Bank Performance

A theoretical and empirical framework for the analysis of profitability, competition and efficiency

Jacob A. Bikker and
Jaap W.B. Bos

Routledge International Studies in Money and Banking

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The economic literature pays a great deal of attention to the performance of banks, expressed in terms of competition, concentration, efficiency, productivity and profitability. This book provides an all-embracing framework for the various existing theories in this area and illustrates these theories with practical applications.

Evaluating a broad field of research, the book describes a profit maximizing bank and demonstrates how several widely-used models can be fitted into this framework. The authors also present an overview of the current major trends in banking and relate them to the assumptions of each model, thereby shedding light on the relevance, timeliness and shelf life of the various models. The results include a set of recommendations for a future research agenda.

Offering a comprehensive analysis of bank performance, this book is useful for all of those undertaking research, or interested, in areas such as banking, competition, supervision, monetary policy and financial stability.

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Foreword

This book provides a comprehensive analysis of bank performance, expressed in terms of competition, concentration, efficiency, productivity and profitability. Bank performance has for many years been a topic of major interest both in Europe and elsewhere, notably in the USA. The principal reason for this is that banks are seen as special, given their pivotal role in providing credit to enterprises. Competition and efficiency are important for social welfare since they promote low prices, high quality and innovation, and afford both consumers and enterprises ready access to financial resources. Moreover, competition adds to the speed and strength of monetary policy transmission.

Competition and efficiency are difficult if not impossible to observe directly, since comparative data on individual banks' output prices (or credit rates) are rare and figures on the cost of individual banking products are generally unavailable. The literature has tried to measure these elusive variables with many different methods, none of which, however, has been conclusive or unchallenged. Apart from theoretical shortcomings, a practical problem is that different methods yield different estimates. The literature on this topic is enormous and this book provides a welcome synthesis. Furthermore, it offers a unique collection of empirical results for most of the discussed measurement approaches, all based on a single worldwide data set. Thus it spans a bridge between the theoretical literature, which is hardly accessible to practitioners in the field, and the requirements of commercial and central bankers, policy makers and supervisors.

The topic of this book is of great interest to academics, bankers, and policy makers, but also particularly important for supervisors and central banks. Supervisors need to be well-informed about the financial institutions under their responsibility and about the markets they operate in. Well-functioning banking markets are a prerequisite for sound and solvent banks, and contribute to financial stability, one of the major concerns of central banks. For this reason, I recommend this book, written by two authors who have made their marks in these fields. I do so with great pleasure, because I know the authors personally, as they combined academic careers with work in the Netherlands central bank. I trust that this book will become a standard work in the field and will act as a benchmark for future banking performance studies.

Dr. A.H.E.M. Wellink
President of De Nederlandsche Bank
Chairman of the Basel Committee of Banking Supervisors

Preface

In the spring of 2005, we started working on what we thought was an 'easy' joint project. Our aim was to bring together the array of models we had used over time to assess and compare bank performance. Our motivation was the discussion we had among ourselves about the appropriateness of the various approaches, the comparability of our results with those found in the literature, and the effects that the changing nature of banking was having on the (crucial) assumptions underlying the models we – and the rest of the banking literature – used to compare bank performance.

Actually, the project turned out to be far from easy. As our work on collating the various competition models as well as productivity and efficiency measures progressed, we also became more ambitious. With a 'unifying theoretical framework' at hand, would it not be great if we could also compare each one of our approaches empirically? Thus, the idea for this book was born.

The final result of our project is a mixture of a theoretical discourse and an applied modeling guide. To an applied economist wishing to estimate, for instance, the Panzar–Rosse model of competition, this book provides a comparison of this model's key assumptions with those of its rival competition models. On the other hand, for a theoretical economist seeking to work on concentration measures, we present an empirical overview of the most common measures for many countries and show how they have been used to test for collusion. To a practitioner asking what the 'true' measure for bank performance is, we would answer that this depends on the problem at hand. This book is intended as a guide to the most appropriate measure(s), rather than the single true measure, which in our view does not exist. If anything, we encourage those interested in bank competition, productivity and efficiency to use 'balanced scorecards' when assessing bank performance. In fact, an example of such a balanced scorecard concludes this book.

Our experiences as bank supervisors and academic lecturers in (under)graduate banking courses further inspired us in writing this book. We like to think that the mixture of theory and empirics we provide is a sound recipe for students taking a banking course. Acquiring textbook knowledge about bank regulation, bank competition, scale economies and the like is a first step forward. Applying this information to data and struggling with model choices and hypothesis tests is a different scientific discipline. As part of the preparations for this book, we encouraged our students to follow this path of struggling with models and hypotheses. In our experience, this combination of teaching both the theory and the empirics of banking makes for a more challenging, rewarding and entertaining course. Therefore, we present all the tools that teachers, students and (young) researchers need to follow suit and use our empirical applications. Finally, as an example, Appendix A explains how this book can be used in a (graduate) banking course.

We owe a debt of gratitude to De Nederlandsche Bank and Utrecht University for the opportunity to prepare this book, to De Nederlandsche Bank for the use of BankScope, and to Jack G.J. Bekooij for outstanding statistical assistance. We are appreciative of René Kurpershoek for helping us with his excellent language editorial skills. Also, we like to thank our co-authors on several published articles and working papers that have left their footprint on this book: Paul Finnie, Michael Koetter, Clemens Kool, James Kolari and Laura Spierdijk. Finally, our approach in writing this book has been heavily influenced by our experiences in teaching the subjects discussed here. In particular, we render thanks to all students that have taken the graduate course on "Regulatory Policy in Financial Markets and Banking" at Utrecht School of Economics, and the students whose graduate and undergraduate theses we supervised: sharing the theory and empirics of bank performance with you has been a great stimulus in writing this book. Of course, all remaining errors are ours.

Jacob A. Bikker and Jaap W.B. Bos

Part I
Background

1 Introduction

The economic literature pays a great deal of attention to the performance of banks, expressed in terms of competition, concentration, efficiency, productivity and profitability. The key reason is that banks are seen as special, given their pivotal role in providing credit to enterprises. Banks and other financial institutions are also regarded, particularly in the aforementioned phenomena, particularly, competition and efficiency, as difficult if not impossible to observe directly, since information on output prices (or credit rates) is rare and figures on the costs of banking products are unavailable. The literature has tried to measure these unobservable variables by many different methods, none of which, however, has been entirely conclusive or unchallenged. Apart from theoretical shortcomings, a practical problem is that different methods yield different estimates.

Evaluating a broad field of research, this book introduces a general framework to describe a profit maximizing bank, elaborating on Bikker and Bos (2005), and demonstrates how several widely used types of models can be fitted into this framework. Particularly, this framework points up the assumptions that are implicit in various competition and efficiency measurement approaches. This explains (part of) the theoretical shortcomings of the various methods as well as the great diversity in the empirical outcomes. Next, we present an overview of the current major trends in banking and relate them to the assumptions of each model, thereby shedding light on the relevance, timeliness and shelf life of the various models. This way, we arrive at a set of recommendations for a future research agenda. We advocate a more prominent role for output prices, and suggest a modification of the intermediation approach. We also indicate ways to distinguish more clearly between market power and efficiency, and explain why we need time-dependent models. Finally, we propose the application of existing models to different size classes and sub-markets. Throughout, we emphasize the benefits of applying several complementary models to overcome the identification problems that we observe in individual models.

A unique characteristic of this book is its use of a single data set on 46 countries across the 1996–2005 period, to which it applies all the different approaches to competition and efficiency measurement and all explanations of bank performance that it presents. This allows for a broad comparison of the empirical approaches across methods, which is not disturbed by differences in the underlying data set.

The countries cover the EU, OECD, Eastern and Central Europe and a number of (other) emerging countries. The empirical results presented in this book are entirely new.

The great diversity in the various estimates of competition and efficiency across countries is a very unsatisfying aspect of the empirical banking literature. This book takes a first step in the direction of a solution in lessoning this problem by developing a 'balanced scorecard' approach. Similar to forecasting where it helps to join predictions from several origins to obtain a more reliable forecast, we find that integrating various estimates of competition and efficiency produces an improved measure. Further, a balanced scorecard may help to assess the measurement qualities of the widely used simple proxies as well as our model-based approaches. Many measures commonly used in theory and practice appear to be useless on their own, often due to their ambiguous interpretation.

This book has been written for academic researchers, both theoretical and empirical, policy makers at the government level, supervisory bodies, commercial banks and (graduate) students. Among its distinguishing features is a comprehensive guide on how to use this book in a university master's course on banking. In addition, it also includes practical guidelines for empirical work on performance, competition, and efficiency. Finally, we provide all Stata and Limdep programming files, used to estimate our empirical results, which are available on our website www.jwbbos.com, as well as a small bank sample with a structure similar to BankScope's balance sheets and profit and loss accounts, so that interested readers can review the discussed models. Those who have the full BankScope dataset at hand can replicate our estimations, or much better, extend them.

This book consists of five parts, which may be studied in the order in which they are presented, but they can also be read separately as they are to a greater extent self contained. In most cases the chapters can also be studied separately. Part I aims at creating a level playing field for readers, and presents background material. We briefly review the existing theory on the production of the banking firm. This part of the book provides the reader with sufficient links to additional literature, should she or he wish to investigate further a particular area.

Part II presents a 'theoretical framework for a profit maximizing bank'. In the first chapter of this part, the key extract of the book, we present a basic model of bank performance. Subsequent chapters show how this model of a profit-maximizing bank can be used to derive a series of well-known competition models. Finally, we use this basic model to derive measures for cost and profit X-efficiency, scale economies, and scope economies. Part III reviews some of the most important 'trends in banking'. The discussions in this part aim to critically evaluate the key assumptions of the various models derived in Part II. Varying with the respective situation, some models may be more suitable than others, depending on the plausibility of the corresponding assumptions. In particular, we want to stimulate thinking on the validity of these assumptions now that the banking industry is changing rapidly.

Part IV contains the ‘empirical results’. We introduce a data set that contains figures for banks in 46 countries, over the period 1996–2005. Subsequently, we use this data set for estimations of the Panzar–Rosse model, the Structure-Conduct-Performance model, the Cournot model, cost and profit X-efficiency, and scale and scope economies. The final chapter of this part develops the balanced scorecard and assesses the qualities of the estimated measures. Part V starts with conclusions, and also summarizes our main findings. In addition, we present a research agenda.

2 Production of the banking firm

Introduction

There exists an extensive literature that seeks to explain bank performance. In this chapter, we take large strides and briefly review parts of the literature that have also sought to explain bank performance, but are not key to the discussion in this book.[1] The remainder of this chapter is organized as follows. In the first section we briefly review alternative explanations for firm performance. Included in this section is a justification for our focus on efficiency. In the next section we introduce a simple production function and show how it can be used to infer economic behavior and performance. The final section elaborates on this by introducing a cost minimization model as well as a profit maximization model.

Alternative explanations for bank performance

The shareholders of a bank are entitled to its profits and it is therefore in their interest to maximize these profits.[2] They can achieve this by maximizing revenue and by minimizing costs. Also, depending on the market power of the bank in the input and output markets respectively, they may be able to increase output prices or decrease input prices. Speculative motives aside, shareholders are indifferent to the distribution of profits, receiving a return on their investment in the bank either through an increase in the bank's share price or through dividends received.

Economic theory tells us that in a perfectly competitive situation, profit maximization is equivalent to cost minimization. In practice however, maximization of profits and/or minimization of costs is not necessarily observed. Of course, exogenous factors such as regulation or (economic) shocks can cause suboptimal performance. To the extent that such factors do not have a similar impact on both cost minimization and profit maximization, they can drive a wedge between the two.

Other possible explanations for deviations from profit maximization fall into two categories. The first category includes all deviations that can be attributed to incentive problems. Wrong incentives cause banks to depart from a purely cost minimizing and/or profit maximizing policy. The second category harbors all deviations that can be attributed to inefficiency. Inefficiency is defined here as the suboptimal use of inputs given outputs or the suboptimal use of outputs given inputs.

Incentive problems

Imperfect competition causes a situation where profits are maximized at an output level where average costs are no longer minimized. Theoretically, a second and related reason why shareholders may abstain from maximizing expected profits and minimizing costs depends on their degree of risk preference. If shareholders are both highly risk averse and underdiversified, they will want to ensure their bank performs counter-cyclically and hence take decisions that may be suboptimal for the bank.[3] Aside from the questionable assumption that shareholders know precisely the correlation between the economic cycle and the bank's performance, the prerequisite that shareholders are underdiversified is impossible to uphold in practice.

Incentive problems that translate more easily into banking practice hinge on the separation of ownership and control and are – *ceteris paribus* – independent of market structure.[4] In the absence of complete information, principal–agent theory states that the inability of shareholders to adequately monitor bank management and the resulting managerial discretion may induce nonoptimal behavior, i.e. profits are not maximized and/or costs are not minimized. As long as shareholders can not insure themselves against this possible suboptimal behavior, bank management may show expense-preference behavior or – if it is highly risk averse – any other strategy that reduces profits.[5] This means that the asymmetric information between principal and agent that was once used by Diamond (1984) to explain that banks exist because they reduce audit costs for lenders to non-financial firms, now helps explain why banks themselves may also suffer from moral hazard and other incentive problems.

Dewatripoint and Tirole (1994) note that principal–agent problems are of particular importance in banking, where debt is highly dispersed among a bank's deposit holders. The high leverage of banks should negatively affect incentives of management to spend much on perks and reduce managerial slack. Individual deposit holders, however, are too small and freeriding stands in the way of monitoring coalitions. This problem is especially pressing in bad times, when the concave return structure of risk-averse deposit holders should ensure sufficient pressure on a bank's management to avoid excessive risk-taking and stimulate a high level of efficiency.

A vast amount of literature deals with ways to minimize the negative effects of these principal–agent problems. A detailed discussion is beyond the scope of this book. Pecuniary and non-pecuniary incentives and yardstick competition are ways to reduce managerial slack while keeping managerial discretion intact.[6] Discretion itself is affected for instance by external control mechanisms, supervisory institutions, collateralized debt and takeover bids.[7] Price and non-price competition, the substitutability of a bank's products and the contestability of its markets may also serve to ensure a bank's optimal performance by putting competitive pressure on its management, provided management compensation is performance-based.[8] A similar role may be played by signalling devices such as ratings. Finally, it is important to note that although we emphasize incentive problems between bank management and debtholders, the same type of problems – if to a lesser extent – also exist for shareholders.

Whether incentive problems are important in European banking is questionable. First, few studies have attempted to test empirically the impact of principal–agent conflicts on the performance of European banks. Translations of the above-described situations where hidden action by or hidden knowledge of bank management results in suboptimal performance into empirical tests are rare.[9] Second, to the extent that the principal–agent relationship results in moral hazard conflicts, it is only problematic as long as the principal (i.e. the shareholder) can not insure himself against excessive risk-taking by the agent (cf. Tirole (1993), Paragraph 2.1). Third, although incentive problems lead to suboptimal performance of a bank, the extent to which this affects European banking dynamics is unclear. There is little reason to suspect that the incentive problems that may hurt a bank's profits or boost its average costs are significantly different from bank to bank, or from country to country. The separation between ownership and control is highly similar for commercial banks in Europe, even if institutional supervision is not.[10]

Summing up, even if incentive problems can help explain bank performance, empirically testing whether they can explain *differences* in bank performance has been difficult and to date far from conclusive.

Inefficiency problems

An approach that may prove more rewarding is to explain bank performance through inefficiency. A bank may produce at lower costs and with a higher profit than other banks if it makes better use of its inputs and transforms them into outputs in the cheapest possible way. In the long run, every bank has to produce efficiently in order to survive.[11]

Molyneux *et al.* (1997) underscore the importance of efficiency in European banking and point out that higher efficiency can be expected to 'lead to improved financial products and services, a higher volume of funds intermediated, greater and more appropriate innovations, a generally more responsive financial system, and improved risk-taking capabilities if efficiency profit gains are channelled into improved capital adequacy positions' (p. 9). In short, bank efficiency is highly important in explaining and interpreting bank performance. Important examples are given by Berger and Humphrey (1992) and Avkiran (1999), who argue that the only way consumers can potentially benefit from large bank mergers is through enhanced efficiency, resulting in lower prices and an increased service level. Likewise, Rose (1995), Altunbas *et al.*, (1997) and Akhavein *et al.*, (1997) have examined whether merged banks are more efficient than similar non-merged banks that are of the same size. Baker and Bresnahan (1985) examine whether stepped-up product differentiation may contribute positively to an increase in efficiency after a merger. Haynes and Thompson (1999) more specifically ask the same question for

British building societies.[12] The importance of questioning whether inefficiency can explain bank performance is underlined by the outcomes of these studies. Only in the last case is there some evidence of efficiency benefits from mergers. In the other studies, there is either no evidence (e.g. Rose, 1987) or even evidence *against* efficiency benefits from mergers (e.g. Altunbas *et al.*, 1997).

The renewed attention for efficiency as an explanatory factor in bank performance as well as its potential role in policy-making sufficed for Economic Research Ltd. (1997) to engage in its own all-encompassing study of market power and efficiency in European banking. The authors hypothesize that the single market integration program (S.M.P.) 'has allowed the (increased) realization of [efficiency gains] in European banking markets' (p. 187). Results show that the impact of the S.M.P. on bank efficiency varied across different countries. Importantly, although not concluded by the authors themselves, this impact is itself not related to the explanatory power of the models applied to different countries. The results are strong and robust enough however, for the commission to conclude that 'there does appear to have been a trend for European banks, on average, to move closer to the EU cost efficiency frontier' (p. 195).

Summing up, efficiency plays an important role in explaining the forces behind European bank performance. Furthermore, it can aid in measuring and interpreting the sources driving bank performance. And it serves as a crucial policy-making tool in reacting to the dynamics of the single market for financial services. In the next sections, we will therefore build an analytical framework that allows for accurate measurement and interpretation of the (relative) efficiency of European banks.

