective values for the United Kingdom (column *UK*), thereby producing a mean value of 0.85 along with a 0.03 standard deviation (s).

mid-level competition intensity (0.55) which is contrasted by high DC values amounting to 0.88 under the performance-based DC measures (P) and a very low competition score (0.25) produced under the conduct-oriented approach (C). Overall, the resulting general ranking order in DC values at the approach level (P > S > C) holds for 87 % (13 out of 15) of the countries with the only exceptions being Finland and Italy. The respective systematic differences are statistically significant at the 1 % level in pairwise two-sided t-tests (S vs. C: $t_{28} = 6.16$, $p < 0.01$; S vs. P: $t_{28} = -4.78$, $p < 0.01$; C vs. P: $t_{28} = -19.62$, $p < 0.01$).

Furthermore, in a longitudinal analysis covering the ten-year percentage change of the produced DC values under the three approaches over the years 1998–2007, substantial discrepancies in the observed trends become salient. Averaged across the 15 countries under examination, the DC values under the S approach are positioned almost at the same level in 1998 and 2007 (–0.65 %), whereas the DC values under the C (vs. P) approach increase (vs. diminish) over the ten years of observation by no less than +12.83 % (vs. –6.46 %).

Finally, as depicted in Figure 3, the identified general systematic difference in terms of the order of DC values produced under the approaches consistently holds throughout the whole time span. That is, from the beginning of the observation period (1998) until the end (2007), DC values subsumed under the P (vs. S vs. C) approach produce the highest (vs. smallest vs. medium) DC values, thereby indicating a fierce (vs. diminished vs. medium) competition intensity.

To sum up the findings thus far, the result of assessments of the observed markets' competition intensity and their change over time seems to be sensitive to the application of a certain DC measurement approach. Thus, the central hypothesis is violated.

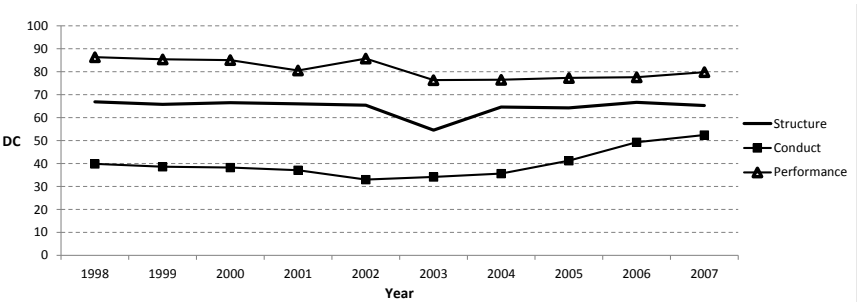

Figure 3: Time Series of DC Values Produced Under the Approaches S, C, and P

2. Analyses at the DC Measure Level (Disaggregated DC Values)

The more disaggregated analysis of the six DC measures considered in this work regarding the year 1998 (see Table 5) further reveals severe inconsistencies, thereby raising further doubts as to what extent those measures represent the same measurement construct in the form of the true competition intensity. Specifically, averaged across the 15 countries, the concentration measures CR_3 (DC = 0.60), CR_5 (0.49) as well as the *H-statistic* (0.50) indicate a medium degree of competition intensity. At variance with this presumption, *Boones'* β suggests assuming a diminished degree of competition along with a substantial market power of banks (0.29), whereas the performance-oriented LI (0.87) as well as the *HHI* (0.89) provide strong support for the assumption that the competition between national banks in the European financial system is best considered intense to fierce.

In line with this finding, the country-specific analysis in Table 5 further depicts the vivid spreads between the minimum and maximum scores of the national DC values. Considering the French banking system as an example, this deviation amounts to a remarkable 73 % spread as the *HHI* predicts on the basis of five reported DC measurements a score of 96 % of the maximum possible competition intensity, whereas *Boones'* β (based on six values) amounts to only 23 %, which points to weak competition and a substantial market power of French banks, respectively.

As a further inconsistency, the expected relationship between CR_3 and CR_5 values (i. e. $CR_3 < CR_5$) is contradicted both on average as well as for six out of the 15 observed countries.[18]

Additionally, despite the observed absolute and systematic differences between the DC measures across the countries, pairwise correlations[19] between the produced DC measures along the 15 countries are supposed to meet two natural conditions: They should be a) unidirectional, in that they produce a positive sign, and b) substantial in value as to indicate a strong relation along with statistical significance. However, as depicted in Table 6 for the year 1998, in contrast to what the central hypothesis would predict, six out of the 15 respective

[18] Although this finding seems illogical at first glance, the respective raw data of the original studies provide an explanation: The market shares are derived using the balance sheet total – however, sometimes based on the yearly average and sometimes based on year-end figures. This example precisely shows the consequences of using different operationalizations of the competition measurements.