From economic rationality to production functions

Our framework starts with the identification and description of why banks pursue efficiency. In order to do so, we must first define bank production and show why and how production is optimized.[13]

We introduce banks as rational economic agents. This concept merits some explanation. To start with, we assume that banks act rationally. That is, a bank operates in such a way that it pursues its own goals in what is – *ceteris paribus* – the best conceivable, optimal way. Of course, this means banks are assumed to know the mechanics of their own production and have the ability and will to use it to attain their goals. Second, banks are agents, interacting with other agents, such as consumers and governments. Therefore in pursuing their goals, banks have to take exogenous factors into account. Finally, banks are *economic* agents, in that these goals are defined from now on in economic terms. In reference to the previous section, this means that we disregard any non-pecuniary objectives.[14] Beyond that, banks are assumed to maximize profits and/or minimize costs.[15]

More precisely, a bank tries to be *productive* and *efficient*. In order to explain both concepts, we introduce a simple production function:

$$y = f(x) \tag{2.1}$$

Where output y is produced using input x, all outputs and inputs are homogenous

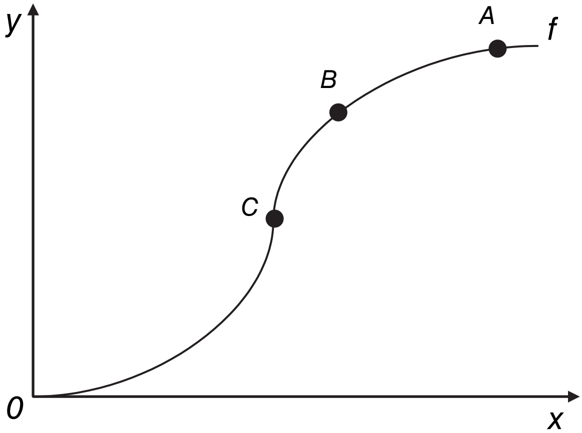

Figure 2.1 Productivity

and the production function is twice continuously differentiable. Also, there is no budget constraint.[16]

Figure 2.1 is a graphical depiction of f, the production function. It helps to illustrate productivity.

In the example, a bank produces a single output with a single input, although the analysis that follows here can easily be generalized to a multi-output, multi-input case. Always, however, we do consider *long-run* production functions. The long run is defined by the fact that none of the inputs or outputs is fixed. Also, all inputs and outputs are assumed to be infinitely divisible. We start with what is generally called productivity and then discuss efficiency.

Productivity is defined here as y/x, i.e. the number of outputs produced with a single unit of input. For the production function in the graph, $\partial y/\partial x > 0$ and from C onwards $\partial^2 y/\partial^2 x < 0$. Economies of scale are defined as the rate at which output changes as all inputs are varied simultaneously. Thus, we observe increasing returns to scale from 0 to C, constant returns to scale at C and decreasing returns to scale from C onwards. On and below f, we find the feasible production set, i.e. the set of all possible input-output combinations. In the graph, bank B has the highest (possible) productivity, followed by banks A and C. In a multiple-input, multiple-output setting, total factor productivity is the sum of all output-specific productivity (first and second-order partial derivatives).

> Economies of scope generate cost savings from delivering multiple goods and services jointly through the same organisation rather than through specialised providers. These potential cost savings are to be differentiated from economies of scale, which refer to lower costs per unit of a single good or service as total output of that good or service rises
>
> (Altunbas *et al.* 1997, p. 143).

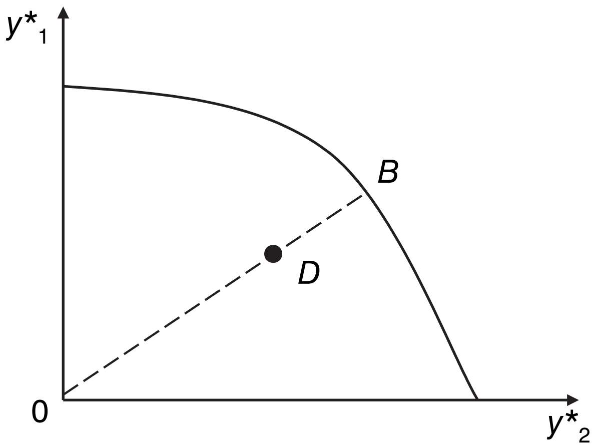

Figure 2.2 Efficiency

In a two-output, single-input setting, economies of scope measure the net cost savings from producing two outputs jointly rather than separately.

Efficiency on the other hand relates to the feasible production set, depicted for a two output setting in Figure 2.2. Generally, efficiency is defined in a similar way as productivity, with one important difference: now, instead of y, the actual output, we use y^*, the maximum output for a given level of input. Therefore, efficiency refers to the difference between observed and optimal input/output mixes.[17] In Figure 2.2, this means measurements are relative to the frontier, which defines the maximum output for each input level (or the minimum input level, for input minimization). Efficiency is defined as $(y/x)/(y^*/x) = y/y^*$, where y is the vector of outputs y_1 and y_2. Thus, bank B is efficient, since it is positioned on the frontier.[18]

The type of efficiency described here is referred to as X-efficiency. It measures the efficiency that results from the position of a bank within the feasible production set and relative to the production frontier. What is not taken into account is the role of prices. In order to do so, we can split up X-efficiency into technical and allocative efficiency. Coelli *et al.* (1998) define allocative efficiency as the ability of a firm to use inputs and/or outputs in optimal proportions, given their respective prices and given production technologies. The term allocative efficiency is sometimes also called price efficiency, see Lovell (1993). Of course, for allocative efficiency we need price information. Since bank output prices are hard (if not impossible) to obtain for banks, in what follows here, we will focus solely on technical efficiency when discussing X-efficiency.

Recapitulating, economies of scale and scope as productivity measures are closely related to (especially) X-efficiency. Both measure how well a bank combines its inputs to produce its outputs. But whereas the economies of scale and scope are absolute – though comparable – measures, X-efficiency is measured relative to a benchmark. Put differently, the optimal output y^* is an efficient and feasible point on the productive frontier, that may or may not be observed in practice.[19] An important similarity between economies of scale and technical efficiency is that they are both radial measures.[20] Technical efficiency is measured in Figure 2.2 by the ratio of the linear distance between 0 and *D* and between 0 and *B*, respectively.

Finally, all efficiency measures derived so far may change over time. A special case is a symmetrical shift (i.e. also a radial measure) of the productive frontier resulting from technological advances making their way into the production process. This shift is called technical change.[21]

Summing up, we have defined a simple production function and introduced a number of efficiency measures. In the context of the banking industry it is important to note the particular problems arising from the ambiguity of bank's underlying production technologies. This ambiguity is one of the major reasons to model efficiency analyses on the basis of cost and/or profit functions. In the next sections, we further elaborate on the use of these efficiency measures to explain (relative) bank performance.

From production functions to cost and profit functions

We have explained why efficiency can help explain bank performance. In this section and the next we further refine the type of efficiency that best serves this purpose as well as means to measure this efficiency. We start with a short introduction into bank behavior. Next, we briefly explain the importance of the concept of duality. Then we turn to bank production and examine how it is best captured. What remains are the formulation of a cost minimization model and a profit maximization model respectively.

Bank behavior

Standard microeconomic theory argues that in a perfect competition setting a bank will be a price taker that maximizes profits by minimizing costs.[22] It increases output up to the point where marginal costs equal marginal revenue and average costs are minimized.

There are a number of reasons why banks may not be price takers and may not operate in a perfectly competitive market. As a first example, in the presence of increasing returns to scale a single bank should theoretically serve the market.[23] Second, price discrimination can give rise to monopsony powers, for instance through switching costs, search costs and product differentiation.[24] Third, cross-subsidization may cause spill-over effects from one concentrated banking market to another.[25] A fourth example depends on the existence of regulatory barriers such as the ban on interstate branching in the U.S. following the enactment of the Glass–Steagall act or the existence of interest rate regulation (in the form of maximum rates) in France and Spain in the early 1990s.

We therefore need an analytical framework that can incorporate and thereby measure behavioral assumptions about banks. Consider the bank operating in the perfectly competitive market and the bank that has a natural monopoly both maximize outputs, possibly using the same production technology. Hence, they have the same production function. Therefore, we distinguish explicitly between cost minimization and profit maximization. In a perfectly competitive market, the two approaches should yield identical results for any single bank. However, in the case of imperfect competition, the existence of market power (for whatever reason) may create a bank that maximizes profits without minimizing costs or vice versa. The combined use of both cost and profit optimization is therefore a good – albeit indirect – way to incorporate bank behavior in response to its competitive environment.

Duality

In order to use the production function described in the previous section as well as the efficiency measures described there for a cost minimization model and a profit maximization model, we have to make use of duality.[26]

First, we can use the production function described in the previous section to formulate input demand and output supply equations. In a single-input, single-output model, we can find across inputs the output level that minimizes costs and/or maximizes profits.[27] Ignoring the difference between given and optimal inputs and prices for now, profits (π) are maximized by taking: $Max\ \pi : y - x$. We can find the input demand equations by setting $\partial\pi/\partial x = 0$.[28] By substituting the resulting equations back into the profit maximization model (or cost-minimization model) we find the primal. In order to follow suit empirically, we would have to estimate the production function and estimate the input demand and output supply equations within a system of simultaneous equations. Such an estimation may then suffer from simultaneous equations' bias if one or more inputs are not exogenous. In addition, the resulting efficiency measures would not correct for the possible impact of market power on price-setting. Furthermore, this method requires information on input and output volumes. For banks this is not always a straightforward exercise. For example, a loan can be described by outstanding value or by indebted interest rate.

With the help of the envelope theorem the derivation of the dual becomes much easier. For a profit maximization model, Hotelling's Lemma (see Beattie and Taylor (1985), p. 227) tells us that the negative of input demand and output supply equations can be derived by taking the first order partial derivatives from a profit function. Likewise, for a cost minimization model, Shephard's Lemma states that the first partial derivative of the cost function with respect to each of the input prices defines the conditional input demand functions (i.e. conditional upon the output level, y). For both models, Young's Theorem states that a second-order partial derivative is invariant to the order of differentiation, and the cross partial derivatives are symmetrical (cf. Chiang, 1984). Now, there is no simultaneous equations bias, and we can easily use the resulting cost minimization model and profit maximization model to interpret the role of market dynamics for bank efficiency.

Bank production

In later chapters, we will introduce a profit maximization model for the banking firm that will serve as the basic framework for this book. Now, we briefly discuss different views on how to select the variables that best describe bank production.

The specification of inputs to and outputs of bank production is part of an ongoing debate. On the one hand, the production approach distinguishes labor and physical capital as inputs and numbers of processed documents or transactions as output. In the literature, consensus exists that it is mostly appropriate for bank branches with low autonomy in loan policy (see also Ferrier and Lovell, 1990). On the other hand, the intermediation approach starts from the traditional core function of financial institutions and takes deposits as inputs and defines loans and investments as output.[29]

The appropriate definition of output in banking has been a frequent topic of discussion, the two mainstreams being the intermediation approach and the production approach. The former assumes that a bank attracts deposits and other funds and transforms them into loans and securities (investments), using inputs such as labor, capital and materials. Interest payments are seen as part of the costs and the corresponding dual cost function includes not deposits but the interest rate paid on deposits as an input factor. Loans and investments are the output components. Examples of this view are found in Altunbas *et al.* (1994, 1995) and Barr *et al.* (1994). The latter approach assumes that a bank provides services related to loans and deposits. In this view, interest payments are not regarded as banking costs. The output components comprise loans and deposits. Examples of this approach can be found in Swank (1996), Resti (1997) and Berger and DeYoung (1997), among others. Since operating costs appear to make up the bulk of banks' cost inefficiency (Berger and Humphrey, 1991), this analysis, in line with most of the literature, takes the production approach.

Both approaches have their disadvantages. Under the production approach, output may be better specified as the yield to maturity plus notional amounts. Equivalently, some authors have argued that under the intermediation approach, deposits may be included as outputs rather than inputs.[30] However, the main motivation for this seems to be that banks create revenue from deposits. This would suggest including the interest margin, which does not fit the definition of an output. Rather, it is a performance measure in itself. Concluding, we consider the inclusion of loans as outputs a reason in itself to include deposits as inputs (hence the term intermediation approach).

Both approaches also fail to incorporate the management of risk, information processing and the solution of agency problems arising due to the differences between loans and deposits and the separation between management and ownership. Potential solutions to these shortcomings may be a different formulation of the constraint under which banks solve their minimization and maximization problems, respectively. An example of the incorporation of risk management is the inclusion of the level of equity in bank production.[31] In funding loans, equity may be used as an alternative instead of deposits. Clearly, this would have an impact on both costs and profits. Furthermore, Mester (1996) argues that the inclusion of equity in the analysis may account for differences in bank managers' risk attitude, since higher levels of equity reduce the risk of default all else being equal. Finally, Berger and Mester (1997) mention the larger dependence of huge banks on debt financing as a reason to include equity. We will therefore include equity (or a close proxy for equity as a risk variable) as an additional explanatory control variable in our empirical models.

3 Regulation of the banking firm

Motivation for capital regulation of financial institutions

Society wishes to regulate and supervise banks for a number of reasons related to consumer protection, the operation of financial institutions and markets, the incentives for participants, market imperfections and failures and, finally, the special nature of financial products.[1] Critics of regulation argue that market failures or imperfections are not serious or even that they do not exist at all.[2] Moreover, they say that regulation cannot prevent failures or imperfections, or is too costly, whereas some forms of regulation might even generate new sources of moral hazard. We distinguish the following three objectives for the supervision of financial institutions: consumer protection, the promotion of systemic stability, and maintaining the financial soundness of individual institutions.[3] Following Llewellyn (1999), the instruments at hand are prudential regulation and conduct of business regulation. The former aims to promote solvency and thus the general safety and soundness of institutions, while the latter concerns the customer–firm relationship.[4]

Contrary to other firms, banks may use deposits for their funding needs. Deposits differ from other types of debt, in that a substantial part of deposits may be retrieved on sight. Demandable deposits generate the possibility of a bank run on an individual bank, which is suspected to be insolvent. The first come, first served constraint, applicable for demand depositors, means that there is a strong incentive for depositors to be in the front of the queue (Chen, 1999). In regular near-bankruptcies it is more difficult to jump the queue and thus evade costs.

Another typical characteristic of banks is their opacity: it is hard to assess the total risk a bank is running. In particular, the value of longer-term investments that are not publicly traded is difficult to establish, let alone by relative outsiders such as depositors.[5] As the banking operations of different banks are fairly similar, financial stress emerging in one bank may indicate similar difficulties in others. In many cases it is difficult to distinguish bank-specific shocks from general shocks. Therefore, a run on one bank may generate runs on other banks, bringing about serious financial instability.[6] Contagion may also be reinforced because banks are interwoven through heavy interbank lending and cross participations. If bank runs are not triggered by true insolvency, they are detrimental to social welfare, because in a bankruptcy contracts will have to be renegotiated or traded at a discount. Hence, special measures are required to reduce welfare impairing bank runs and their threat of financial instability.

Banks also differ from other industries in that the contracts on both sides of the balance sheet have different maturities: funding is of a short-term nature, whereas lending is generally long term. This creates both liquidity risk, which is often the immediate cause of a bank run, and interest rate risk, possibly damaging solvency. Therefore public authorities must act to control these risks and safeguard the public interest. Finally, banks have a pivotal role in the financial system, in the clearing and settlement of transactions and – above all – providing finance, in particular to small and medium-sized enterprises.

In industrial countries, two solutions for bank-run problems have been proposed and adopted. The first is the implementation of a deposit insurance scheme for the deposits of households.[7] Many deposits are insured up to a certain floor. In most countries, banks pay premiums to fill a fund, whereas in others, such as the Netherlands, banks need only to cover sustained losses after a failure. An additional motivation for deposit insurance is consumer protection.[8] The second solution for bank-run problems is the role of the central bank as the lender of last resort, which may provide funds to illiquid but solvent banks (in principle, only against collateral). The support can also go further, as the central bank or the supervisor may carry out a rescue operation.

Deposit insurance produces risk shifting from the bank's deposit holders to all other banks or taxpayers. In this case the risk of deposit holders is not priced, which makes this type of funding cheap.[9] Risk insensitivity of funding creates an incentive for banks to expose themselves to more risky and thus more rewarding investment. Similarly, the lender of last resort function implies that risk is shifted from all funding parties of the bank to the taxpayer, which may provoke more risky bank behavior, because an unpriced insurance covers part of the possible damage. These moral hazard problems brought about by instruments to reduce the fragility of banks imply a need to further refine banking regulation in order to prevent banks from overly risky behavior at the expense of others. When it comes to safeguarding the financial soundness of banks and, more generally, achieving financial stability, minimum capital requirements are seen as the most effective tools of banking supervision, as they guarantee that banks have buffers to absorb unexpected losses. Ideally, the level of these requirements is linked to the probability of default on the part of the bank and reflects the degree of confidence society demands with respect to financial stability and the financial soundness of individual banks. Many banks choose a capital level that is substantially higher than the regulatory minimum for purely commercial reasons, e.g. in order to obtain a higher rating, as this makes capital market funding cheaper, or to avoid downgrading for reputational reasons.[10]

Basel I and II

In 1988, the Basel Committee introduced the first Basel Accord on minimum capital requirements for internationally active banks, in order to promote sound and stable banking systems and a world-wide level-playing field.[11] At present, over 100 countries have adopted this capital regulatory framework, often also applying it to locally active banks. The BIS or solvency ratio shows a bank's actual own funds (capital) as a percentage of its risk-weighted assets, and must not fall below 8 percent. The risk-weighted assets relate mainly to the credit risk run by banks, but other risks – such as market risk – are also included in the denominator of the BIS ratio. This ratio therefore indicates a bank's capability to absorb losses. However, as not all risks are explicitly taken into account for the BIS ratio – take for example operational risk – banks are required to maintain a capital adequacy ratio of over 8 percent. The denominator is calculated by multiplying a bank's assets by a weighting coefficient. The greater the (credit) risk, the higher the coefficient. Five coefficients were distinguished: 0 percent, 10 percent, 20 percent, 50 percent and 100 percent. The actual own funds forming the numerator of the BIS ratio consist of Tier 1, Tier 2 and Tier 3 capital less deductible items. Tier 1 capital, or core capital, tops the list in qualitative terms. It is made up mainly of equity capital, reserves and retained profits, but may, subject to conditions, also include certain innovative forms of capital. At least half of a bank's capital requirement should consist of such core capital, which means that the ratio of Tier 1 capital to risk-weighted assets should be at least 4 percent. Tier 2 capital is made up of preferred shares and debt certificates with no fixed maturity (upper Tier 2) and of preferred shares with a limited lifespan and long-term subordinated debts (lower Tier 2).[12] Tier 3, at the bottom of the list in qualitative terms, consists of short-term subordinated debts, and accounts for only a small share of actual own funds.