[19] A correlation coefficient according to Bravais-Pearson (r) has been calculated for which the following classification concerning the strength of the linear relationship is accepted: weak correlation ($|r|<0.5$), moderate correlation ($0.5 < |r| < 0.8$) and strong correlation ($|r| > 0.80$) (see *Fahrmeir* et al. 2011: 139 f.).

Table 5

DC Measure Level Analysis of DC Values Regarding 1998

DC/ Country	AVG[a]	*AT*	*BE*	*DE*	*DK*	*ES*	*FI*	*FR*	*GR*	*IE*	*IT*	*LU*	*NL*	*PT*	*SE*	*UK*
CR3	0.60	*0.50* (n = 1/ s = 0.00)	*0.26* (n = 1/ s = 0.00)	*0.62* (n = 2/ s =0.44)	n.a (n = 0/ s = 0.00)	*0.63* (n = 1/ s = 0.00)	n.a (n = 0/ s = 0.00)	*0.71* (n = 1/ s = 0.00)	n.a (n = 0/ s = 0.00)	n.a (n = 0/ s = 0.00)	*0.73* (n = 1/ s = 0.00)	*0.78* (n = 1/ s = 0.00)	*0.53* (n = 1/ s = 0.00)	n.a (n = 0/ s = 0.00)	*0.51* (n = 1/ s = 0.00)	*0.73* (n = 1/ s = 0.00)
CR5	0.49	*0.55* (n = 3/ s = 0.05)	*0.34* (n = 3/ s = 0.05)	*0.82* (n = 4/ s = 0.01)	*0.27* (n = 3/ s = 0.03)	*0.51* (n = 2/ s = 0.22)	*0.18* (n = 3/ s = 0.07)	*0.6* (n = 3/ s = 0.01)	*0.34* (n = 3/ s = 0.06)	*0.53* (n = 3/ s = 0.12)	*0.70* (n = 3/ s = 0.08)	*0.75* (n = 3/ s = 0.00)	*0.18* (n = 3/ s = 0.00)	*0.56* (n = 3/ s = 0.00)	*0.34* (n = 3/ s = 0.17)	*0.73* (n = 3/ s = 0.01)
HHI	0.89	*0.85* (n = 4/ s = 0.15 %)	*0.82* (n = 4/ s = 0.09)	*0.97* (n = 5/ s = 0.03)	*0.78* (n = 3/ s = 0.16)	*0.93* (n =4/ s = 0.04)	*0.79* (n = 1/ s = 0.00)	*0.96* (n = 5/ s = 0.02)	*0.87* (n = 2/ s = 0.03)	*0.94* (n = 2/ s = 0.02)	*0.96* (n = 4/ s = 0.02)	*0.97* (n = 3/ s = 0.01)	*0.78* (n = 4/ s = 0.16)	*0.93* (n = 2/ s = 0.02)	*0.87* (n = 4/ s = 0.07)	*0.90* (n = 4/ s = 0.12)
H statistic	0.50	*0.48* (n = 8/ s = 0.21)	*0.58* (n = 8/ s = 0.16)	*0.53* (n = 10/ s = 0.09)	*0.36* (n = 8/ s = 0.18)	*0.45* (n = 7/ s = 0.16)	*0.93* (n = 1/ s = 0.00)	*0.46* (n = 7/ s = 0.21)	*0.21* (n = 7/ s = 0.62)	*0.54* (n = 4/ s = 0.30)	*0.52* (n = 9/ s = 0.23)	*0.67* (n = 6/ s = 0.29)	*0.55* (n = 8/ s = 0.33)	*0.53* (n = 6/ s = 0.28)	*0.24* (n = 5/ s = 0.22)	*0.51* (n = 8/ s = 0.18)
Boone indicator	0.29	*0.20* (n = 6/ s = 0.21)	*0.34* (n = 5/ s = 0.28)	*0.23* (n = 6/ s = 0.20)	*0.236* (n = 3/ s = 0.19)	*0.29* (n = 5/ s = 0.24)	*0.18* (n = 3/ s = 0.28)	*0.23* (n = 6/ s = 0.24)	*0.34* (n = 3/ s = 0.15)	*0.50* (n = 3/ s = 0.06)	*0.24* (n = 6/ s = 0.22)	*0.40* (n = 6/ s = 0.32)	*0.26* (n = 6/ s = 0.29)	*0.34* (n = 4/ s = 0.30)	*0.40* (n = 4/ s = 0.27)	*0.19* (n = 4/ s = 0.22)
Lerner index	0.87	*0.88* (n = 10/ s = 0.07)	*0.87* (n = 10/ s = 0.08)	*0.88* (n = 13/ s = 0.08)	*0.86* (n = 8/ s = 0.06)	*0.84* (n = 12/ s = 0.06)	*0.83* (n = 4/ s = 0.10)	*0.91* (n = 10/ s = 0.06)	*0.88* (n = 8/ s = 0.06)	*0.83* (n = 7/ s = 0.02)	*0.84* (n = 13/ s = 0.09)	*0.91* (n = 8/ s = 0.06)	*0.90* (n = 9/ s = 0.07)	*0.88* (n = 8/ s = 0.05)	*0.86* (n = 8/ s = 0.07)	*0.85* (n = 8/ s = 0.03)
	MAX	0.88	0.87	0.97	0.86	0.93	0.93	0.96	0.88	0.94	0.96	0.97	0.90	0.93	0.87	0.90
	MIN	0.20	0.26	0.23	0.24	0.29	0.18	0.23	0.21	0.50	0.24	0.40	0.18	0.34	0.24	0.19
	SPREAD	0.68	0.61	0.74	0.62	0.64	0.75	0.73	0.67	0.44	0.72	0.57	0.72	0.59	0.63	0.71