Bikker and Metzemakers (2007) present figures of the BIS capital ratio, based on a sample of 1320 banks, which indicate a clear increase from, on average, 8.7 percent in 1990 to 10.1 percent in 1994, until in 1995 a tentative equilibrium level has been reached - which was, incidentally, well above the 8 percent minimum level. Using data from national supervisors and the Basel Committee, Jackson *et al.* (1999) also observed that between 1988 and 1992, the transition period, the average capital ratio of the whole sector rose significantly. Apparently, the Accord, indeed, strongly induced banks to increase their capital reserve. Apart from raising capital, US banks shifted sharply from risky corporate lending to investment in safe government securities. There is an extensive amount of literature on this topic due to the fact that the adjustment to Basel I capital levels coincided with a recession in most industrialized countries. A number of studies made a persuasive case that capital requirements played a role in this switch to less risky assets, supporting the credit crunch hypothesis,[13] but others have provided evidence suggesting that this decline in private lending is better explained by banks' own internal capital targets than by regulatory capital requirements (Hancock and Wilcox, 1993; Ediz *et al.*, 1998).[14] The observed world-wide (total-assets weighted) average of above 11 percent indicates that banks choose to maintain capital levels that in almost all cases result in BIS ratios well above the required minimum. This outcome underlines that banks may have their own motives for setting capital targets independently from supervisory rules. Banks may be more risk averse and aim at lower funding costs, they may assess the risk of their portfolio as being higher than the outcome of the BIS risk weighting scheme (de Bondt and Prast, 2000), or they may wish to hold a capital buffer enabling them to exploit unexpected investment opportunities (Berger *et al.*, 1995). An alternative would be that banks set their capital a certain time-invariant percentage (points) above minimum requirements. Ediz *et al.* (1998) found for the UK that banks adjust their capital upwards if it comes close to the minimum requirement level or to the trigger value of the UK supervisors (where the supervisors start 'drastic actions'). By contrast, Hancock and Wilcox (1993) did not find such adjustments for the US banks.

Under the new Basel Capital Agreement (Basel II), risk weighting for solvency measurement has been substantially refined in that banks, under the so-called standardized approach, will be permitted to make use of external ratings by acknowledged rating agencies.[15] This introduces risk differentiation for counterparties, whereas uniform risk weights applied under Basel I. In addition, banks able to demonstrate the adequacy of their own credit risk measurement methods – under the so-called Internal-Rating Based (IRB) approach – are allowed to use internal ratings of lending risk. This IRB approach is even more risk sensitive.[16] In addition, the new Agreement makes greater allowance for risk-reducing factors such as collateral and guarantees. Also, it provides for a risk-sensitive capital adequacy requirement for operational risk. Finally, the Supervisory Review of Pillar II requires banks to demonstrate that their capital is sufficient to cover (all) risks, given their specific activities and environment, both under normal and stress conditions.

The regulatory regimes evolve over time. Shortcomings of existing regimes as emerging in practice and new developments, e.g. on information technology, data collections and risk management theory, are stimuli to develop new risk management techniques and new regulatory regimes. In fact, it is the responsibility of banks to have adequate capital; regulation only prescribes minimum requirements. Under the increasing complexity of financial products and financial markets, the development of new regulatory rules depend more than before on cooperation between the most advanced financial institutions and regulators. This is also what happened during the development of Basel II. Experiences with new developments in the market help in developing new regimes, such as the internal-rating-based models, which force less developed banks to improve their risk management further. Basel II has been constructed in such a way that new developments can be implemented quickly, indicated with the evolutionary approach. New steps ahead could be the introduction of estimated correlations among loans and between loans and other financial assets, so that diversification of risk can be taken into account, allowing the use of, for example, credit risk models. Of course, regulators will require sufficient reliability of such estimates of correlations and possibilities to assess them.

Procyclicality of the regulatory regime

Under the risk-sensitive Basel II regime, the minimum required capital depends on the business cycle, following the general assumption that credit risk increases during a downturn, and as is also reflected by the measurement approaches (Catarineu-Rabell *et al.*, 2003). As raising new capital is costly – especially during a downturn – increasing capital requirements might force banks to reduce lending, which might exacerbate or prolong the recession. Of course, such behavior will only be exhibited by the relatively few banks that do not have capital well in excess of the minimum requirements. At an earlier stage, the Basel Committee recognized the possible procyclical effects of the Agreement and made far-reaching adjustments, elaborated in the later proposals of the new Agreement. First, the final new capital requirements are less risk sensitive than earlier proposals, reducing the procyclical impact by one third (Segaviano and Lowe, 2002). Second, banks are allowed to treat some types of loans to small and medium-sized enterprises as retail loans, which carry lower capital requirements and are less risk sensitive, because the dispersion of small loans over many counterparties in the retail portfolio reduces the risk run by the bank. Third, more types of collateral are recognized for capital reduction, an instrument typically used by banks when the business cycle deteriorates. In the fourth place, banks need to show by means of stress testing that their capital is adequate to cope with a recession (that is, six months without economic growth) without a reduction of lending. Finally, banks are free to estimate through-the-cycle ratings instead of point-in-time ratings.[17] In the end, risk-sensitive capital is thought to trade off greater efficiency in capital allocation across banks against macroeconomic stability.

Recently, a number of empirical studies have touched upon the issues of the possible procyclicality of Basel II. Carpenter *et al.* (2001) examined the potential cyclical effects of the revised standardized approach for the US. They combined data on borrower credit ratings with the risk profile of business loans by commercial banks to approximate the capital requirements over the preceding period according to the standardized approach. They did not find any substantial additional cyclicality of the new Agreement relative to the current regime. Of course, the risk sensitivity of the standardized approach is less than that of the IRB approach. For Spain, Ayuso *et al.* (2004) found a significant negative relationship between capital buffers and GDP growth under Basel I, although the effect of GDP is quite moderate. They argue that if banks maintain a sufficient buffer in excess of the minimum requirements, the alleged procyclicality of the new Agreement will turn out to be non-existent. For Norway, Lindquist (2004) also found a negative relation between capital buffers and GDP growth. This result should be interpreted with caution, however, because her data do not cover a full business cycle. Lowe and Segoviano (2002) examines how capital requirements might have moved over time in Mexico had the 'foundation' IRB approach been in place during the nineties. They use credit ratings to construct a transition matrix. The authors conclude that required capital increased significantly in the aftermath of the crisis of 1995, and fell as the economy recovered.[18] If actual capital shows the same cyclical variation under the new Agreement, business cycle fluctuations may be amplified. Estrella (2004) developed a dynamic model for banks where the optimum capital level is related to a period-dependent Value at Risk (VaR) model, while the optimum probability of failure is determined endogenously. He found that regulatory minimum capital requirements based on VaR, if binding, would probably be procyclical. Peura and Jokivuolle (2004) developed a simulation model to estimate the necessary buffers on top of the minimum requirements.[19] They found that capital requirements are lower under Basel II, but that the major part of that reduction is needed as extra buffer. Jackson *et al.* (2002) also conclude that Basel II capital requirements will not represent a binding constraint on banks' operations, given their buffers at that time.

Under Basel I, the minimum capital requirements for credit did not fluctuate over the business cycle.[20] Under Basel II, they became cyclical, but the measures of the Basel Committee listed above have strongly limited the possible range of cyclical fluctuations. There is no compelling prior evidence on whether banks will change their own actual capital buffer targets after the changeover to Basel II. Banks will further improve their risk measurement tools and may arrive at a more risk sensitive risk assessment. Nevertheless, we expect banks to continue basing their final capital level decisions on their own risk aversion, an optimal funding strategy, buffers allowing them to exploit unexpected investment opportunities and other arguments based on their own independent judgement. Borio *et al.* (2001) assume that underlying risks are built up during booms instead of during recessions, so that forward-looking banks will reserve capital in time, that is, in a manner that is neutral to the cycle or even countercyclically. That would also contribute to capital levels that would, on balance, be less cyclical. If banks already risk-adjust their capital more than implied by Basel I, Basel II may not affect the capital much. Currently, most banks set their capital reserve well above the minimum level. If continued, this policy will provide most banks with large 'buffers' to absorb fluctuations in their minimum requirements. An exception would be the strategy to set capital a fixed percentage (points) above the minimum requirements.

Part II
Theoretical framework

4 Basic model of bank performance

Introduction

The profitability of banks is of interest to bank management, financial markets, bank supervisors and academics. This interest is driven by increasing consolidation in the banking sector, changes in production technology and regulation, and dissolving borders, both geographically and vis-à-vis related financial products and industries. As a result, explaining (changes in) the profitability of banks is the implicit or explicit subject of much of the banking literature. When we estimate a market power model, we look for – the abuse of – market power as a means of explaining increases and differences in profitability. And when we employ an efficient frontier model, we expect suboptimal management decisions regarding production factors to lead to differences in profitability.

Interestingly, and often implicitly, these expectations reflect important assumptions not just with respect to a bank's decision making process or its competitive behavior, but also with respect to other factors that may help explain changes and differences in profitability. For example, a market power model that assumes output price competition, thereby also assumes that products are fairly homogeneous, perhaps as a result of harmonization and liberalization of bank regulation. And by focusing on efficiency, we implicitly assume that inefficiency dominates other types of suboptimal production decisions related to for example scale (or scope). Our motivation for doing so may be the increase in average size as a result of the increasing consolidation in the banking industry.

This chapter tries to bring to the forefront the assumptions that we make when focusing on a particular type of explanation for bank profitability. We attempt to evaluate a broad field of research by introducing a general framework for a profit maximizing bank and demonstrating how different types of models can be fitted into this framework. The fact is that not all models introduced here are nested and difficulties encountered in comparing past empirical evidence complicate our comparisons of empirical evidence for different models. However, we can relate the current major trends in European banking to each model's assumptions and thereby shed light on the relevance, timeliness and shelf life of different models. This way, we aim to arrive at a set of recommendations for a future research agenda that is both well motivated and in keeping with current and future developments (see Chapter 18).

Profit maximization

A key assumption in much of the literature is that banks are profit maximizers. It is in fact one of the (few) assumptions shared by all models reviewed in the chapters of Part II. At this point in our discussion of trends in bank profitability, it is therefore instructive to remind ourselves of exactly why banks maximize profits. To be sure, standard theory tells us that a bank's shareholders are claimants for its profits and it is thereby in their interest to maximize these profits.[1] They maximize their return on investment by maximizing revenue and by minimizing costs. Depending on the market power of the bank in input and output markets respectively, it may be able to increase output prices or decrease input prices. Bank management can select the mix of inputs and outputs by which profits are maximized. In order to avoid stating the obvious, and to clarify our motivation further we therefore begin by asking why a bank should *not* be able to attain maximum profits. In this section, we consider four issues related to profit maximization: (a) the role of diversification and risk preferences; (b) principal agent problems between shareholders and bank management; (c) imperfect competition; (d) inefficient use of inputs and outputs.

A first consideration relating to bank profit maximization concerns the concepts of risk and diversification. Shareholders balance their appetite for maximizing expected profits and minimizing costs against the amount of risk they are willing to take. Abstracting from speculative motives, shareholders are generally assumed to be indifferent to the distribution of profits, receiving a return on their investment in the bank either through an increase in the bank's share price or through dividends received. If all banks share the same risk-return preferences, or if the risk-return relationship can be described by some relatively simple homothetic continous function, then there is no serious problem with the fact that we do not know how to control a bank's risk preferences.[2] This is different, however, in a situation where some banks (e.g. cooperative banks) are highly risk averse and not well diversified. Such banks have different preferences, forego high-risk, high-return opportunities and optimize towards an altogether different maximum profit.[3] Although control variables aimed at proxying for this risk attitude are frequently used in the literature, comparatively little work has been done on modelling banks' risk-return trade-off. Recent work by Hughes *et al.* (2000) and DeYoung *et al.* (2001) has tried to incorporate risk into a bank benchmarking exercise. Koetter (2004) has applied their model to German banks. Given that this type of work is still in its infancy, we refrain from including it in our general framework. Instead, we rely on control variables that aim to proxy for banks' risk-return preferences.

A second consideration relating to banks' profit maximization concerns incentive structures. Even risk-neutral shareholders who are well diversified may have problems translating their claim on profits into the actions required to maximize revenue and minimize costs. In the absence of complete information, principal–agent theory states that shareholders are unable to adequately monitor bank management and that the resulting managerial discretion may induce suboptimal behavior, i.e. profits are not maximized and/or costs are not minimized.[4] As long as shareholders cannot monitor and penalize bank management, the latter may show expense-preference behavior or – if it is highly risk averse – any other strategy that reduces profits.[5] This means that the information asymmetry between principal and agent that was once used by Diamond (1984) to explain the existence of banks from the reduction in audit costs for lenders to non-financial firms, now helps explain why banks themselves may also suffer from moral hazard and other incentive problems. A vast amount of literature exists on ways to minimize the negative effects of these principal–agent problems. A detailed discussion is beyond the scope of this chapter. Pecuniary and non-pecuniary incentives and yardstick competition are ways to reduce managerial slack while keeping managerial discretion intact.[6] Discretion itself is affected by, for instance, external control mechanisms, supervisory institutions, collateralized debt and takeover bids.[7] Price and non-price competition, the substitutability of a bank's products and the contestability of its markets may also serve to ensure a bank's optimal performance by putting competitive pressure on its management, provided management compensation is performance-based.[8] A similar role may be played by signalling devices such as ratings. Whether incentive problems are important in European banking is questionable. First, few studies have attempted to test empirically the impact of principal–agent conflicts on the performance of European banks. Translations into empirical tests of the situations described above where hidden action by or hidden knowledge of bank management results in suboptimal performance are rare.[9] Second, to the extent that the principal–agent relationship results in moral hazard conflicts, this will only create problems if the principal (i.e. the shareholder) can not insure himself against excessive risk taking by the agent (cf. Tirole (1993), paragraph 2.1). Third, although incentive problems lead to suboptimal performance by a bank, the extent to which this affects European banking dynamics is unclear. There is little reason to suspect that the incentive problems that can cause a bank to make less profit or experience above-minimum average costs are significantly different from bank to bank, or from country to country. The separation between ownership and control is highly similar for commercial banks across Europe, even if institutional supervision is not.[10] Summing up, even if incentive problems can help explain bank performance, testing empirically whether they can explain *differences* in bank performance is difficult and to date results have been far from conclusive.

Banks' performance is related to changes in their environment and the behavior of their competitors. Therefore, a third consideration relating to banks' profit maximization concerns market power. Economic theory also tells us that in a perfectly competitive situation, profit maximization is equivalent to cost minimization. In practice however, we do not necessarily observe maximization of profits and/or minimization of costs. Of course, exogenous factors such as regulation or (economic) shocks can cause suboptimal performance. To the extent that such factors do not have similar effects on both cost minimization and profit maximization, they can drive a wedge between the two. Imperfect competition causes a situation where profits are maximized at an output level where average costs are no longer minimized. It can thus be used to explain changes in profitability over time as well as between banks. Therefore, the first class of models considered in the next chapters is that of market power models.

A bank may also produce at lower costs and with a higher profit than other banks if it makes better use of its inputs and transforms them into outputs in the cheapest possible way. In the long run, every bank has to produce efficiently in order to survive.[11] The fourth consideration relating to banks' profit maximization therefore concerns efficiency. For the EU, Economic Research Ltd. (1997) hypothesizes that the single market integration program (S.M.P.) 'has allowed the (increased) realization of [efficiency gains] in European banking markets' (p. 187). The authors conclude that 'there does appear to have been a trend for European banks, on average, to move closer to the EU cost efficiency frontier' (p. 195). Summing up, efficiency plays an important role in explaining the forces behind European bank performance. Furthermore, it can aid in measuring and interpreting the sources driving bank performance. Therefore, the second class of models considered in the next chapters includes various methods for the measurement and interpretation of the (relative) efficiency of European and non-European banks.

Basic model

This section develops a basic model of a profit maximizing bank.[12] Equilibrium conditions from this model can be used to test more extreme models, namely perfect competition and myopic oligopoly behavior (the classic Cournot model). Without loss of generality, we assume all costs to be variable costs (in the long run), and all outputs to be perfect complements with zero cross-price elasticity. For now, banks are also assumed to be myopic (we will later relax this assumption). For a bank i, we define profit Π_i, the output vector Y_i, the input vector X_i, the output price vector p, and the input price vector w_i. Each bank i maximizes profit using transformation function T and pricing opportunity set H, which captures the bank's assessment of its competitive position and concomitant willingness of customers to pay the prices charged by the bank. Part of the pricing opportunity set is Z, the level of equity.[13] For now we drop subscripts that denote different inputs, outputs, input prices or output prices, for ease of exposition. All variables used in this section are therefore vectors, and a subscript i always refers to individual banks, whereas a variable without a subscript denotes the aggregate vector for all banks in a market.

Since we use duality (and thus do not have to estimate input-demand and output-supply functions), there is no need to further specify the transformation function T or the opportunity set H.[14] For each output in the output vector Y_i, bank i faces the price p based on the inverse demand function $f(Y)$. Bank i then maximizes:

$$
\begin{aligned}
\Pi_i &= pY_i - w_iX_i, \textit{ subject to} \\
T(X_i, Y_i) &= 0 \\
H(p, Y_i, w_i, Z_i) &= 0 \\
p &= f\left(\sum_{i=1}^{N} Y_i\right) = f(Y)
\end{aligned}
$$

where $f(Y)$ is inverse market demand and N the number of banks. The corresponding Lagrangian system can be written as:

$$L\Pi_i = pY_i - w_iX_i - \xi T(\bullet) - \theta H(\bullet) \tag{4.1}$$

Solving for p and X simultaneously yields the optimal output prices and input quantities (denoted by asterisks):

$$p^* = p(Y_i, w_i, Z_i)$$

$$X_i^* = X_i^*(Y_i, w_i, Z_i)$$

Profits are maximized if:[15]

$$\frac{d\Pi_i}{dY_i} = p^* + Y_i \quad f'(Y)\frac{dY}{dY_i} - w_i\frac{dX_i^*}{dY_i} = 0 \tag{4.2}$$

where the optimal number of inputs X_i^* depends on the demand for outputs Y_i. Multiplying by Y_i yields:

$$p^*Y_i - w_i\frac{dX_i^*}{dY_i}Y_i = -(Y_i)^2 f'(Y)\left(\frac{dY}{dY_i}\right) \tag{4.3}$$

where revenue is denoted by p^*Y_i. Here, banks are assumed to face perfectly competitive input markets, but operate in output markets where price differentiation is potentially possible. Thus, banks may compete via their output pricing strategies, by adjusting prices and fees according to market conditions.[16] The extent to which they can influence prices depends on output quantities, input prices and other factors, all of which are given at the time of price setting. In the empirical analysis, we can disregard output prices, which are subject to severe measurement problems according to Berger and Mester (1997) and Vander Vennet (1997), as they are not required for the empirical analysis.