Notes: [a] Average across all selected countries in 1998

pairwise correlations between the DC measures considered in this study have a negative sign. Specifically, the *Boones' β* is negatively correlated with CR_3, CR_5, the *Lerner index* and even with the (likewise conduct-oriented) *H statistic*. Further, only three of the remaining nine correctly signed (i. e. positively signed) correlations are of both economical as well as statistical significance. Specifically, they indicate a moderate/strong correlation which is at least larger than 0.5. This at least logically pertains to the three structure-oriented measures CR_3, CR_5 and *HHI*. However, the remaining six correlations (e. g. between *Lerner index* vs. CR_3, or *H statistic* vs. CR_5) fail to reach statistical significance which obviously contradicts the central construct hypothesis.

Table 6

Correlation Between DC Measures Level Analysis of DC Values Regarding 1998

		CR3	*CR5*	*HHI*	*H*	*ß*
	Pearson's r	*.70**				
CR5	Significance (two-sided)	0.03				
	N	10				
	Pearson's r	*.76**	*.88***			
HHI	Significance (two-sided)	0.01	0.00			
	N	10	15			
	Pearson's r	*0.15*	*0.02*	*–0.06*		
H	Significance (two-sided)	0.67	0.94	0.82		
	N	10	15	15		
	Pearson's r	*–0.21*	*–0.01*	*0.27*	*–0.23*	
ß	Significance (two-sided)	0.55	0.98	0.32	0.40	
	N	10	15	15	15	
	Pearson's r	*0.06*	*0.15*	*0.11*	*–0.15*	*–0.01*
LI	Significance (two-sided)	0.87	0.60	0.68	0.58	0.97
	N	10	15	15	15	15

* Significant at the 5 % level (two-sided test)

** Significant at the 1 % level (two-sided test)

Moreover, discrepancies are likewise detected in the longitudinal analysis covering the produced ten-year percentage change in DC values between 1998 and 2007 as observed for the 15 countries. As depicted in Table 7, the resulting inconsistencies must be considered dramatic to a certain degree. Specifically, averaged across the 15 countries, while some DC measures (CR_3, *H statistic*, *Boone indicator*) detect an increase in the competitive pressure, the opposite is true for CR_5, *HHI* and the *Lerner index*. Further, taking the Greek banking system as a country-specific example, the *H-statistic* indicates a 46 % increase in competition intensity over the observational decade whereas the *Lerner index* predicts it to shrink by more than 12 %.

In summary, results indicate that the central hypothesis does not hold at the level of DC measures in the respective cross-sectional (i. e. country-specific) as well as in longitudinal analyses.

3. Analyses at the Indicator Level: A Critical Look at Specific DC Measure Applications

The analysis of the six DC measures at the most disaggregated indicator level likewise provides strong support for a rejection of the central construct hypothesis. Specifically, the findings presented in this subchapter are based on specific applications (i. e. different operationalizations) of the six introduced DC measures in the German banking system. To this end, Table 8 gives an overview of the number of observations as reported in the respective studies covering this national banking system using specific operationalizations for the years 1998 and 2007.

According to the analysis and in line with the previous findings, the heterogeneity in the resulting assessment of the true competitive conditions in the German banking system across the alternative DC measures proves to be true. Specifically, the average spread between the highest and the lowest competition score as produced by the total of 40 (vs. 17) applications of the considered six DC measures was 20 % in 1998 (13 % in 2007). As for the respective DC measures that seem to be most sensitive to varying applications, this spread is above average in 1998 for applications of the *Boone indicator* (41 %) as well as the *H-statistic* (26 %). In addition, when considering the Lerner index application by *Maudos/Fernández de Guevara* (2007) as calculated for 1998, a nearly maximum competition score of 97 % is detected. However, the apparent conclusion of a de facto perfect competition is challenged by the *Lerner index* application of *Ayadi* et al. (2009), who determined for 1998 a closer to mid-level competition score of 67 %, which clearly indicates a substantial degree of market power of German banks. In the end, a remarkable intra-measure spread of 30 % is produced for the *Lerner index*. Note that this *Lerner index*-specific spread between the highest

Table 7

DC Measure Level Analysis of Percentage Changes in DC Values from 1998 to 2007

DC/ Country	*AVG*	*AT*	*BE*	*DE*	*DK*	*ES*	*FI*	*FR*	*GR*	*IE*	*IT*	*LU*	*NL*	*PT*	*SE*	*UK*
CR3	*4.09*	0.00	0.00	18.00	9.05	0.00	–4.61	0.00	12.52	9.37	0.00	0.00	0.00	16.01	0.00	0.00
CR5	*–2.77*	+1.69	–16.83	–3.54	8.67	8.50	–0.16	–11.60	–1.74	–3.30	–3.42	–6.14	–4.10	0.00	4.88	–14.42
HHI	*–3.26*	–6.20	–5.62	–1.71	–4.06	–1.74	–4.20	–2.71	2.52	–0.61	–0.42	–0.07	–10.42	–3.88	–3.26	–6.45
H statistic	*9.82*	15.08	5.86	5.24	8.24	19.69	–25.78	14.30	45.92	–0.61	10.57	3.62	3.32	16.52	18.94	6.42
Boone indicator	*15.84*	25.43	20.53	16.57	36.20	26.29	–16.61	22.97	4.37	6.23	18.55	4.30	18.43	14.84	11.70	27.78
Lerner index	*–6.46*	–1.18	–4.01	–4.08	–3.38	–3.18	–8.39	–12.69	–12.43	–3.34	–9.94	–8.04	–9.01	–10.80	–5.30	–1.20
AVG[a]	*2.88*	5.80	–0.01	5.08	9.12	8.26	–9.96	1.71	8.53	1.29	2.56	–1.06	–0.30	5.61	4.49	2.02

and lowest produced DC values is even larger for measurements in 2007, when it amounted to 48 %. Taking into account that this spread is based on a small number of studies (n = 7), the significance of divergence in the produced competition score is further highlighted.

Moreover, as obviously the most frequently applied DC measure in current competition measurements in local, national and global financial systems, the various operationalizations of the *Lerner index* seem to be especially prone to producing substantial variations in the DC values. As a vivid example, consider the German banking system in 2003, which was subjected to a total of nine studies in that year. Regarding the results, *Ayadi* et al. (2009) as well as *Gischer* et al. (2015) calculate competition scores that indicate at best mid-level competition along with a latent market power of banks (DC = 58 % and 46 %, respectively). By comparison, the *Lerner index* applications as published by *Brissimis* et al. (2014) and *Koetter/Vins* (2008) report higher competitions scores of 81 % and 76 % for the same market. Finally, both *Liu* et al. (2010) as well as *Coccorese* (2014) report *Lerner index* values that amount to 92 %, thereby clearly indicating fierce competition in the German banking system.

To summarize, even in an intra-measure-comparison at the most specified indicator level, substantial differences in the produced DC values emerge which, again, challenge the notion of a valid central construct hypothesis.

Table 8

Analysis of DC Measure Applications at the Indicator Level for the German Banking System in Year 1998 and 2007

Studies (n)	*DC measure*	*DE 2007*			*Spread*
		Max	*Min*	*Mean*	
2	*CR3*	0.77	0.66	0.72	0.11
2	*CR5*	0.78	0.68	0.73	0.10
2	*HHI*	0.98	0.92	0.95	0.06
2	*H statistic*	0.58	0.58	0.58	0.00
2	*Boone indicator*	0.41	0.37	0.39	0.04
7	*Lerner index*	0.92	0.44	0.83	0.48
17	*MEAN*	*0.74*	*0.61*	*0.70*	*0.13*

(continue next page)

(Table 8 continued)

Studies (n)	*DC measure*	*DE 1998*			*Spread*
		Max	*Min*	*Mean*	
2	*CR3*	0.89	0.77	0.83	0.12
4	*CR5*	0.83	0.8	0.82	0.03
5	*HHI*	0.99	0.92	0.97	0.07
10	*H statistic*	0.62	0.36	0.53	0.26
6	*Boone indicator*	0.44	0.03	0.23	0.41
13	*Lerner index*	0.98	0.68	0.87	0.30
40	*MEAN*	*0.79*	*0.59*	*0.71*	*0.20*