We also rewrite and rearrange Equation 4.3, in order to arrive at an equation that is more closely in line with what is found in the empirical literature on bank performance. We start by defining λ_i as follows:

$$\frac{dY}{dY_i} = 1 + \frac{d\sum\limits_{j\neq i} Y_j}{dY_i} = 1 + \lambda_i \tag{4.4}$$

where λ_i is known as the conjectural variation of firm i's output.[17] Substitution of λ_i in Equation 4.3 gives:

$$p^*Y_i - w_i\frac{dX_i^*}{dY_i}Y_i = -(Y_i)^2 f'(Y)(1+\lambda_i) \tag{4.5}$$

Dividing both sides by p^*Y_i and rearranging gives:

$$\frac{p^*Y_i - w_i\frac{dX_i^*}{dY_i}Y_i}{p^*Y_i} = -\frac{Y_i}{Y}\frac{f'(Y)\,Y}{p^*}(1+\lambda_i) \tag{4.6}$$

The left-hand side of Equation 4.6 is the bank's mark-up over its total costs. This mark-up can be decomposed into three parts, equivalent to the right-hand side of Equation 4.6:

1. (Y_i/Y) is firm i's market share MS_i, with $0 < MS_i \leq 1$.
2. $f'(Y)Y/p$ is the inverse of the price elasticity of demand, $1/\eta$. Since the main prices for banks in the context of this analysis are interest rates, η is referred to as the interest elasticity of demand. It is equal to the market elasticity if and only if all firms are price takers in the output market and $p_i = p, \forall i$.
3. $1+\lambda_i$ measures firm i's expectations about the reactions of its rivals dY/dY_i, with $-1 \leq \lambda_i \leq 1$.

We can now write Equation 4.6 as:

$$\frac{p^* Y_i - w_i \frac{dX_i^*}{dY_i} Y_i}{p^* Y_i} = (MS_i)\left(-\frac{1}{\eta}\right)(1+\lambda_i) \tag{4.7}$$

After multiplying by $p^* Y_i$ we have:

$$\Pi_i^* = p^* Y_i - w_i \frac{dX_i^*}{dY_i} Y_i = (MS_i)\left(-\frac{1}{\eta}\right)(1+\lambda_i) p^* Y_i \tag{4.8}$$

Therefore optimal profits Π_i^* go up with increased market share MS_i, with decreased price elasticity of demand η, with increased conjectural variation λ_i, with increased output prices p^*, and with increased demand for Y_i. As we shall see in the next chapters, many models that study competition and efficiency can be classified according to this basic framework. Every model contains a partial analysis, and focuses on a single right-hand variable in Equation 4.8, or on a combination of two of these variables.

5 Market power models

This chapter summarizes the various approaches to measuring competition and profitability, and how they are related to the framework presented above. In the context of the models discussed here, there may be circumstances where banks can increase their prices and be rewarded by higher profits. They can do so because the drop in demand that would normally result from such an increase is not entirely offset by the extra marginal revenue gained by the price increase. These circumstances are broadly defined as market power. In light of Equation 4.8 above, market power is derived from MS_i, η, or λ_i, or a combination of these variables.

Iwata

In the Iwata model (Iwata, 1974), the right-hand side of Equation 4.8 is written as:

$$\lambda_i = \eta\left(\left(w_i\frac{dX_i^*}{dY_i} - p^*\right)/p^*\right)/MS_i - 1 \tag{5.1}$$

Thus, the model allows for the estimation of conjectural variation values for individual banks supplying a homogeneous product in an oligopolistic market. Although, to the best of our knowledge, this measure has been applied only once to the banking industry, it is included in the present overview for completeness' sake.

A generic problem with this type of model, which we will see again below, is the fact that some of the profitability determinants that we have identified so far are interrelated and/or cannot be observed in practice. In order to solve a possible identification problem, in particular when applying this model empirically, we generally begin by defining a set of limiting assumptions. In this case, the Iwata model assumes that p and MS_i are strict functions of exogenous variables, and that η, the elasticity of demand, is constant. Now we can derive an indirect estimate of the conjectural variation λ_i by estimating a market demand function and cost functions for individual banks to quantify the conjectural variation for each bank. Applying this model to the banking industry is difficult, particularly for the European industry, where micro data for the structure of cost and production for homogeneous bank products are scarce or lacking altogether.

Bresnahan

Contrary to Iwata (1974), Bresnahan (1982) and Lau (1982) assume that all banks are equal and identical and make an aggregate analysis. In this short-run model, they thereby determine the level of market power in the banking market and take averages over Equation 4.2 thus obtaining:

$$p^* + f'(Y) \sum_i (dY/dY_i)(1/n) Y_i - \sum_i \left(w_i \frac{dX_i^*}{dY_i} \right) /n = 0 \tag{5.2}$$

This is equal to:

$$p^* = -\lambda f'(Y) Y + W \tag{5.3}$$

if we define λ_i as $(dY/dY_i)/n = \left(1 + d\left(\sum_{i \neq j} Y_j\right)/dY_i\right)/n$ and assume that all banks are equal (so that the $\lambda = \lambda_i, \forall i$). W stands for weighed input prices. Banks maximize their profits by equating marginal cost and perceived marginal revenue. The perceived marginal revenue coincides with the demand price in competitive equilibrium and with the industry's marginal revenue in the collusive extreme (Shaffer, 1993). Based on time series of industry data, the conjectural variation parameter, λ, has been determined by simultaneous estimation of the market demand and supply curves (see Chapter 10).

For the average bank in a *perfectly competitive* market, the restriction $\lambda = 0$ holds, as, in a competitive equilibrium, price equals marginal cost. Since prices are assumed to be exogenous to the firm in a perfectly competitive market, an increase in output by one firm must lead to an analogous decrease in output by the remaining firms, in line with Equation 5.3. The *Cournot equilibrium* describes non-cooperative optimization, where agents that mutually influence each other act without explicit cooperation. Under that type of equilibrium, the conjectural variation ($d \sum_{i \neq j} Y_j / dY_i$) for firm i would equal zero. The Cournot equilibrium assumes that a firm does not *expect* retaliation from other firms in response to changes in its own output, so that $\lambda = 1/n$ and $p^* + h(\cdot)/n = W$, with $h(\cdot) = f'(Y) Y$ representing the semi-elasticity of market demand. Under *perfect collusion*, an increase in output by one of the colluders leads to a proportional increase in output by all other colluders, yielding $\lambda = \left(1 + d \sum_{i \neq j} Y_j / dY_i\right)/n = (1 + (Y - Y_i)/Y_i)/n = Y/(Y_i n) = 1, \forall i,$[1] so that $p^* + h(\cdot) = W$. Hence, under normal conditions, the parameter λ here takes values between zero and unity.

Empirical applications of the Bresnahan model are scarce. The model has been estimated by Shaffer (1989 and 1993) for, respectively, the US loan markets and the Canadian banking industry. Suominen (1994) applied the model in its original one-product version to the Finnish loan market for the period 1960–1984. An adapted two-product version is applied to the period after deregulation (September 1986–December 1989). Suominen finds zero λ's for the period with regulated interest rates in both markets, and values of λ indicating use of market power after the deregulation of the loan market. Swank (1995) estimated Bresnahan's model to obtain the degree of competition in the Dutch loan and deposit markets over the period 1957–1990, and found that both markets were significantly more oligopolistic than under Cournot equilibrium. Bikker (2003) presents applications of the Bresnahan model to loans markets and deposits markets in nine European countries over the last two or three decades (see Chapter 10). Where values of λ appear to be significantly different from zero, so that perfect competition should be rejected, they are nevertheless close to zero. In many submarkets, the hypothesis $\lambda = 0$ (that is, perfect competition) cannot be rejected.

Panzar–Rosse

Most of the models we employ here assume Cournot competition. In fact, this is the assumption in the model by Cowling (1976) from which our basic framework has been derived. An important exception is the Panzar–Rosse model. Aside from the fact that price information is notoriously scarce and unreliable for banking markets, not much is known about the role of Cournot and Bertrand competition, respectively, in banking.[2] However, with quantity precommitments the Panzar–Rosse model reduces to a basic Cournot model. Therefore, we include it in the present analysis.

The method developed by Panzar and Rosse (1987) estimates competitive behavior of banks on the basis of the comparative static properties of reduced-form revenue equations based on cross-section data. Panzar and Rosse (P–R) show that if their method is to yield plausible results, banks need to have operated in a long-term equilibrium (that is to say, the number of banks needs to be endogenous to the model) while the performance of banks needs to be influenced by the actions of other market participants. Furthermore, the model assumes a price elasticity of demand, η, greater than unity, and a homogeneous cost structure.[3] To obtain the equilibrium output and the equilibrium number of banks, profits are maximized at the bank as well as at the industry level when marginal revenue equals marginal cost (cf. Equation 4.8). In equilibrium, the zero profit constraint holds at the market level. Multiplying Equation 4.8 with Y_i/Yp^*, in order to obtain the price-cost margin (PCM), and summing the results over all banks i yields:

$$\begin{aligned} PCM &= (\textstyle\sum_i p^* Y_i - w_i\,(dX_i/dY_i)\,Y_i))/p^* Y \\ &= \textstyle\sum_i (Y_i/Y)^2\,(-1/\eta)\,(1+\lambda_i) \\ &= HHI\,(-1/\eta)\,(1+\lambda_i) \end{aligned} \tag{5.4}$$

The last equality holds by approximation. *HHI* stands for the Herfindahl–Hirschman Index of market shares of banks weighted with their own market shares. Variables marked with an asterisk represent equilibrium values. Now we assume that *HHI* and γ are strict functions of exogenous variables. Market power is then measured by the extent to which a change in factor input prices (∂w_{k_i}) is reflected in the equilibrium revenues (∂R_i^*) earned by bank i. Panzar and Rosse define a measure of competition, the 'H-statistic' as the sum of the elasticities of the reduced-form revenues with respect to the K input prices:[4]

$$H = \sum_{k=1}^{K} (\partial p^* Y/\partial w_k)\,(w_k/p^* Y) \tag{5.5}$$

The estimated value of the H-statistic ranges between $-\infty$ and 1. H is smaller than zero if the underlying market is a monopoly, it ranges between zero and unity for other types of competition such as oligopoly, and an H of one indicates perfect competition. P–R developed a test to discriminate between these market structures. Shaffer (1983) demonstrated formal linkages between the Panzar–Rosse H-statistic, the conjectural variation elasticity and the Lerner index. Table 1 in Bikker *et al.* (2006a) provides an overview of 28 studies that apply the P–R method to the banking industry. Chapter 11 provides an empirical application of the P–R model.

Structure-Conduct-Performance

The Structure-Conduct-Performance (SCP) model assumes that market structure influences bank behavior (conduct), which in turn affects bank performance. In a market with a higher concentration, banks are more likely to show collusive behavior, and their oligopoly rents increase performance (profitability). Here, conduct is an unobservable and is measured indirectly through market concentration.

Although the SCP hypothesis lacks a formal underpinning, we can use our basic profit model to derive the SCP relationship. We start by deriving our basic framework by summing Equation 4.5 over N firms:

$$p^*Y - \sum_{i=1}^{N} w_i \frac{dX_i^*}{dY_i} Y_i = -\sum_{i=1}^{N} \left((Y_i/Y)^2 \right) \left(f'(Y)Y^2 \right) \left(1 + (\Sigma \lambda_i Y_i) / \left(\Sigma Y_i^2 \right) \right) \quad (5.6)$$

Dividing by p^*Y gives us:

$$\Pi^* = p^*Y - w_i \frac{dX_i^*}{dY_i} Y_i = -\left((HHI) \left(\frac{1}{\eta} \right) (1+\mu) \right) \quad (5.7)$$

where the Herfindahl–Hirschman Index, $HHI = \Sigma\,(Y_i/Y)^2$, $\frac{1}{\eta} = f'(Y)Y^2/p^*Y$ and $\mu = (\Sigma \lambda_i Y_i)/\left(\Sigma Y_i^2\right)$.

To arrive at the basic SCP relationship, we have to make two additional assumptions. The first is that η, the price elasticity of demand is constant. If not, the interpretation of a coefficient for HHI – in the absence of a proxy for η – could be biased downward (upward) by increases (decreases) in the interest elasticity of demand over time. The second assumption concerns the individual firm's conjectural variation μ, the extent to which it expects other firms to react to a change in output. Here, there are two options. The first is to assume that μ is constant and equal across firms, in which case it drops out of the above equation and we are left with a relationship between performance and concentration.[5] The second option is to formalize the relationship between μ and HHI, under the presumption of collusive behavior. Following Stigler (1964), we can show that an increase in concentration HHI or in market share MS_i is expected to increase awareness (μ) and thereby lead to more collusive behavior (for proof, see the final section of this chapter). Although this still leaves us without a direct measure of

μ, it does allow us to capture its impact through *HHI*. After all, the collusive oligopolist realizes a more than proportional increase in performance as a result of an increase in concentration. Alternatively, the foregone rents for uncollusive behavior increases with market size.

All in all, if we take η to be constant and μ to be an implicit function of *HHI*, we have developed a basic relationship between performance and structure that is consistent with the SCP relationship.[6] Thus the basic equation (without control variables) becomes:

$$\Pi^* = ((HHI)(1+\lambda))p^*Y \tag{5.8}$$

The model amounts to interpreting the combined impact of λ and *HHI* on performance. In two extreme cases, interpretation of the coefficient $\frac{\partial \Pi^*(Y,w)}{\partial (HHI)}$ is straightforward. The Cournot oligopoly prediction is $\frac{\partial \Pi^*(Y,w)}{\partial (HHI)} = 1$, since $\lambda = 0$ and impact of *HHI* is exactly proportional. If collusive behavior exists, $\lambda > 0$ and the impact of market share is more than proportional, and $\frac{\partial \Pi^*(Y,w)}{\partial (HHI)} > 1$. Finally, in the case of perfect competition an increase in market share has no impact on performance and since $\lambda = -1$, this means that $\frac{\partial \Pi^*(Y,w)}{\partial (HHI)} = 0$.

Summing up, we have derived a relationship between market structure and performance, allowing us to test the SCP hypothesis (cf. Bos (2004) for an overview and a critical analysis). Chapter 12 provides an empirical application of this model.

Cournot model

In deriving the SCP model in the previous section, we have assumed that all banks react similarly to an increase in market concentration, and that they benefit equally. Thereby we have implicitly addressed one of the major weaknesses of the SCP hypothesis: the choice of a measure for market concentration.

It is the reason why the SCP model became subject to criticism. For example, the idea that all banks benefit equally from a high level of market concentration runs counter to much of the theoretical literature that identifies strategic group behavior and more elegantly translates asymmetric market structures into performance differences. In Chapter 4, we have developed a model that also describes a relationship between *industry* performance and market concentration. In fact, the model described in Chapter 4 is the disaggregated version of the basic framework that we used to derive the SCP model. As we will see in the present section, this modification makes it easier to accommodate asymmetric market structures, differences in cost structures and collusive behavior.

As in the previous section, we start out from Equation 4.8, assume that η is constant and arrive at:

$$\Pi_i^* = MS_i(1+\lambda_i)p^*Y_i \tag{5.9}$$

Following the proof in the next section we can again show that an increase in market share MS_i is expected to increase awareness (λ_i) and hence to lead to more collusive behavior. We can therefore model λ_i as an implicit function of MS_i and have now arrived at the same relationship as in Equation 5.8, albeit on a disaggregated level.[7]

Although all coefficients can be interpreted in the same way as those in Equation 5.8, this Cournot model does not measure exactly the same relationship as the SCP model. Whereas the latter concentrates on the impact of market structure, the former focuses on individual banks' market shares. However, in doing so it more accurately captures asymmetric market structures, differences in cost structures and collusive behavior. In fact, Bos (2004) has shown empirically that estimates of Equation 5.9 are consistent with the model's assumptions, whereas the same does not always hold for Equation 5.8. Chapter 13 provides an empirical application of the Cournot model.

The Stigler approach

In this section we show that, presuming the de facto existence of collusive behavior, the extent to which banks will engage in collusive behavior is directly and positively related to their market share.[8] An increase in market share (MS_i) leads to an increase in awareness (λ_i), and thus to collusive behavior.[9]

To prove this, we depart from Stigler's rule that the (pricing) behavior of firms must be inferred from the way their customers react. The assumption then is that '[T]here is no competitive price-cutting if there are no shifts of buyers among sellers' (Stigler (1964), p. 48). Thus, the stronger the loyalty of customers, the less likely a bank is to behave collusively. Intuitively, the stronger customer loyalty, the less a bank will stand to gain by cutting prices: it does not need to do so to keep its old customers nor does it expect to gain many new customers. In terms of the dynamic Cournot model, the lower the conjectural variation λ_i, the more likely the bank is to engage in collusive behavior.

In line with Stigler (1964), a bank targets three groups of customers. First, it wants its share of the growth of new customers [C_n]. Second, it wants to retain as many of its old customers as possible [C_r]. Third, it wants to win over other banks' old customers [C_o]. Let N_n = number of new customers, and N_o = the total number of old buyers in the market.[10] Also, let n_o^i = the number of old customers for bank i. The probability of repeat purchases is denoted p, and MS_i is bank i's market share.[11] The expected number of customers for each group is given by:

$$E\left(C_n^i\right) = MS_i * N_n \tag{5.10a}$$

$$E\left(C_r^i\right) = p * MS_i * N_o \tag{5.10b}$$

$$E\left(C_o^i\right) = (1-p) * MS_i * \left(N_o - n_o^i\right) \tag{5.10c}$$

For each group the cost of cheating (i.e. not behaving collusively) is given by the variance of the expected number of customers. The higher this variance, the more likely a bank is to show collusive behavior. For each set of customers, variances are given by:[12]

$$var\left(C_n^i\right) = \left[N_n * MS_i * (1 - MS_i)\right] \tag{5.11a}$$

$$var\left(C_r^i\right) = \left[N_o * p * MS_i * ((1-p)\, MS_i)\right] \tag{5.11b}$$

$$var\left(C_n^i\right) = \left[\left(N_o - n_0^i\right) * (((1-p)\, MS_i) * (1 - (1-p)\, MS_i))\right] \tag{5.11c}$$

As explained, an increase in market share (MS_i) leads to more collusive behavior if $\partial var(\cdot)/\partial MS_i > 0$. This requires:

$$\frac{\partial var\left(C_n^i\right)}{\partial MS_i} = N_n - (2 * N_n * MS_i) > 0 \tag{5.12a}$$

$$\frac{\partial var\left(C_r^i\right)}{\partial MS_i} = SpN_o - \left(2 * N_o * p^2 * MS_i\right) > 0 \tag{5.12b}$$

$$\frac{\partial var\left(C_o^i\right)}{\partial MS_i} = \left((1-p)\left(N_o - n_0^i\right)\right) - \left(2(1-p) * \left(N_o - n_0^i\right) * MS_i\right) > 0 \tag{5.12c}$$

Equations 5.12a and 5.12c hold iff $MS_i < 0.5$. Equation 5.11b holds iff $p > 2p^2 * MS_i$. If $MS_i < 0.5$, this condition is also satisfied.

Since C_n^i, C_r^i and C_o^i are disjoint subsets of the whole customer population (i.e. there is no overlap), we can simply add up their variances, which under the above mentioned conditions are larger than zero. Summing up therefore, an increase in market share MS_i leads to an increase in awareness λ_i and hence to more collusive behavior.

6 Efficiency of banks

In all models introduced so far, we have assumed that banks choose optimal output prices p and inputs x that maximize profits, *given* existing market power. Therefore, any deviations from the profits that would prevail under perfect competition are entirely attributed to (changes in) the degree of competition in the market.

In practice, of course, banks may choose suboptimal combinations of output prices and inputs. They may produce output at a suboptimal scale, produce a suboptimal combination of outputs, or select a suboptimal combination of inputs (or input prices) to produce outputs. In short, banks may be inefficient.[1] The general concept of efficiency refers to the difference between observed and optimal values of inputs, outputs and input/output combinations. In this chapter, we therefore introduce a second class of models that attempt to measure the extent to which firms may realize suboptimal profits. Since it has been shown by Berger and Humphrey (1991) to dominate other inefficiencies, we start with X-efficiency in the first section. Next, we introduce scale and scope economies in the second section. Of course, as is already clear from this short introduction, the effects of efficiency and competition on profitability are not always easy to distinguish. Therefore, in the final section, we present a discussion of the efficiency hypothesis as an example of the relationship between both classes of models.

X-Efficiency

Berger *et al.* (1993) define X-efficiency as the economic efficiency of any single firm minus scale and scope efficiency effects.[2] Berger and Humphrey (1991) report that scale and scope inefficiencies (amounting to about 5 percent) are less important in the banking industry than X-inefficiencies (in the range of 20–25 percent).[3]

This book uses stochastic frontier models to measure X-efficiency (as well as scale and scope economies, see Chapters 14 and 15). In light of the framework presented here, stochastic frontier models have the advantage that they use the same elementary set of assumptions about bank production as our basic model, and can thus be easily fitted into the framework.[4] By the same token, in using stochastic frontiers, we recognize the fact that in measuring bank profitability as we do with our basic model, we also face a degree of measurement error because not all deviations from optimal (predicted) profit may be due to inefficiency. A final, but less specific, advantage that has been widely used in the literature, is the fact that stochastic frontier models generate bank-specific efficiency estimates, which allow us to test for differences in efficiency among banks in different countries as well as to measure the scale and scope economies of banks that operate close to the frontier.

Stochastic frontier approaches have been based most frequently on *cost minimization* models. In fact, most of the empirical evidence we present in this book refers to cost efficiency estimations. Here, however, we make a case for *profit maximization* models. In particular, we build on our basic model from Chapter 4 to arrive at the alternative profit model by Humphrey and Pulley (1997), Berger and Mester (1997), and DeYoung and Hassan (1998). In this model, banks are assumed to face perfectly competitive input markets but while operating in output markets where price differentiation is potentially possible. Thus, the model allows for market power. Banks can compete via their output pricing strategies by adjusting prices and fees according to market conditions. The extent to which they can influence prices depends on output quantities, input prices and other factors, all of which are given at the time of price setting. A further advantage of the profit model is that it can both account for differences in the quality of outputs (to the extent that it is reflected in prices) and correct for scale bias. Also, output prices, which according to Berger and Mester (1997) and Vander Vennet (1997) are subject to severe measurement problems, are not required for the empirical analysis.[5] The same holds, of course, for our basic model from Chapter 4. Let us therefore start by making that model stochastic:[6]

$$\Pi_i^* = \left(p^* Y_i - w_i \frac{dX_i^*}{dY_i} Y_i \right) * \exp(\varepsilon_i) \tag{6.1}$$

We assume that ε_i can be decomposed into a noise component ν_i, and an efficiency component u_i, where $\varepsilon_i = \nu_i - u_i$. Here, ν_i is normally distributed, i.i.d. (individually, independently distribute) with $\nu_i \sim N(0, \sigma_\nu^2)$. The inefficiency term u_i is drawn from a non-negative half-normal distribution truncated at μ and i.i.d. with $u_i \sim \left| N(\mu, \sigma_u^2) \right|$. It carries a negative sign because all inefficient firms will operate *below* the efficient profit frontier. Profit efficiency for bank *i* is defined as:

$$PE_i = E[\exp(-u_i) | \varepsilon_i] \tag{6.2}$$

This measure takes on a value between 0 and 1, where 1 indicates a fully efficient bank. The frontier functions are estimated through maximum likelihood methods. In the estimation, the terms σ_u^2 and σ_ν^2 are reparameterized by $\sigma^2 = \sigma_u^2 + \sigma_\nu^2$ and $\lambda = \sigma_\nu / \sigma_u$. If γ is close to zero, little structural inefficiency exists and standard ordinary least squares (OLS) estimation may be appropriate. Extremely large parameter values of λ suggest a deterministic frontier.[7] We can of course apply the same logic to a cost minimization model, considering that $\varepsilon_i = \nu_i + u_i$ since inefficient banks now operate *above* the minimum cost frontier.

The parameter λ represents the share of inefficiency in the overall residual variance and ranges between 0 and 1. A value of 1 for λ suggests the existence of a deterministic frontier, whereas a value of 0 represents evidence in favor of a standard OLS estimation (see Coelli *et al.* (1998) for further discussion).

Chapter 14 provides empirical results for our efficiency model.

Scale and scope economies

X-inefficiency results from a suboptimal *choice* of output prices and inputs. Hence it is also frequently referred to as managerial efficiency. Although, when measuring performance, it is sometimes difficult to disentangle endogenous factors from exogenous factors, there is evidence that X-efficiency captures the former far more fully than the latter. For example, Bos and Kool (2006) find that exogenous, environmental factors explain no more than 20 percent of the differences in X-efficiency among a group of relatively homogeneous banks.

There are, however, other types of efficiency (or economies) that – although much more exogenous to the bank – can have a significant impact on a bank's performance. Banks may be operating at a suboptimal scale, or with a suboptimal mix of outputs. Here, we therefore briefly discuss economies of scale and economies of scope, respectively.[8]

We define output-specific economies of scale as the *ceteris paribus* increase in profits that results from an increase in output Y_k. For this purpose we take Equation 4.8 and calculate the derivative with respect to Y_k:

$$\frac{\partial \Pi_i^*}{\partial Y_{i,k}} \tag{6.3}$$

A value larger (smaller) than one indicates increasing (decreasing) returns to scale, and unity indicates constant returns to scale. Overall economies of scale are simply the sum of output-specific economies of scale.

Berger *et al.* (1993) identified four aspects of the measurement of economies of scale that are relevant to our analyses. First and foremost, research has confirmed that banks have U-shaped cost curves. Economies of scale increase up to a relatively modest size, often estimated in the range of \$100–\$500 million in total assets, after which they tend to decrease (albeit slowly). Second, risk variables are often excluded when measuring economies of scale. Following Mester (1996) and Berger and Mester (1997), this problem can be resolved by including an equity/total assets ratio that enters scale measures via interaction terms in for example a translog specification.

Third, many studies base their scale measures on averages, thereby including observations that do not lie on or close to the efficient frontier. In such cases economies of scale will be biased to the extent that banks do not lie on or close to the efficient frontier.[9] Fourth, the most reliable measure of economies of scale is an overall estimate, defined as the sum of output-specific economies of scale. The sum of the partial derivatives of each output is less dependent on changes and differences in the output mix.

The extent to which that output mix itself is optimal is measured by calculating scope economies. Unfortunately, calculating scope economies is not as straightforward as calculating scale economies. The derivation itself is straightforward, however, and analogous to Equation 6.3:

$$\frac{\partial \Pi_i^*}{\partial Y_{i,k}\, \partial Y_{i,l}},\ for\ k \neq l \tag{6.4}$$

The main problem with this method lies in the fact that, at least theoretically, we require banks with zero outputs for specific outputs Y_k (cf. Berger and Humphrey (1994)). However, the models we have discussed so far are usually estimated using logarithmic (semi-)flexible forms and thereby cannot handle these zero outputs. In addition, Berger *et al.* (1987) observed that for translog functions complementarities cannot exist at all levels of output. Finally, in many cases there is an extrapolation problem as well. Given a sample containing both universal banks and other banks, only the former typically offer the full range of financial services. Consequently, the economies of scope derived from the cost (or profit) function tend to overestimate the true economies of scope among most sample banks. A further problem is that measurements of *average* economies of scope are biased due to the inclusion of X-(in)efficiencies. In the search for a better functional form, some researchers have used a Box–Cox transformation for outputs, while others have used a composite function attributing a separate fixed-costs component to scope economies.

For cost models Molyneux *et al.* (1997) proposed a comparison of the separate cost functions for individual outputs to the joint cost of production. However, the branch and bank level data required for this type of analysis are often not available. An alternative method is suggested in Bos and Kolari (2005). They specify a model with three outputs, Y_1, Y_2 and Y_3, which sum to Y. They start by defining $Y_1/Y = a$, $Y_2/Y = b$ and $Y_3/Y = c$. If such a ratio is high, a bank is relatively highly specialized. For overall scope economies, they therefore calculate $d = a^2 + b^2 + c^2$. This measure is bounded by $1/3$ (not specialized) and 1 (specialized). Define 'high' $[H]$ as referring to the upper 25^{th} percentile, and 'low' $[L]$ for the remainder of the observations. Now, the ratio $(\Pi_L^* - \Pi_H^*)/\Pi_H^*$ can be calculated for Y_1, Y_2, Y_3, and Y. Profits Π_i^* are divided by total revenues to adjust for the possibility that banks in high and low bank groups may be different in size. If scope economies exist, the ratio is greater than 0. Note that these ratios can only be constructed using averages; as such, the scope measure itself does not have a standard deviation. This is a common problem, as recognized by Berger and Humphrey (1991). Instead, Bos and Kolari (2005) report a t-value for an independent samples test for $\Pi_L^* - \Pi_H^*$. Note that by varying the cut-off point above and below the 25th percentile, it is possible to check for extrapolation problems. Chapter 15 provides empirical results.

Efficiency hypothesis

An important critique of both classes of models discussed so far is the fact that each focuses on only one half of the story (either market power or efficiency), without being able to control adequately for the other half. For example, in the Cournot model discussed in Chapter 5 we consider market power to be the sole explanation for differences in market share. The Efficiency hypothesis has been developed as an important alternative explanation. This section provides a critical review of the way the Efficiency hypothesis can be tested against the market power hypothesis and proposes an alternative test of the Efficiency hypothesis that resolves identification problems when using market power *and* efficiency to explain bank performance.[10]

The Efficiency hypothesis attributes differences in performance to differences in efficiency (Goldberg and Rai (1996), Smirlock (1985)). According to the Efficiency hypothesis, both a high market share and relatively strong performance result from high efficiency. Thus, whereas according to the traditional SCP hypothesis and the above Cournot model a high degree of market concentration or, respectively, a large market share is an explanatory variable for above-average performance, within the Efficiency hypothesis it is seen as, at most, the result of a higher efficiency. Testing the Efficiency hypothesis against the SCP hypothesis therefore generally involves the inclusion of both market shares and a market structure variable in the estimated equations. The premise is that if the Efficiency hypothesis holds, once individual banks' market share is controlled for, overall market concentration cannot explain profits (cf. Demsetz (1973)).

Tests aimed at setting off both hypotheses against each other tend to suffer from identification problems, since the same market structure variable behaves similarly in both cases. In these tests, market share proxies both for market power – as does the market structure variable – and for efficiency. The market structure variable is an aggregate measure that only changes over time. The market share variable, however, varies from bank to bank as well as over time. In an attempt to overcome this problem Berger and Hannan (1993) and Altunbas *et al.* (2001) use both market share and efficiency as explanatory variables for bank profit. In these studies, however, a multicollinearity problem exists if the Efficiency hypothesis holds.

Another solution is to include the market share that is *not* explained by efficiency, using firm-specific efficiency measures.[11] To do so, $MS_{i,t}$ is regressed on an efficiency measure. Cost X-efficiency $[CE]$ measures how close a bank's costs, conditional upon its output, input prices and equity level, are to the costs a fully efficient bank incurs under the same conditions (e.g. size). As such, it is considered here to be the best efficiency measure to use in this two-step approach:[12]

$$MS_i = f(CE_i) + \omega \tag{6.5}$$

where ω is the error term. Now, we can estimate Equation 5.9, but replace MS_i by $MS(CE)_i$ – the residuals ω of the above equation. This efficiency measure $MS(CE)_i$ is by definition orthogonal on CE_i. If we now ignore λ_i and again keep η constant, the Cournot equation reads:[13]

$$\Pi_i^* = MS\,(CE)_i\,(1+\lambda_i)p^*Y_i \tag{6.6}$$

This way, we can test both the SCP hypothesis and the Efficiency hypothesis without any identification problems. Of course, both hypotheses are not mutually exclusive. We can compare the results of estimating Equation 5.9 with those of estimating Equation 6.6. If the market power hypothesis holds, $\frac{\partial \Pi_i^*(Y_i,w_i,Z_i)}{\partial MS_i}$ is significant and positive under both specifications. On the other hand, if $\frac{\partial \Pi_i^*(Y_i,w_i,Z_i)}{\partial CE_i}$ is positive and significant when estimating Equation 6.6, this is evidence in favor of the Efficiency hypothesis.

As a final remark, note that our improvement of the Efficiency hypothesis comes at a cost: in Equation 6.6, ϕ is a function of ε and ω. Since we use a proxy instead of MS_i in this two-step estimation, our standard errors may suffer from the generated regressor problem, and the accuracy of our estimates as well as the significance of our parameters may be overestimated. Chapter 14 provides empirical tests of the efficiency hypothesis.

7 Synthesis

In Chapter 4, we have established that banks maximize profits according to Equation 4.1. Subsequently we looked at different models in the literature that have tried to explain bank profits, either through market power or through efficiency, and saw how they fitted into this basic framework. In Table 7.1 we summarize the results from our tour of profit models.[1]

To be sure, we have made an attempt at rewriting two classes of models so that they can be compared to our baseline model introduced in Chapter 4. Our own main assumption in doing so is that all models discussed here share the same features that our baseline model has. Our basic framework is a profit maximization model, and we abstract from product differentiation. There is the possibility of price competition and market power in outputs. However, input markets are perfectly competitive and all banks act as price takers in these markets.

In addition, we have tried to stay away from defining any functional forms or empirical specifications. We return to this issue in Part IV, where we discuss empirical evidence. For now it is important to keep in mind that:

Proposition 1 *The models described here are not nested.*

In fact, models [2] and [4] are aggregate models, whereas models [1], [3] and [5]–[9] (can) provide bank-specific estimates of market power with respective to efficiency. In practice, however, models [4] and [9] are also estimated on an aggregate level, with a single coefficient for all banks in a market. In fact, all models focus on one or two variables. This is why, in empirical applications, we seldom find the complete specification as it was derived here. More in general, these models may – in the way they are presented here – suffer from identification problems, as they can perhaps also be derived using somewhat different assumptions and a different underlying basic model.

Proposition 2 *The price elasticity of demand η is assumed to be constant.*

The first reason for this particular feature of the models presented here is of course the fact that they all build on pure price competition. There is no product differentation, and all banks in a market are assumed to face the same market demand.

Table 7.1 Synthesis of models

Model		Hypotheses	Key assumptions	Key variable(s)
[1]	Iwata	$\frac{\partial \Pi_i^*(Y_i,w_i)}{\partial \lambda_i} > 0$	η is constant, MS_i is ignored	λ_i
[2]	Bresnahan	$\frac{\partial \Pi^*(Y,w)}{\partial \lambda} > 0$	η is constant, MS_i is ignored, $\lambda_i = \lambda,\ \forall\, i$	λ
[3]	Panzar Rosse	$\left(\frac{\partial p^* Y}{\partial w_k}\right)\left(\frac{w_k}{p^* Y}\right) > 0$	$\eta > -1$, MS_i and λ_i are ignored	$H(p, Y, w)$
[4]	SCP	$\frac{\partial \Pi^*(Y,w)}{\partial (HHI)} > 0$	η is constant, λ is an implicit function of HHI	HHI
[5]	Cournot	$\frac{\partial \Pi_i^*(Y_i,w_i)}{\partial (MS_i)} > 0$	η is constant, λ_i is an implicit function of MS_i	MS_i
[6]	Profit X-eff.	$(1 - \frac{\Pi_i^*(Y_i,w_i) * \exp(\nu_i)}{\Pi_i^*(Y_i,w_i)}) > 0$	η is constant, λ_i and MS_i are implicit functions of p	$\varepsilon_i = \nu_i - \upsilon_i$
[7]	Scale economies	$\frac{\partial \Pi_i^*(Y_i,w_i)}{\partial Y_{i,k}} > 0$	η, λ and MS_i are ignored	Y_i
[8]	Scope economies	$\frac{\partial \Pi_i^*(Y_i,w_i)}{\partial Y_{i,k} \partial Y_{i,l}} > 0$ for $k \neq l$	η, λ and MS_i are ignored	$Y_{i,k}$, $Y_{i,l}$
[9]	Eff. hypothesis	$\frac{\partial \Pi_i^*(Y_i,w_i,Z_i)}{\partial CE_i} > 0$	η is constant, λ_i and MS_i implicit function of $p, \phi = \varepsilon + (\beta_1 * \omega)$	$(MS(CE))_i$

The second reason is the fact that almost all models included here share an inherent cross-sectional nature. A prime example is model [5] (the Cournot model) which builds on the model that Cowling (1976) and Cowling and Waterson (1976) used for inter-industry comparisons. An exception is perhaps model [2] (the Bresnahan model) as that usually is applied to only one country.