V. Discussion

The main objective of the present study was to determine whether the various applications of DC measures applied to gauge the degree of competition in banking systems would lead to identical conclusions regarding assessments of the true competition intensity. Specifically, despite the diversity in the developed conceptual approaches, measures and applied approximations, the produced DC values should in the end yield the same result, in that they allow for a valid qualitative economic evaluation of the real competitive condition in the examined market (i. e. 'the central construct hypothesis'). Against this background, the present work is based on a profound review of 35 academic studies providing 5,784 data observations for empirically oriented DC measurements in 15 important national banking systems in the European Union in the years 1997 to 2008.

In sharp contrast to the assumed central construct hypothesis, the analysis indicates outstanding discrepancies in the produced DC values. Specifically, in an aggregated analysis at the conceptual approach level (i. e. averaged across DC measures subsumed under each of the three general conceptual approaches), the market-performance- (vs. conduct-) oriented measures produce significantly higher (vs. lower) DC values, hence clearly indicating an intense (vs. diminished) degree of competition, whereas the structure-oriented DC values indicate a mid-level competition intensity.

Secondly, in a disaggregated analysis at the measure level (i. e. a comparison of DC measures within each of the conceptual approaches), further inconsisten-

cies, such as contradicting temporal changes of DCs both across as well as within national banking systems, were identified.

Finally, even when focusing on specific DC measure applications at the indicator level (i. e. operationalized through different approximations), substantial differences in the produced DC values and the derived intensity of competition as predicted for a selected point of time and/or country are detected.

As a consequence, the profound cross- and longitudinal analyses presented in this work evidently indicate that the economic validity of current best-in-practice DC measurements is (at least partly) in question. In fact, the qualitative evaluation of the actual state of competition based on these DC measures turns out to be rather sensitive to the application of a specific approach, measure and approximation, respectively. As a logical consequence of the observed systematic differences in DC measure values at any level of disaggregation, it becomes obvious that decision makers in important and responsible economic positions (e. g., in regulatory institutions) are subject to a severe threat. Specifically, by referring to a certain approach, measure or approximation, higher or lower DC values can be produced for the considered relevant market/market segment. As a final effect, the derived conclusions about the true competition intensity and the suggested recommendations on corporations' business actions (e. g. the approval or rejection of mergers) within those markets may be prone to manipulation.

As an example, consider a major merger in the national British banking market that happened in 2008. Specifically, as a consequence of the proclaimed merger plans between Lloyds TSB (LLOYDS) and the verging on bankruptcy Halifax Bank Of Scotland (HBOS), several stakeholders, competitors and other parties of interest raised severe concerns as to what extent the degree of competition in the whole British financial system would be negatively affected both in the long as well as the short term. Thus, the Office of Fair Trading (*Smith*, 2008) was called on to make an announcement on the subject matter. As is the predominant practice among regulatory organizations and/or advisory institutions such as the OFT, the market concentration in the form of the player's aggregated market shares in the pursued relevant markets was considered. As a result, the structure-oriented *CR3, CR5* and *HHI* measures for the resulting post-merger institution exceeded some critical benchmarks. Consequently, the merger was put into question and initially suspended due to potential competition concerns.[20]

[20] As an example, consider the product line of personal current accounts (PCA). The OFT argued as follows: "On the basis of 2007 market share estimates, the merged entity will be the clear market leader in terms of stock of PCAs in Great Britain, with a combined market share of 33 percent (increment 14 percent). The next three players (RBSG, HSBC and Barclays) have market shares between 14 and 17 percent, and the concentra-

However, the Bank of England and even members of the government (e. g. the then British Chancellor of the Exchequer [Minister of Finance] Alistair Darling) intervened in later instances and finally overruled the OFT's concerns, among other reasons for the sake of maintaining the long-term financial stability in the whole British financial market. Consequently, in late 2008 LLOYDS and HBOS were officially allowed to proceed with the merger, with the deal finally being concluded in January 2009 mainly via an exchange of shares.