Proposition 3 *Output prices are absent from almost all models.*

Output prices are notoriously difficult to measure in banking. As a result, almost all models presented here have found ways to argue around explicitly using prices. One obvious exception is the Bresnahan model (model [2]), which does include prices, but only for one output (loans or deposits). Also, the Panzar–Rosse framework (model [3]) includes revenues. This limitation has one very important drawback, that holds particularly for the market power models ([1], [4] and [5]): it severely restricts interpretations of tests of the null hypotheses with respect to the existence of market power to limiting cases. Only perfect competition and a perfectly collusive oligopoly result in values for the null hypothesis that are easy to interpret.[2] Any oligopolistic behavior that is less than perfectly collusive will at most result in the impossibility to reject the hypothesis that there is market power, without any *measurement* of market power.

The intuition is clear: uniform price setting only occurs in both extreme cases. In between, we need – in the absence of good output prices – a known relationship between the key variable in the model and the output price vector p in order to be able to interpret the market power tests more accurately. As an example, consider model [5], where interpretation of $\frac{\partial \Pi_i^*(Y_i,w_i)}{\partial(MS_i)}$ is straightforward only in two extreme cases: the Cournot oligopoly prediction is $\frac{\partial \Pi_i^*(Y_i,w_i)}{\partial(MS_i)} = 1$, since λ_i= 0 and impact of MS_i is exactly proportional. And in case of perfect competition an increase in market share has no impact on performance and since λ_i= -1, this means that $\frac{\partial \Pi_i^*(Y_i,w_i)}{\partial(MS_i)} = 0$. However, if any type of collusive behavior exists, $\lambda_i >$ 0 and the impact of market share is more than proportional, the prediction is that $\frac{\partial \Pi_i^*(Y_i,w_i)}{\partial(MS_i)} > 1$. We can then only rank predictions for $\frac{\partial \Pi_i^*(Y_i,w_i)}{\partial(MS_i)}$ for one market over time. But we cannot (i) compare scores across markets, or (ii) compare the magnitudes of different predictions of $\frac{\partial \Pi_i^*(Y_i,w_i)}{\partial(MS_i)}$.

Part III
Trends in banking

8 Trends and the basic framework

This chapter surveys general trends in the banking industry, particularly those relating to competition and profitability, keeping in mind the assumptions underlying the various approaches for measuring competition and efficiency. This assessment of current banking market conditions enables us to evaluate which approaches have become obsolete and which are most appropriate today.

In observing trends, we distinguish original causes, subsequent changes in banking behavior and in the structure of financial markets, and final consequences, aware all the while, that this classification may be somewhat arbitrary.[1]

Causes

Developments in information and financial technologies

Advances in information technologies, in particular regarding the personal computer, software, databases and communication, have transformed banking practices and products. Information technology has contributed to the internationalization of the money and capital markets, to the development of new risk management techniques and to the arrival of a spate of new complex financial products. Furthermore, the Internet has created a world of new challenges and threats in banking services and sales potential. Transaction costs are substantially lower using new distribution channels such as the Internet, encouraging banks to develop these channels further. Many banks are cautious about these developments and are opting for a multi-channel distribution strategy, combining the traditional 'bricks-and-mortar' branch network with remote distribution channels, such as telephone banking and Internet banking. The Internet has made established markets more vulnerable to new entrants.

Liberalization and harmonization

Liberalization and harmonization in the European Union (EU), culminating in the Second Banking Co-ordination Directive as part of the single European market project in 1992[2] and the establishment of Economic and Monetary Union (EMU) in 1999, have dramatically changed the financial environment in Europe over the

Table 8.1 Classification of trends in original causes and consequences

Causes
- IT developments (change in production technology and distribution channels, quick exchange of information, new products)
- Changes in (legal) environment of banks and other financial institutions (liberalization/deregulation, economic and financial integration within the EU, introduction of the euro, new regulatory, tax and accounting regimes, Single European Payments Area (SEPA))

Subsequent changes in banking behavior and the structure of financial markets
- Internationalization
- Disintermediation (lower market shares for savings and lending, increase of other types of banking activities)
- More (foreign) competition
- Blurring of borders (both geographically and between sectors)
- Concentration (mergers and acquisitions)
- Higher contestability

Final consequences
- Lower profit margins
- Higher efficiency
- Cost reductions

past decade and are expected to bring further changes in the near future.[3] Likewise, the Riegle–Neal Act of 1994 and the gradual repeal of the 1933 Glass–Steagall Act have drastically transformed the banking landscape in the U.S. The creation of large and transparent euro capital markets further enhanced competition in the European banking industry and stimulated disintermediation and securitization. The comparative advantages of domestic banks on national markets for bonds and equity in the field of underwriting and trading activities have diminished since the euro has replaced national currencies. For similar reasons, fund management is no longer the preserve of local financial institutions. These contributions to international integration, together with national deregulation and entry of new types of competitors, have boosted competition between banks in the countries involved and will continue to do so in the years to come. These developments contribute to further consolidation and rationalization in the European banking sectors.[4] Moreover, EMU will also further increase the pressure for ongoing harmonization of regulation across EU countries, cutting down remaining obstacles to cross-border competition. The Financial Service Action Plan of the EU (to be implemented in 2005) seeks to finalize the integration of the EU financial markets. The 2004 Basel Accord on capital requirements formed a new regulatory regime for banks to enter into force by end 2006, and is another new development that may affect competition, consolidation and efficiency in the banking industry, though such effects are extremely difficult to predict.

Trends

Internationalization

The steady development towards integrated European financial markets has made the banking sector more international. Banks are increasingly involved in offering financial services to foreign businesses and individuals. Although internationalization has been a long-term trend, it has been fostered by the introduction of the euro, for example the merging of the infrastructures for large-value payments and interbank markets, as well as the increasing integration of capital markets. The most visible response has been consolidation either through mergers and acquisitions or through cross-shareholdings. Other ways to internationalize are the development of foreign banking through direct provision of financial services and through foreign branches. Persistent significant differences in national legal and regulatory environments continue to hinder cross-border mergers. Cultural factors and differences in the framework for corporate governance also tend to discourage cross-border consolidation.

Disintermediation

Non-financial sectors in the euro area increasingly direct their savings and surplus funds away from banks towards new forms of financial intermediation, such as investment funds, insurance corporations and pension funds, as well as towards the capital markets, to invest in shares or debt instruments (as is quite common in the U.S.). Non-financial enterprises increasingly access the capital markets for their financing and, although still on a limited scale, increasingly use debt securities. Underlying causes are the development of capital markets and increased possibilities for asset diversification (thanks to liberalization and new information technologies), the introduction of the euro, changes in tax regulations and an increased demand among investors for high-yield, though riskier, instruments. While the importance of traditional banking activities (collecting deposits and extending loans on a retail basis) has diminished in relative terms, banks still remain the predominant players in the euro area financial system. Because the euro area economy is dominated by small- and medium-sized enterprises (ECB, 2002), traditional bank loans, trade credits and non-listed shares, as well as other equity, tend to be the primary sources of financing rather than market-based financing, such as publicly listed shares and corporate debt issuance. Moreover, despite a gradual shift towards more transaction or deal-based banking, the relationship between banks and their corporate customers continues to be very important in all EU countries. Disintermediation is a relative phenomenon as bank loans, expressed as a percentage of gross domestic product (GDP), are still increasing substantially in most countries and regions and also in the EU as a whole.

As a consequence of disintermediation, banks have shifted their activities from traditional bank lending towards investment banking style activities such as enhancing financial market intermediation by creating and selling new capital market products or advising clients on the pricing and structuring of a merger or acquisition. This is in turn reflected by a shift in bank revenue flows away from interest income alone towards non-interest income such as fees, commissions and trading profits.

Concentration

Intensified competition on the financial markets, on which banks operate, has further encouraged consolidation, for example through mergers and acquisitions (M&A). A clear majority of M&A transactions has occurred between banks, but financial conglomerates involving banks, insurance companies and securities firms have also been created. Domestic mergers continue to dominate international mergers. The relatively modest volume of international mergers could indicate that domestic banking mergers are apparently more advantageous than international mergers. Individual European economies are rather heterogeneous, implying that purely domestic banking mergers offer ample opportunities for asset risk diversification. Domestic mergers will therefore be preferred to international mergers, with their concomitant cultural and language problems, differences in national regulations on, for instance, deposit insurance systems, taxation differences and country-specific restrictions on banking activities. This will discourage cross-border consolidation.

The strong world-wide consolidation observed during the past decades is reflected by a sharp fall in the number of banks, increased concentration, and the increased size of the largest (five) banks, both in absolute terms and relative to the smaller banks. Table 8.2 illustrates these developments for the major economies during 1990–2005. While the level of concentration for the EU as a whole, though rising, is still substantially lower than in the U.S., reflecting the limited level of cross-border consolidation in Europe, the pace at which concentration is progressing is higher in Europe than in the U.S.

Contestability

Banking contestability is a major condition for sound competition, particularly where the number of banks is declining due to consolidation. Various developments have contributed to an increase in contestability. The EU's single passport policy allows banks with a banking permit in one EU country to operate in all EU countries. Low-cost distribution channels such as the Internet enable banks to expand their activities across countries at limited expense. Not only have geographical borders become blurred, the borders between sectors tend to fade away. Other financial institutions, such as insurance firms, pension funds and investment funds, have moved into the mortgage and general lending markets, and various financial institutions can manage private sector savings and investments. On the other hand, new foreign entries may in practice be deterred by differences in legal, tax and regulatory regimes and in language, preferences and so on. Moreover, the Internet may prove not to be the right medium for many banking activities where face to face contact is important and for the many clients who rely on more traditional distribution channels. Finally, neither foreign banks nor the Internet have solved the problem of information asymmetry in lending to small and medium-sized enterprises.

Consequences

The Internet and EU liberalization and harmonization have contributed enormously to enhancing competition among banks, particularly competition across borders. Increased competition has also forced banks to improve their efficiency, in order to avoid being pushed out of the market. On the other hand, increased concentration and the enlarged market shares of major banks may have impaired competition somewhat (see Bikker *et al*. (2006b)). Bikker and Spierdijk (2008) suggest also disintermediation may have contributed to weaker competition. As competition cannot be measured directly (in the absence of clear prices of banking output), we have to observe this trend of changed competition and efficiency indirectly. We discuss a few proxies of competition and efficiency here, while the measurement of competition and efficiency and empirical results are treated in Part IV.

The net interest rate margin is an interesting measure of bank profitability, which allows comparison over time and across countries. It also reflects competitive conditions or efficiency on the banking markets, assuming that competition enforces efficiency and presses the margin down. Margins in most countries fell during the last decade, indicating growing competition, although the gradual decline in interest rates may also have contributed to lower margins.

Operating expenses expressed as a percentage of gross income is also often used as a proxy of competitive conditions, although its interpretation is somewhat ambiguous (as will be explained in Chapter 16. This ratio tends to fall over time, indicating lower costs compared to income. Given the falling interest rate margins, this is remarkable, and points to cost reduction. Indeed, the staff costs ratio also declines over time, reflecting rationalization of bank production. Evidently, what we observe here are the efficiency effects of increased competitive pressure. Increased attention to shareholder value may have contributed to this trend too.

On average across Europe, returns on assets and returns on equity – as measures of profitability – remained roughly constant during the last decade. This is remarkable, given the observed decline in net interest rate margins, and reflects cost reduction and the increasing non-interest income from non-traditional banking activities, such as asset management, the management of stock and bond issues and trading. Returns diverged strongly across countries, reflecting varying levels of profitability and of economic and institutional conditions.

Synthesis

We have seen that the banking landscape has changed considerably in the last decade. First, significant changes have occurred on the demand side. It has become easier for customers to shop across borders, just like it has been easier for banks to compete across borders. In addition, competition from non-bank financial firms

Table 8.2 Banking consolidation in the EU: number of banks and concentration ratios,1990-2005

	Number of institutions					HHI (total assets)					CR5 (total assets)				
					% decrease					% increase					% increase
Year	1990	1995	2000	2005	1990-2005	1997	2000	2004		1997-2004	1997	2000	2005		1997-2005
Austria	1210	1041	923	873	28	831	548	552		-34	48	43	45		-6
Belgium	115	143	118	101	12	699	1505	2100		200	54	75	85		57
Denmark	189	114	99	98	48	1431	863	1146		-20	70	60	66		-6
Finland	523	351	342	338	35	2307	2359	2615	*	13	89	87	83		-7
France	1981	1453	1108	814	59	449	589	606	*	35	40	47	53		33
Germany	3913	3500	2575	1949	50	114	151	178		56	17	20	22		29
Greece	15	18	17	21	-40	885	1122	1069		21	56	65	65	*	16
Italy	1138	959	827	770	32	306	190	230		-25	31	23	27		-13
Luxemburg	177	220	202	155	12	210	242	307		46	23	26	31		35
Netherlands	180	174	87	72	60	1654	1694	1726		4	79	81	84	*	6
Portugal	33	37	42	43	-30	600	1000	1103	*	84	46	59	69		50
Spain	327	318	281	269	18	496	874	738	**	49	45	54	51	*	12
Sweden	12	13	23	26	-118	2040	1975	2219	**	9	87	88	91	**	5
United Kingdom	47	40	44	30	36	207	278	389	*	88	28	30	37	*	33
Total number of banks	9860	8381	6688	5559											
Average % change EU					44					38					18
					% decrease										
Year	1990	1995	2000	2003	1990-2003							2001			
Switzerland	457	382	335	301	34							65			
United States	12369	9982	8361	7825	37							21			
Japan	154	149	136	131	15							31			

HHI = Hirschman Herfindahl Index; these figures are taken from different sources. Number of institutions: OECD Bank profitability 2004 (1990-2003; thereafter: ECB, the numbers in the table are corrected for a definitional break). Concentration indices: ECB, Structural analysis of the EU banking sector 2002; ECB, EU Banking Structures, October 2006; Switzerland, US and Japan: World Bank 2001. Regarding the correction for the definitional break, (*) indicates a small correction, (**) a substantial correction.

(insurance companies, brokerage firms, etc.) continues to have an impact on demand, both observed and potential. As a result, the assumption that the price elasticity of demand faced by all firms is the same and constant over time seems more and more questionable. All models included here have problems adjusting to this new reality.

Second, banks themselves have reacted to changes in regulation and (production) technology. They have branched out into new products and become less and less like the traditional intermediaries we model them after. What we do not know is how this process has affected bank *behavior*. Reaction curves may have shifted considerably, both on a market level (λ) and for individual banks (λ_i). In what direction is uncertain and probably depends on the individual bank. While competition may have increased on an international level, some banks may occupy dominant positions within national borders that allow them to react differently from their smaller competitors. Some of the models we reviewed are theoretically able to cope with these changes. However, empirical applications of these models have traditionally assumed that all banks react similarly to each other.

Third, the markets banks operate in have themselves also changed. Concentration has gone up in all countries and markets. This holds particularly for retail markets, which are still predominantly national. This has mostly plagued reduced form market structure models, such as the Cournot model and the SCP model. In principle, we expect a decrease in competition as a result of this increase in concentration. Other trends, however, have opposite effects. For example, foreign banks have started to join the ranks of banks' traditional competitors. As a result, it is uncertain what the effect of the increase in concentration has been on *individual* banks.

With respect to the individual trends we have identified here, we find that disintermediation undermines the Panzar–Rosse approach as the Panzar–Rosse model is based entirely on banks' traditional role as financial intermediator (attracting deposits and other funds and transforming them into loans and investments in securities). Other income from bank services and trading can be incorporated into the P–R model in various ways, so that the model continues to be useful, but less so because the model structure reflects reality less accurately. Iwata and Bresnahan do not have this drawback for disintermediation.

Internationalization, foreign competition, contestability and concentration do not generate problems for the Iwata, Bresnahan and Panzar–Rosse approaches. The mark-up set on cost-based prices (conjectural variation, estimated by λ) and the interest rate revenue elasticities of input prices (constituting H) are direct measures of competition. Observations of new (or potential) entries, foreign competitors or competitors from other sectors are not needed, as their effects on competition are already reflected in the estimated measures. Of all the models that study a specific market, the reduced-form market structure models – the SCP model in particular – are most strongly affected by these trends, as the market structure measure has become less and less easy to define.

Most approaches measure the competitive position (or efficiency) of a bank as a whole, ignoring the fact that banks produce various products and operate on various

Table 8.3 Effects of trends on approaches

Trend	Variable(s) affected	Models most affected	Explanation
[a] Internationalization	$\eta \uparrow$, λ_i, λ	[1], [2], [4], [5], [6]	All market power models affected. Bos and Kolari (2005) show that profit X-efficiency [6] goes up with internationalization.
[b] Disintermediation	Y	[2], [7], [8]	Model [2] focusses exclusively on the loans/deposits market.and thus becomes less relevant. Scale and scope economies have altered.
[c] Foreign competition	$MS_i\downarrow$, $HHI\downarrow$, $\lambda\uparrow$	[4], [5]	Models [4] and [5] both assume an implicit, stable relationship between λ and MS_i (resp. HHI)
[d] Contestability	$\lambda\uparrow$, $\lambda_i\uparrow$	all	Estimates of market power are affected, but contestability itself is not identified, since prices are not available.
[e] Concentration	MS_i, $HHI\uparrow$, λ, λ_i	[2], [4]	Unlike their "rival" models [1] and [5], models [2] and [4] assume that all banks in a market react similarly to an increase in concentration.

[1] = Iwata; [2] = Bresnahan; [3] = Panzar Rosse; [4] = SCP; [5] = Cournot; [6] = Profit X-efficiency; [7] = Scale economies; [8] = Scope economies; [9] = Eff. hypothesis.

markets. Competitive positions may differ per product or market. An exception is the Bresnahan model, which considers the competitive position of one product (for example loans, deposits) and hence measures competition on a single submarket. Approaches based on observations of individual banks (Iwata, Panzar–Rosse, X-efficiency) can circumvent this problem somewhat, as they distinguish various bank-size classes, operating on different markets, e.g. small banks on local or retail markets and large banks on international or wholesale markets (Bikker and Haaf (2002a), Bikker *et al.* (2006b)).

Gradual effects on competition of these (and other) trends over time can be incorporated by using time (or trend) dependent coefficients (Bikker and Haaf, 2002a, Bikker and Spierdijk, 2008). An alternative would be to split the sample into periods or separate years. This works out well for the Panzar–Rosse and Iwata models, where many observations provide enough information to estimate time dependent coefficients, but not for the Bresnahan approach, where observations are scarce owing to its aggregated level. The Bresnahan approach is based on time series of country-specific data. Due in particular to structural changes in banking markets over time, and also to reduced reliability of the required data (among them, interest rates for credit loans and deposits), the estimation of λ appears to be fairly ponderous. Empirical estimations are rare and results are generally far from robust. The Iwata model could provide a solution, but it is applied only once because of problems with the required data, especially given the lack of micro-data for the structure of cost and production for homogeneous products offered by a large number of players in the European banking markets.

The major problem presented by the efficiency models discussed here is the fact that their outcomes are very difficult to validate. We have no sound theory that tells us what is the correct distribution of the efficiency term, and we know very little about the economic validity of our efficiency scores. In particular, and related to increasing internationalization, contestability and foreign competition, it is hazardous to transpose best practice in one country/market to another country/market.

To conclude, it would seem that these trends have similar consequences for most banks. Increases in competition would result in lower profit margins, higher cost efficiency and lower profit efficiency. In absolute levels, we also expect cost reductions. The dynamics of the consolidation process, however, may have increased the volatility of earnings.

Part IV
Empirical results

9 Data

Bank data sample

This book uses a detailed data set obtained from Fitch IBCA's BankScope. The data set covers 13,000 private and public banks throughout the world with more or less standardized reporting data that facilitate comparison across different accounting systems.[1] The panel data set, prior to outlier reduction, is fairly extensive covering banks in 46 countries and spanning the years 1996–2005. The set includes the EU-25, the partly overlapping 30 OECD countries and 10 non-overlapping, larger emerging countries (see Table 9.1).[2] The data set is unbalanced as for various reasons not all banks are included throughout the entire period. We focus on data from commercial, cooperative and savings banks (on average, 75 percent of all banks in BankScope) and remove all observations pertaining to other types of financial institutions, such as securities houses, medium and long term credit banks, specialized governmental credit institutions, mortgage and central banks. The latter types of institutions may be less dependent on the traditional intermediation function and may have a different financing structure compared to our focus group. In any case, we favor a more homogeneous sample.

We apply a number of selection rules to the most important variables and eliminate data of banks under special circumstances (e.g. holding companies, banks in start-up or discontinuity phases), erroneous data and abnormally high or low ratios between key variables. To compensate for structural differences across countries, we adjust the bounds as necessary. This allows for some flexibility regarding the inclusion of countries that have experienced (extremely) high inflation rates and hence (extremely) high interest rates, or which are more labour intensive. This operation reduces the number of observations by 6 percent. These selection rules are similar to those of Bikker *et al.* (2006a). Table 9.2 shows the complete set of selection rules and the exclusion rates. For each variable we define plausible value ranges, that is, between a lower and an upper bound, see the main lines in this table (e.g. values of the ratio of interest income over total assets (II/TA) should be positive but below 0.2). Observations with one or more variables outside these ranges are excluded. Possible exceptions to these basic clearing rules are based on the 10 percent and 90 percent quantile calculated for each of the ratios for each country. If the 90 percent quantile of a particular ratio lies above the basic upper bound, the upper bound is adjusted to take structural differences in a country into account. Similarly, some non-zero upper bounds have been lifted, where necessary and plausible. For example, in case of II/TA different upper bounds have been set for 40 percent of the countries, while the basics selection rules apply to the other 60 percent of the countries. In total, 0.8 percent of the observations did not satisfy the set of selection criteria for II/TA.

Apart from the selection rules explicated in Table 9.2 we also, for each country, exclude all bank data for each year, if the number of banks in the next year increased by 100 percent or more. This typically may happen in the earliest years of the sample period, where the coverage of the BankScope data set sometimes improved drastically for some countries. This rule, which excludes 10.2 percent of the (remaining) observations, guarantees that the surviving sample is fairly comparable across the years. Finally, we eliminate isolated observations, that is, observations of banks that are not in the sample in the previous year and the next year. This reduces the sample by another 2.3 percent.

The final sample consists of 45,858 bank-year observations on 7,266 different banks. Germany has by far the largest number of bank-year observations at 15,239, followed by the U.S. (6,056), Italy (4,714), Japan (3,340), and France (2,450). The data set has not been adjusted for bank mergers, which means that merged banks are treated as two separate entities until the point of merger, whereafter only one bank is reported. As noted by other authors (in particular, Kishan and Opiela (2000) and Hempell (2002)) it is implicitly assumed that the merged banks' behavior does not change with respect to its competitive stance and business mix. This is because most mergers take place between small cooperative banks that are assumed to have the same features as regards their competitive stance and business mix. Table 9.1 provides a detailed overview of the countries in the sample and the data period considered.

For all countries in our sample, Table 9.3 gives an overview of the most important market structure variables as averages over 1995–2005 ('maximum market share' is given for one year). We observe striking differences across countries. For example, the largest bank in Luxembourg in a given year has a market share of 11 percent, whereas in Romania the largest bank in a given year has a market share of no less than 92 percent. Of course, as mentioned before, we have to interpret these numbers with the utmost caution. The coverage of the BankScope database tends to increase over time. For some countries, its coverage falls short. Further, most countries went through a consolidation phase during our sample period.

As a result of these considerations, we emphasize market structure variables (the Herfindahl–Hirschman Index (*HHI*) and the C_3, C_5, C_{10} ratios) rather than numbers of banks or the maximum market shares. The composition of market shares varies significantly across the considered countries. If all markets had the same structure, the ratios C_3, C_5, C_{10} would increase at the same rate across the board. For example, the banks that rank 4th to 10th in the U.S. have a combined market share of 18 percent, whereas in Argentina the fourth to tenth ranked banks have a combined market share of 37 percent.

Table 9.1 Country overview

Country	Code	Banks	Obs.	EU25	EU15	EMCO	OECD
Argentina	AR	100	494	0	0	1	0
Australia	AU	36	221	0	0	0	1
Austria	AT	179	1081	1	1	0	1
Belgium	BE	66	425	1	1	0	1
Brazil	BR	116	581	0	0	1	0
Bulgaria	BG	26	130	0	0	1	0
Canada	CA	61	392	0	0	0	1
Chile	CL	24	155	0	0	1	0
China People's Rep.	CN	50	268	0	0	1	0
Croatia	KR	30	254	0	0	1	0
Cyprus	CY	18	109	1	0	0	0
Czech Republic	CZ	29	168	1	0	0	1
Denmark	DK	99	835	1	1	0	1
Estonia	ES	147	43	1	0	0	0
Finland	FI	11	71	1	1	0	1
France	FR	366	2450	1	1	0	1
Germany	DE	2088	15239	1	1	0	1
Greece	GR	23	121	1	1	0	1
Hungary	HU	25	165	1	0	0	1
Iceland	IS	7	46	0	0	0	1
India	IN	69	477	0	0	1	0
Indonesia	ID	91	393	0	0	1	0
Ireland	IE	30	181	1	1	0	1
Italy	IT	744	4714	1	1	0	1
Japan	JP	673	3340	0	0	0	1
Korea, Rep. of	KR	30	171	0	0	0	1
Latvia	LV	20	107	1	0	0	0
Lithuania	LT	8	47	1	0	0	0
Luxembourg	LU	125	836	1	1	0	1
Malta	MT	4	40	1	0	0	0
Mexico	MX	33	166	0	0	0	1
Netherlands	NL	49	285	1	1	0	1
New Zealand	NZ	6	49	0	0	0	1
Norway	NO	51	293	0	0	0	1
Poland	PL	51	285	1	0	0	1
Portugal	PT	31	191	1	1	0	1
Romania	RO	27	118	0	0	1	0
Russian Federation	RU	118	404	0	0	1	0
Slovakia	SK	17	84	1	0	0	1
Slovenia	SI	18	115	1	0	0	0
Spain	ES	147	984	1	1	0	1
Sweden	SE	86	287	1	1	0	1
Switzerland	CH	351	1942	0	0	0	1
Turkey	TR	33	123	0	0	0	1
United Kingdom	GB	151	922	1	1	0	1
U.S.A.	US	802	6056	0	0	0	1
Total		7266	45858	25	15	10	30

Note: Banks is the number of banks and Obs is the number of observations

Table 9.2 Rules for data filtering

Variables	Lower bound	Upper bound	Number of countries %	Data fallout %
II/TA	0.0000	0.20	60	0.8
	0.0000	0.30	12	
	0.0000	0.40	18	
	0.0000	0.50	5	
	0.0000	0.80	5	
IE/FUN	0.0000	0.20	60	0.9
	0.0000	0.30	12	
	0.0000	0.40	18	
	0.0000	0.50	5	
	0.0000	0.80	5	
PE/TA	0.0050	0.05	40	0.9
	0.0001	0.05	10	
	0.0050	0.10	43	
	0.0050	0.20	7	
ONIE/TA	0.0050	0.05	36	1.1
	0.0001	0.05	4	
	0.0050	0.10	35	
	0.0050	0.15	15	
	0.0050	0.25	10	
EQ/TA	0.0100	0.50	100	2.2
DPS/F	0.0000	0.98	100	0.1
LOANS/TA	0.0000	1.00	100	0.1

Notation: II/TA (ratio of interest income to total assets), IE/FUN (average funding rate), PE/TA (wage rate), ONIE/FA (price of capital expenditure), EQ/TA (equity ratio), DPS/F (ratio of customer deposits to the sum of customer deposits and short term funding), LOANS/TA (loan ratio).

Variable list

We now briefly introduce the variables we will use for our empirical applications. $IR_{i,t}$ is the ratio of total interest income ($II_{i,t}$) to total assets ($TA_{i,t}$) of bank i in year t. $AFR_{i,t}$ is the ratio of annual interest expenses ($IE_{i,t}$) to total funds ($FUN_{i,t}$), or the Average Funding Rate. $PPE_{i,t}$ is the ratio of personnel expenses ($PE_{i,t}$) to total assets ($TA_{i,t}$), or the (approximated) Price of Personnel Expenses (labor costs). $PCE_{i,t}$ is the ratio of other non-interest expenses ($ONIE_{i,t}$) to fixed assets ($FA_{i,t}$; or corrected $FAc_{i,t}$[3]), or the (approximated) Price of Capital Expenditure. $LNS/TA_{i,t}$ is the ratio of customer loans ($LNS_{i,t}$) to total assets, representing credit risk. $ONEA/TA_{i,t}$ equals the ratio of other non-earning assets ($ONEA_{i,t}$) to total assets, which mirrors characteristics of the asset composition. $DPS/F_{i,t}$ is the ratio of customer deposits ($DPS_{i,t}$) to the sum of customer deposits and short term funding $F_{i,t}$, capturing features of the funding mix. $EQ/TA_{i,t}$ is the ratio of equity ($EQ_{i,t}$) to total assets, used to account for the leverage reflecting differences in the risk

Table 9.3 Market structure overview 1996-2005

Country	Obs.	Banks	MS	Max MS	C_3	C_5	C_{10}	*HHI*
Argentina	494	100	0.020	0.32	0.42	0.59	0.79	0.09
Austria	221	36	0.045	0.33	0.66	0.87	0.95	0.18
Australia	1081	179	0.009	0.41	0.58	0.69	0.80	0.15
Belgium	425	66	0.024	0.44	0.61	0.81	0.94	0.18
Brazil	581	116	0.017	0.26	0.49	0.63	0.78	0.11
Bulgaria	130	26	0.069	0.74	0.51	0.67	0.86	0.14
Canada	392	61	0.026	0.23	0.55	0.84	0.96	0.15
Chile	155	24	0.065	0.30	0.57	0.79	0.96	0.15
China People's Rep.	268	50	0.037	0.51	0.78	0.85	0.94	0.23
Croatia	254	44	0.039	0.39	0.63	0.75	0.89	0.18
Cyprus	109	18	0.092	0.53	0.87	0.96	1.00	0.31
Czech Republic	168	29	0.060	0.30	0.70	0.82	0.93	0.18
Denmark	835	99	0.012	0.63	0.81	0.87	0.92	0.34
Estonia	43	9	0.209	0.74	0.93	0.99	1.00	0.47
Finland	71	11	0.141	0.77	0.86	0.98	1.00	0.38
France	2450	366	0.004	0.18	0.35	0.50	0.70	0.07
Germany	15239	2088	0.001	0.19	0.35	0.45	0.51	0.06
Greece	121	23	0.083	0.47	0.67	0.86	0.98	0.20
Hungary	165	25	0.061	0.47	0.62	0.77	0.93	0.18
Iceland	46	7	0.174	0.46	0.82	0.97	1.00	0.26
India	477	69	0.021	0.35	0.33	0.44	0.63	0.07
Indonesia	393	91	0.023	0.53	0.47	0.62	0.81	0.12
Ireland	181	30	0.055	0.40	0.69	0.82	0.93	0.20

Country	Obs.	Banks	MS	Max MS	C_3	C_5	C_{10}	*HHI*
Italy	4714	744	0.002	0.16	0.32	0.45	0.61	0.05
Japan	3340	673	0.003	0.16	0.27	0.39	0.55	0.04
Korea, Rep. of	.171	30	0.058	0.27	0.39	0.57	0.88	0.10
Latvia	107	20	0.093	0.56	0.65	0.80	0.98	0.19
Lithuania	47	8	0.149	0.74	0.87	0.96	1.00	0.41
Luxembourg	836	125	0.012	0.11	0.25	0.38	0.60	0.05
Malta	40	4	0.250	0.51	0.96	1.00	1.00	0.43
Mexico	166	33	0.054	0.58	0.64	0.80	0.97	0.18
Netherlands	285	49	0.035	0.47	0.86	0.92	0.96	0.32
New Zealand	49	6	0.204	0.40	0.72	0.96	1.00	0.22
Norway	293	51	0.034	0.47	0.67	0.75	0.87	0.20
Poland	285	51	0.035	0.42	0.48	0.65	0.86	0.13
Portugal	191	31	0.052	0.31	0.63	0.79	0.94	0.17
Romania	118	27	0.076	0.92	0.68	0.80	0.94	0.24
Russian Federation	404	118	0.022	0.77	0.63	0.71	0.81	0.27
Slovakia	84	17	0.119	0.64	0.81	0.90	1.00	0.30
Slovenia	115	18	0.087	0.46	0.62	0.76	0.96	0.18
Spain	984	147	0.010	0.30	0.52	0.62	0.73	0.11
Sweden	287	86	0.031	0.37	0.84	0.97	0.98	0.26
Switzerland	1942	351	0.005	0.81	0.86	0.88	0.92	0.53
Turkey	123	33	0.081	0.51	0.60	0.79	0.97	0.18
United Kingdom	922	151	0.011	0.24	0.48	0.66	0.85	0.11
U.S.A.	6056	802	0.002	0.13	0.22	0.29	0.40	0.03

Note: Obs is the total number of observations over the sample period. Banks is the number of banks and MS the average market share based on total assets, both as average over 1996-2005. Max MS is the maximum market share of one of the years. The concentration indices C_3, C_5, C_{10} and *HHI* are averages over 1996–2005.

preferences across banks. $OI/II_{i,t}$ is the ratio of other income ($OI_{i,t}$) to interest income ($II_{i,t}$) which takes into account the increasing role of banking activities other than financial intermediation, which draw on the same inputs.

Our profit and cost frontiers models are based on a production set consisting of three outputs, namely loans (Y_1), investments (Y_2) and off-balance sheet items (Y_3), and three input prices: the prices of financial capital (W_1), labor (W_2) and physical capital (W_3). The price of financial capital or funding is calculated as the ratio of interest expenses over customer and short-term funding, the price of labor is approximated as the ratio of personnel expenses over total assets (since the number of employees is not available for many banks), and the price of physical capital is taken as the ratio of other operating expenses over fixed assets. To control for risk-taking preferences, we also include the equity over asset ratio (Z) as an explanatory variable.

The dependent variable in the profit efficiency model is profit before tax (PBT), whereas the sum of all (interest and non-interest) expenses is our measure of total cost (TC), the dependent variable in the cost efficiency model. Profit, total cost and all outputs are expressed in thousands of PPP dollars, and input prices are in percentages.

10 The Bresnahan model

Bresnahan (1982) and Lau (1982) present a short-run model for the empirical determination of the market power of an average bank. Based on time series of industry data, the conjectural variation parameter $\lambda = (1 + d\sum_{i \neq j} Y_j / dY_i)/n$, with $0 \leq \lambda \leq 1$, is determined by simultaneous estimations of the market demand and supply curves. Banks maximize their profits by equating marginal cost and perceived marginal revenue. The perceived marginal revenue coincides with the demand price in competitive equilibrium and with the industry's marginal revenue in the collusive extreme (Shaffer, 1993). This chapter presents an application of the Bresnahan model to both loans markets and deposits markets in nine European countries over 1971-1998, based on Bikker (2003), and gives a survey of other applications of the Bresnahan approach in the literature.

The Bresnahan model we will use is based on the intermediation paradigm of a bank, as in Shaffer (1989, 1993), who furthermore assumes that banks produce only one product and use several input factors. As proposed by Shaffer, the cost functions are based on factor input prices. Taking for granted that factor inputs are not the same for loans and deposits, our Bresnahan model separates the costs of both banking activities, that is to say it ignores the interdependence of cost functions for the two products. We estimate the demand and supply relations separately for the deposit and loan markets, assuming that banks try to maximize profits at the product level rather than taking advantage of possible cross-subsidization between products.

Theoretical structure of the Bresnahan model

Assuming n banks in the industry supplying a homogeneous product, the profit function of the average bank i takes the form:

$$\Pi_i = pY_i - c_i\,(Y_i, S_i) - F_i \tag{10.1}$$

where Π_i is profit, Y_i is the volume of output, p is the output price, c_i are the variable costs, S_i is a vector of exogenous variables affecting the marginal costs, but not the industry demand function, and F_i are the fixed costs of bank i. In the loan market, the output price p can be defined as the difference between the lending rate and the rate of risk-free investment (such as government bonds). An alternative would be to assume that p is equal to the lending rate and to include the funding rate as a cost factor. In the deposit market, the output price p is the difference between the risk-free rate and the deposit rate, hence what the discount banks receive when they fund with deposits instead of other types of funding.

Banks face a downward sloping market demand function, the inverse of which is defined as:

$$p = f(Y,D) = f(Y_1 + Y_2 + \ldots + Y_n, D) \tag{10.2}$$

where D is a vector of exogenous variables affecting industry demand but not marginal costs. The first order condition for profit maximizing of bank i yields:

$$\frac{d\Pi_i}{dY_i} = p + f'(Y,D)\frac{dY}{dY_i}Y_i - c_i'(Y_i,S_i) = 0 \tag{10.3}$$

Taking averages over all banks produces:

$$p + f'(Y,D)\frac{dY}{dY_i}\frac{1}{n}Y - \sum_i c_i'(Y_i,S_i)/n = 0 \tag{10.4}$$

so that:

$$p = -\lambda f'(Y,D)Y - \sum_i c_i'(Y_i,S_i)/n \tag{10.5}$$

where $\lambda = (dY/dY_i)/n = (1 + \sum_{i \neq j} Y_j/dY_i)/n$. Thus, λ is a function of the conjectural variation of the average firm in the market. The conjectural variation of banks is defined as the change in output of all remaining banks anticipated by bank i in response to an initial change in its own output. As explained in the next section, the restriction $\lambda = 0$ holds in a perfectly competitive market, whereas $\lambda = 1/n$ would indicate a Cournot equilibrium. Under perfect collusion, λ would be equal to 1, so that under normal conditions, the λ parameter takes values between zero and unity.