By way of contrast, consider the following two alternative scenarios: Imagine that an important decision maker in an advisory council position had benevolently weighted the two banks' self-interested well-being ex ante higher than the long-run persistence of social welfare-maximizing competitive market conditions. Following the consistent results of our DC analyses across and within the examined countries and the observed time period, the selection of a certain *Lerner index* application would then have produced higher DC measures, thereby indicating a more intense (i. e. uncritical) level of competition. As a result, the OFT would have been likely to support the merger plans of LLOYDS and HBOS initially. On the other hand, when applying structure- or conduct-oriented DC measures to assess the degree of competition (*e. g. HHI* or the *H*-statistic), which throughout all of our analyses systematically indicate a lower degree of competition intensity, it is likely that even the Bank of England would have noticed a certain degree of threat towards the British financial market when assessing the respective merger. Accordingly, Table 9 provides a brief comparison of specific DC measures for the UK in 2007 (that is, one year before the merger actually took place). Obviously, the data (*LI* = 84 % vs. *HHI* = 68 % vs. *H* = 57 % of the maximum possible intensity of competition) provide strong support for the addressed potential interplay between the outcome of an important regulatory decision and the preceding selection of a particular DC measure.

Table 9

DC Measures for the UK Banking System in the Year 2007

UK/Measurement	*HHI*	*H statistic*	*Lerner index*
Number of Studies	2	2	5
AVG	0.68	0.57	0.84

tion ratio of the top four players in the market (C4) is increased by the merger from 67 % to 80 %. All other players have shares of less than ten percent each. The post-merger HHI is 1950, which indicates that this is a highly concentrated market, with an increment of almost 500. The Guidance40 states that any market with a post merger HHI in excess of 1000 is concentrated, and that in a concentrated market a merger with a delta in excess of 100 may give rise to potential competition concerns".

As a general suggestion for further academic research, it has to be concluded that the empirical implementation of the competition measurement approaches, which are rooted as alternative concepts in the general theory of industrial organization, is problematic in the specific field of financial market analyses, especially due to the high data requirements. Thus, regulatory recommendations for decision makers in the realm of banking systems can only then be formulated when the limitations of the respective research methodology are thoroughly considered.

In the same vein, subsequent evaluations regarding the stability, profitability and productivity of banks or banking systems likewise require a thorough examination of the underlying competition measurement method. Generally, the regular use of different measurement concepts appears reasonable in order to control the sensitivity of the determined degrees of competition regarding the applied measurement method.

An "across-the-board" conclusion as to which specific DC approach, measure or approximation is generally preferable in empirical applications in banking systems seems neither reasonable nor possible in light of the measurements' specific strengths and weaknesses. Obviously, both the specific type (for instance interest rates) as well as the number of data points (e. g. observed periods of time stored in databases) which are available to the researcher will naturally predetermine the selection of a certain DC approach, measure, and approximations to gauge competition intensity. However, in the course of further academic research it would be, in fact, of the greatest interest to identify the main drivers of the observed substantial heterogeneity in the DC values produced even for identical objects (i. e. identical countries at a given time period).

Moreover, to account for the outstanding importance of valid assessments of the degree of competition (at least) in the short or middle run, it seems to be a proper suggestion that national regulatory institutions and/or competition authorities should 1) officially produce proxies for the total set of established types of competition measures at the total market level, and 2) provide academic researchers and policy consultants access to it in that those proxies are published periodically.

By doing so, the necessity of both selecting one specific DC measure out of the total set of available measures as well as consistently trying to apply coherent approximations of that particular DC measure in competition assessments to ensure that the results allow for valid cross-study comparisons becomes obsolete.

As a further positive effect, consistent and interpretable time series plots depicting aggregated developments of the competition intensity in national banking systems over time would be available similar to the well established – and from the economic perspective highly valuable – official statistics on inflation

rates, unemployment rates, and general interest rates. In light of the obvious importance of correct DC measurements as discussed in the introduction to this work, the following statement by *Liu* et al. (2010) should be carefully taken into account before drawing any conclusions about the true competitive state in any financial market:

> "*Given the doubts raised about the efficacy of competition measures caution should be taken in formulating regulatory policies and decisions based on the extant empirical literature*".

References

Abell, D. F. (1980): Defining the Business: The Starting Point of Strategic Planning. Prentice Hall, Englewood Cliffs.

Allen, F./*Gale*, D. (2004): Competition and Financial Stability, Journal of Money, Credit and Banking, 36, 3, pp. 453–480.

Anginer, D./*Demirguc-Kunt*, A./*Zhu*, M. (2014): How does competition affect systemic risk?, Journal of Financial Intermediation, 23, 1, pp. 1–26.

Ayadi, R./*Schmidt*, R. H./*Valverde*, S. C. (2009): Investigating Diversity in the Banking Sector in Europe: The Performance and Role of Savings Banks, Center for European Policy Studies, Brüssel.

Bain, J. S. (1950): Workable Competition in Oligopoly: Theoretical Considerations and some Empirical Evidence, American Economic Review, 40, 2, pp. 35–47.

Baumol, W. J. (1982): Contestable Markets: An Uprising in the Theory of Industry Structure, American Economic Review, 72, 1, pp. 1–15.

Beck, T./*De Jonghe*, O./*Schepens*, G. (2013): Bank competition and stability: Cross-country heterogeneity, Journal of Financial Intermediation, 22, 2, pp. 218–244.

Bencivenga, V. R./*Smith*, B. D. (1991): Financial Intermediation and Endogenous Growth, Review of Economic Studies, 58, 2, pp. 195–209.

Benston, G. J. (1965): Branch Banking and Economies of Scale, Journal of Finance, 20, 2, pp. 507–549.

Berg, S. A./*Kim*, M. (1994): Oligopolistic Interdependence and the Structure of Production in Banking: An Empirical Evaluation, Journal of Money, Credit and Banking, 26, 2, pp. 309–322.

Berger, A. N./*Klapper*, L. F./*Turk-Ariss*, R. (2009): Bank Competition and Financial Stability, Journal of Financial Services Research, 35, 2, pp. 99–118.

Bertay, A. C./*Demirgüc-Kunt*, A. (2013): Do we need big banks? Evidence on performance, strategy and market discipline, Journal of Financial Economics, 98, pp. 626–650.

Bharat, N. A./*Galetovic*, A. (2006): Relationships, competition and the structure of investment banking markets, Journal of Industrial Economics, 54, 2, pp. 151–199.

Bikker, J. A./*Haaf*, K. (2002): Competition, concentration and their relationship: an empirical analysis of the banking industry, Journal of Banking and Finance, 26, 11, pp. 2191–2214.

Bikker, J. A. (2003) Testing for imperfect competition on EU deposit and loan markets with Bresnahan's market power model, Research Series Supervision no. 52, Section Banking and Supervisory Strategies, Directorate Supervision, De Nederlandsche Bank.

Bolt, W./*Humpfrey*, D. (2015): A frontier measure of US banking competition, European Journal of Operational Research, 246, 2, pp. 450–461.

Boone, J. (2008): A new way to measure competition, Economic Journal, 118, 531, pp. 1245–1261.

Bresnahan, T. F. (1982): The Oligopoly Solution Concept is Identified, Economics Letters, 10, 1–2, pp. 87–92.

Brissimis, S. N./*Delis*, M. D./*Iosifidi*, M. (2014): Bank Market Power and Monetary Policy Transmission, International Journal of Central Banking, 10, 4, pp. 173–214.

Cāpraru, B./*Andries*, M. (2015): Nexus between concentration and fragility across EU banking systems, Procedia Economics and Finance, 32, 1, pp. 1140–1147.

Carbó-Valverde, S./*Humpfrey*, D./*Maudos*, J./*Molyneux*, P. (2009): Cross-country comparisons of competition and pricing power in European banking, Journal of International Money and Finance, 28, 1, pp. 115–134.

Carbò-Valverde, S./*Rodríguez-Fernández*, F./*Udell*, G.F. (2016): Trade Credit, the Financial Crisis, and SME Access to Finance, Journal of Money, Credit and Banking, 48, 1, pp. 113–143.

Carvalho, D. R. (2014): The Real Effects of Government-Owned Banks: Evidence from an Emerging Market, The Journal of Finance, 69, 2, pp. 577–609.

Clerides, S./*Delis*, M. D./*Kokas*, S. (2015): A New Data Set On Competition In National Banking Markets, Financial Markets, Institutions & Investments, 24, 2–3, pp. 267–311.

Coccorese, P. (2014): Estimating the Lerner index for the banking industry: A stochastic frontier approach, Applied Financial Economics, pp. 1–38.

Delis, M. D. (2012): Bank competition, financial reform, and institutions: The importance of being developed, Journal of Development Economics, 97, 2, pp. 450–465.

Delis, M./*Kokas*, S./*Ongena*, S. (2016): Foreign Ownership and Market Power in Banking: Evidence from a World Sample, Journal of Money, Credit and Banking, 48, 2–3, pp. 449–483.

Demsetz, H. (1974): Two systems of belief about monopoly, in: H. J. *Goldschmid*/H. M. *Mann*/J. F. *Weston* (Hrsg.), Industrial concentration: The new learning, Boston [u. a.], pp. 164–184.

Fahrmeir, L./*Künstler*, R./*Pigeot*, I./*Tutz*, G. (2011): Statistik. Der Weg zur Datenanalyse, Springer-Verlag Berlin/Heidelberg.

Feng, G./*Zhang*, X. (2014): Returns to scale at large banks in the US: A random coefficient stochastic frontier approach, Journal of banking and Finance, 39, pp. 135–145.

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

German Monopolies Commission (2014): Major Report 2012/2013: Eine Wettbewerbsordnung für die Finanzmärkte, NOMOS, Baden-Baden.

Gischer, H./*Müller*, H./*Richter*, T. (2015): How to measure the market power of banks in the lending business accurately: A segment-based adjustment of the Lerner Index, Applied Economics, 47, 4, pp. 1–10.

Hall, M./*Tideman*, N. (1967): Measures of concentration, Journal of the American Statistical Association, 62, 317, pp. 162–168.

Hirschman, A. O. (1964): The paternity of an index, American Economic Review, 54, 5, 761–762.

Hirschman, A. (1945)*: National Power and the Structure of Foreign Trade.Berkeley: University of California Press.*

Herfindahl, O. (1950)*:* Concentration in the U.S. SteelIndustry. Dissertation. Columbia University, New York.

Iwata, G. (1974): Measurement of Conjectural Variations in Oligopoly, Econometrica, 42, 5, 947–966.

Koetter, M./*Nestmann*, T./*Stolz*, S./*Wedow*, M. (2006): Still Overbanked and Unprofitable? Two Decades of German Banking, Kredit und Kapital, 39, 4, pp. 1–15.

Koetter, M./*Vins*, O. (2008): The Quiet Life Hypothesis in Banking – Evidence from German Savings Banks, Finance and Accounting Working Paper Series, 190.

Lau, L. J. (1982): On Identifying the Degree of Competitiveness from Industry Price and Output Data, Economics Letters, 10, 1–2, pp. 93–99.

Leon, F. (2015): Measuring competition in banking: A critical review of methods, CERDI – Centre d'Études et de Recherches sur le Développement International, 2014.12, <halshs-01015794v2>

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

Liu, H./*Molyneux*, P./*Wilson*, J. O. (2010): Measuring competition and stability: recent evidence for European banking, Bangor Business School Working Paper, 57.

Love, I./*Pería*, M. S. M. (2014): How Bank Competition Affects Firms' Access to Finance, World Bank Economic Review, 29, 3, pp. 413–448.

Mason, E. S. (1939): Price and Production Policies of Large-Scale Enterprise, American Economic Review, 29, 1, pp. 61–74.

Maudos, J./*Fernández de Guevara*, J. (2007): The cost of market power in banking: Social welfare loss vs. cost inefficiency, Journal of Banking & Finance, 3, 7, 2103–2125.

Panzar, J. C./*Rosse*, J. N. (1987): Testing for 'Monopoly' Equilibrium, Journal of Industrial Economics, 35, 4, pp. 443–456.

Plearsikas, C. (2001): The analysis of market definition and market power in the context of rapid innovation, International Journal of Industrial Organization, 19, 5, 665–693.

Schaeck, K./*Cihák*, M. (2013): Competition, Efficiency and Stability in Banking, Financial Management, 43, 1, pp. 215–241.

Schnabel, I. (2014): Das europäische Bankensystem: Bestandsaufnahme und Herausforderungen, Wirtschaftsdienst, 94, 13, pp. 6–10.

Shaffer, S./*DiSalvo*, J. (1994): Conduct in a banking duopoly, Journal of Banking & Finance, 18, 6, pp. 1063–1082.

Sealey, C. W./*Lindley*, J. T. (1977): Inputs, Outputs, and a Theory of Production and Cost at Depository Financial Institutions, Journal of Finance, 32, 4, pp. 1251–1266.

Smith, L. (2008): Report to the Secretary of State for Business Enterprise and Regulatory Reform, Standard Note SN/BT/4907, Office of Fair trading (UK).

Tirole, J. (1988): The Theory of Industrial Organization, The MIT Press.

Uchida, H./*Tsutsui*, Y. (2005): Has competition in the Japanese banking sector improved?, Journal of Banking & Finance, 29, 2, pp. 419–439.

Van Leuvensteijn, M./*Bikker*, J. A./*Van Rixtel*, A. R./*Sørensen*, C. K. (2011): A new approach to measuring competition in the loan markets of the euro area, Applied Economics, 43, 23, pp. 3155–3167.

Van Leuvensteijn, M./*Sørensen*, C. K./*Bikker*, J. A./*Van Rixtel*, A. R. (2013): Impact of bank competition on the interest rate pass-through in the euro area, Applied Economics, 45, 11, 1359–1380.

Weill, L. (2013): Bank competition in the EU: How has it evolved? Journal of International Financial Markets, Institutions and Money, 26, pp. 100–112.

Weistroffer, C. (2013): Niedrigzinsumfeld und Banken, Deutsche Bank Research, Aktuelle Themen, Globale Finanzmärkte, pp. 1–12.

Zigraiova, D./*Havranek*, T. (2015): Bank Competition and Financial Stability: Much Ado About Nothing?, William Davidson Institute Working Paper No. 1087, pp. 1–40.