Empirical equations for the deposit and loan markets

We apply the Bresnahan model to the two most prominent submarkets of the banking industry: the loan and deposit markets. For the empirical model of the deposit market, the theoretical demand function (10.2) is redefined as a linear aggregate demand function for deposit *facilities* offered to non-banks and reads:

$$DEP = \alpha_0 + \alpha_1 r_{dep} + \alpha_2 D + \alpha_3 D \cdot r_{dep} + \varepsilon \tag{10.6}$$

where *DEP*, the real value of total deposits, r_{dep}, the market deposit rate, are exogenous variables affecting industry demand for deposits but not marginal costs, such as disposable income, unemployment, the number of bank branches (unavailable here) and interest rates for alternative investment (that is the money market rate and the government bond rate) and ε is the error term.[1] Equation (10.6) should also include one or more cross-terms between the deposit rate and at least one of the exogenous variables determining demand for deposit facilities (on the identifiability of the λ parameter, see below). The time subscripts in Equation (10.6) and later equations are deleted for convenience.

The marginal cost function for bank *i* – in Equation (10.3) – is defined as:

$$MC_i = \beta_0 + \beta_1 DEP_i + \beta_2 S_i + \nu_i \tag{10.7}$$

where S_i are exogenous variables influencing the supply of deposits (costs of input factors for the production of deposits, for instance, wages) and ν_i is the error term. Re-arranging the aggregate demand function (10.6) yields the price function as:

$$r_{dep} = \frac{1}{\alpha_1 + \alpha_3 D}\left[DEP - \alpha_0 - \alpha_2 D - \varepsilon\right] \tag{10.8}$$

which, multiplied by the deposits of bank *i* yields its total revenue as:

$$TR_i = \frac{1}{\alpha_1 + \alpha_3 D}\left[DEP - \alpha_0 - \alpha_2 D - \varepsilon\right] DEP_i \tag{10.9}$$

and, derived with respect to the deposits at bank *i*, its marginal revenues:

$$\begin{aligned} MR_i = \frac{dTR_i}{dDEP_i} &= \frac{1}{\alpha_1 + \alpha_3 D}\left[DEP - \alpha_0 - \alpha_2 D - \varepsilon\right] \\ &+ \frac{1}{\alpha_1 + \alpha_3 D}\frac{dDEP}{dDEP_i} DEP_i \\ &= r_{dep} + \frac{\lambda n}{\alpha_1 + \alpha_3 D} DEP_i \end{aligned} \tag{10.10}$$

where λ is defined as below Equation (10.5). Market equilibrium requires the equality of marginal revenues and marginal costs, so that for each bank:

$$r_{dep} = -\lambda \frac{DEP}{\alpha_1 + \alpha_3 D} + \beta_0 + \beta_1^* DEP + \beta_2^* S + \nu \tag{10.11}$$

where $\beta_1^* = \beta_1/n, \beta_2^* = \beta_2/n$ and $S = \Sigma_i S_i$. In order to determine λ, the degree of competition of the average bank in the deposit markets of the countries considered, the quantity and price Equations, (10.6) and (10.11), respectively, must be estimated simultaneously, as the parameters α_1 and α_3 occur in both equations.[2] Lau (1982) and Bresnahan (1982) show that, whereas both the demand (α) and supply (β) parameters are identified, the λ parameter is identifiable only if the demand function includes the endogenous interest rate (or 'price') and a cross-term with one of the (other) explanatory variables and this interest rate.[3] In other words, λ is identified only if the assumptions $\alpha_1 \neq 0$ and $\alpha_3 \neq 0$ both hold. Note that α_1 is expected to be positive, so the first term of the right-hand side of Equation (10.11) is λ times a *markdown*. This implies a *lower* deposit rate in the case of no or limited competition, as seems plausible.

In a similar manner, the aggregate demand (or quantity) function for loans by households and banks can be defined as:

$$LOANS = \alpha_0 + \alpha_1 r_{lend} + \alpha_2 D + \alpha_3 D \cdot r_{lend} + \varepsilon \tag{10.12}$$

where real *LOANS* are explained by r_{lend}, the lending rate, by D, exogenous variables influencing the demand for loans, such as income, unemployment, the number of bank branches, the share of labor in total value added and the capital utilization rate, and by ε, the error term. Again, the equation should contain at least one cross-term consisting of the lending rate and one of the other variables determining demand for loans facilities in order for the parameter λ to be identified. Analogous to the price equation for deposits presented above, the price relationship for loans may be derived as:

$$r_{lend} = -\lambda \frac{LOANS}{\alpha_1 + \alpha_3 D} + \beta_0 + \beta_1^* LOANS + \beta_2^* S + \nu \tag{10.13}$$

The simultaneous estimation of Equations (10.12) and (10.13) generates the value of λ, provided this parameter is identified. Note that α_1 is expected to be negative, thus the first term of the right-hand side of Equation (10.13) is λ times a *markup*. This means a *higher* lending rate in the case of no or limited competition, as seems plausible.

Estimation results for the market for deposit facilities

The empirical Bresnahan model has been applied to both the deposit and loan markets of Belgium, France, Germany, Italy, the Netherlands, Portugal, Spain, Sweden and the UK, for each country separately as well as for all countries together. First, we discuss the market for deposit facilities. Quantity Equation (10.6) determines the volume of deposits in terms of its price (the deposit rate) and exogenous variables from the demand function, such as the money market rate or the government debt rate, the volume of GDP, unemployment, non-employment and inflation. Deposits are defined as the sum of time deposits and savings, and deflated by the available price index. The coefficient of the deposit rate should have a positive sign, since a higher return on deposits makes deposits more attractive (see Table 10.1). The return on government debt and the money market rate are the prices of two substitutes for deposits. They have negative coefficients, because the opportunity cost of holding money in deposit increases with the price of any of the substitutes. Real GDP proxies income or wealth and should reflect the positive relationship between income and the propensity to save, or between wealth and investment. The coefficients of the other variables, including cross-term coefficients, may be either positive or negative.

Price Equation (10.11) determines the deposit rate as a function of the volume of deposits, the main input price ‘wage rate’, other exogenous variables, such as inflation and the markdown function, that is, output divided by the first derivative of the demand function with respect to r_{dep}. The coefficient of the markdown, -λ,

Table 10.1 Predictions of parameter signs in the Bresnahan model

	Deposits	Deposit rate	Loans	Lending rate
Lagged endogenous	+	+	+	+
Deposit rate	+			+
GDP, real	+		+	
Government rate	–	+		+
Money market rate	–	+		+
Consumer confidence	+			
Unemployment	i		–	
Non-employment	i			
Inflation	i	+	i	+
Cross-terms	i		i	
Time trend	i	i	i	i
Country dummies	i	i	i	i
Intercept	i	i	i	i
Markdown/up ($-\lambda$)		–		–
Deposits		–		
Wages, real		–		+
Loan growth		+		
Lending rate			–	
Labor share			i	
Utilization grade			+	
Loans, real		+		+

Note: i stands for a priori indeterminacy.

is the measure of deposit market competition, which we set out to find. For the coefficient of the volume of deposits, we expect a negative sign, because banks will pay lower rates on deposits the more deposits they have already attracted. The coefficient of bank employee wages should also be negative, as a higher input price has a negative impact on the deposit rate. Consumers need to be compensated for inflation by the deposit rate. Therefore, its coefficient is expected to be positive. Alternative interest rates, which act as a reference for the bank's deposit rate, are related to alternative investment possibilities for the private sector. Therefore, we expect positive signs. An above normal loan level or loan growth may encourage the bank to raise its deposit rate, in order to increase funding. Again, positive signs would be plausible.

EU-wide results for deposit facility markets

For the complete overview of estimation results we refer to Bikker (2003). The EU-wide estimation results of the real deposit equation are based on a large panel data set of 774 observations. At the same time, this model is restrictive, since per variable identical coefficients are assumed for all nine countries involved. All demand variables have significant coefficients with the right signs. The cross-term

Table 10.2 Bresnahan's deposit market model estimates

						Number of banks (n)			
		Estimation				1987		1997	
	Obs.	period	λ	t-value			1/n		1/n
EU-wide	774	varying[a]	0.000002	5.2	***	7346	0.0001	5646	0.0002
Belgium	-	-	-	-		120	0.0083	131	0.0076
France	109	1971:2–98:2	0.000106	1.3		2021	0.0005	1288	0.0008
Germany	84	1978:1–98:4	0.000627	2.2	**	4089	0.0002	3284	0.00030
Italy	64	1983:1–98:4	0.000314	0.7		391	0.0026	255	0.0039
Netherlands	83	1978:2–98:4	0.000023	0.7		170	0.0059	169	0.0059
Portugal[b]	80	1978:1–97:4	-0.000139	1.6		29	0.0345	44	0.0227
Spain	82	1978:3–97:4	0.000504	2.6	**	333	0.0030	307	0.0033
Sweden	110	1971:3–98:4	0.009889	1.3		144	0.0069	124	0.0081
UK	90	1976:3–98:4	0.000001	0.7		49	0.0204	44	0.0227

Note: Two and three asterisks refer to confidence levels of, respectively, 95 percent and 99 percent. [a] Varying by country; [b] A negative value for λ indicates the existence of a supra-negative market condition. This is a non-equilibrium situation in which bank output exceeds a competitive level and prices are too low, so that over time output in these markets will fall and prices will rise.

is also significant. Together with the coefficient of the deposit rate, the coefficient for the cross-term is important, since it constitutes the markdown variable in the deposit rate equation. Five country dummy coefficients show a significant deviation from the Dutch deposits level, indicating a higher (Belgium, France, Spain and the UK) or lower (Sweden) savings level, after taking the other variables into account.[4] This outcome reflects differences across countries and suggests that country-specific estimates might add new insights. We conclude that these estimation results make a firm basis on which to construct the markdown variable, as required in the second equation.

The major explanatory variable of the deposit rate equation is the government (risk-free) rate: the deposit rate is approximately two-thirds of the government rate. Other marginal cost or supply variables have hardly any effect. In the centre of our interest is the coefficient λ of the markdown, representing the banks' (use of) market power in offering deposit facilities. This coefficient is highly significant, indicating, in principle, absence of fully perfect competition and use of at least some market power, but its value is small (see Table 10.2). Actually, λ is so small that, on the scale of the zero to one interval, the observed use of market power is virtually negligible. Apparently, the EU deposit markets seem to be characterized by a certain (possibly high) degree of competition. However, this conclusion may hold true only for the national or local markets. The fact is that we also observe differences in the level of the deposit rates across the EU countries, as four country dummy coefficients are significantly different from zero. Probably, during the pre-euro period under investigation, there was only limited cross-border competition on the EU deposit markets. Under a Cournot equilibrium, λ is assumed to be equal to the reciprocal of the total number of banks in the EU ($\lambda = 1/n$), see above.[5] A test on $\lambda = 1/n$ makes clear that a Cournot equilibrium must be rejected. Actually, a test does not make much sense (at the EU level), given our observation that the EU deposit market is at the least segmented into national submarkets.

Single-country results for deposit facility markets

Table 10.2 also summarizes the estimated values of λ for deposit markets in the nine countries under consideration. The table furthermore indicates the number of observations for each estimation exercise and the respective sample periods. The values for λ in Cournot equilibrium ($\lambda = 1/n$, for n banks) are calculated for 1987 and 1997 on the basis of the number of banks obtained from the OECD (1999). By the way, the figures make clear that, over this period, the number of banks has declined considerably, by around 25 percent, illustrating the current and recent consolidation process in most EU countries.

Apart from the deposit rate, at least one cross-term variable proved significant in the real deposits equation for every country, except Belgium, where neither the deposit rate coefficient nor the cross-term coefficients are significant. For this reason we do not estimate a deposit rate equation for that country, unable as we are to determine a useful 'markdown'. The main demand variable real GDP is significant with the right sign in all countries. Also the government rate coefficient has the right sign wherever it is significant. These estimation results constitute a firm basis on which to construct the markdown variable, as needed in the second equation. In the deposit rate equation, either the government rate or the money market rate is the major significant variable with a positive sign as expected. Somewhat disappointingly, the major output of the two deposit market model equations, the degree of competition λ, is significant only for Germany and Spain (Table 10.2). For the other countries this indicates, in principle, absence of the use of market power, resulting in perfect competition. Since the perfect competition hypothesis ($\lambda = 0$) is the null hypothesis, the approach favors this hypothesis: a 95 percent level of significance is required to reject perfect competition. So instead of 'accepting' perfect competition (where λ does not deviate from zero), we consider both perfect competition and some kind of oligopoly with high competition (including Cournot equilibrium) as conceivable. Furthermore, we cannot exclude the possibility that the Bresnahan approach might not be sensitive enough to measure market power accurately, given the limited number of available observations at the country level and the possibility of trend breaks during the lengthy observation periods. For Germany and Spain, we find at least non-perfect competition, but the use of market power seems limited.

In the case of a Cournot equilibrium, we assume $\lambda = 1/n$.[6] For Spain the value of λ is significantly below the Cournot equilibrium value, which we can therefore reject. For the other countries, it is less easy to draw conclusions, although values of λ and $1/n$ make Cournot less likely in Italy, the Netherlands, Portugal and the UK. For Germany, the value of λ appears to be somewhat higher than $1/n$, but we cannot reject Cournot equilibrium. In the case of Sweden, λ is in fact equal to $1/n$, as under Cournot, but here it is the t-value of λ that makes it impossible to reject other hypotheses, such as perfect competition. Possibly, banks in Germany and Sweden (and in some of the other countries) do not expect other banks to retaliate against changes in their own deposit facilities output, as the Cournot model assumes. While allowing for the limitations of the Bresnahan approach, we conclude that the markets for deposit facilities in the EU countries considered are most probably highly competitive, as we also found for the EU-wide sample.

Estimation results for loan markets

The second market we investigate is the loan market. Quantity Equation (10.12) determines the real loans volume. The loans variable is negatively related to its price, the lending rate, and positively related to increasing investment activity as indicated by a higher real GDP income and a higher capital utilization rate. Unemployment may be another indicator of economic activity or sentiment, which in addition reflects structural disequilibrium. Its coefficient is expected to be negative. Because a high profit income share and inflation may affect the real loans along various channels, we do not have clear a priori expectations regarding the sign of their coefficients. The expected signs are summarized in Table 10.1.

The price relationship (Equation 10.11) determines the lending rate by real loans, input items such as wages and the deposit rate, as well as other exogenous variables such as the money market rate, the government rate, inflation and the markup: output divided by the first derivative of the demand function with respect to r_{lend}. The coefficient of the latter, $-\lambda$, is the crucial variable in our analysis, i.e. the measure of competitive conduct on the loans market. As the value of λ is expected to fall in the range of 0 to 1, $-\lambda$ will be negative. Banks are expected to translate the risk associated with a larger loan portfolio into a higher lending rate. Higher wages and higher costs of funding will probably be reflected in higher lending rates. The money market rate and the rate on government debt were included as comparative measures of product pricing, and are expected to exert a positive influence on the lending rate. They also reflect funding cost related to interbank and capital market borrowing. Finally, banks will take account of the real losses associated with higher inflation by adjusting their lending rate accordingly. Hence, all coefficients are expected to be positive, albeit that we anticipate a negative sign for $-\lambda$.

EU-wide results for loan markets

All major demand variables of the real loans equation have significant coefficients with the right signs (see Bikker, 2003). The two cross-term coefficients are also significant, which is important as, together with the coefficient of the lending rate, they constitute the markup variable in the lending rate equation. Five country dummy coefficients show a significant deviation from the Dutch loans level, indicating higher (Portugal and Spain) or lower (France, Italy and Sweden) lending levels, after taking the other variables into account. These differences across countries suggest that it may be worthwhile to make country-specific estimates.

The major explanatory variable of the lending rate equation is the government rate with a coefficient of 0.964, whereas real loans are also significant. The crucial result is the parameter λ of the markup, measuring EU banks' use of loan market power. This coefficient points significantly towards rejection of perfect competition

Table 10.3 Bresnahan's loan market model estimates

	Obs.	Period	λ	t-value		(1/n) 1987	1997
EU-wide	718	varying[a]	0.000429	2.5	**	0.0001	0.0002
Belgium	75	1980:1–98:3	0.000064	1.4		0.0083	0.0076
France	81	1978:2–98:2	0.000002	0.2		0.0005	0.0008
Germany	84	1978:1–98:4	0	2.7	**	0.0002	0.0003
Italy	64	1983:3–98:4	0.000147	0.5		0.0026	0.0039
Netherlands	83	1978:2–98:4	0	0.1		0.0059	0.0059
Portugal	79	1978:2–97:4	0.001128	2.2	**	0.0345	0.0227
Spain	82	1978:3–98:4	0	2.5	**	0.0030	0.0033
Sweden	76	1980:1–98:4	0.000492	2.3	**	0.0069	0.0081
UK	87	1976:3–98:1	0.020572	2.4	**	0.0204	0.0227

Note: Two asterisks refer to confidence levels of 95 percent; [a]Varying by country.

on the EU loan markets (see Table 10.3). While the value of λ is larger than $1/n$, as in the Cournot equilibrium, the latter cannot be rejected. Significant country dummy coefficients indicate lending rate differences across the EU countries. This underlines our earlier conclusion that competition in the EU is less than perfect. Obviously, during the pre-euro period under investigation, cross-border competition on the EU loan markets has been limited.

Single-country results results for loan markets

Table 10.3 summarizes the estimated values of λ for loans markets in the nine individual countries. Apart from the lending rate, at least one cross-term variable proved significant in the real loans equation for all countries. The major demand variables, real GDP and unemployment, are significant with the right sign in most countries. Either the deposit or funding rate or the government or money market rate figures as the principal significant variables in the lending rate equation. In a number of countries, the real loans variable and the input price 'real wages' are also significant, with signs as expected. The degree of competition λ, is significant in not less than five countries: Germany, Portugal, Spain, Sweden and the UK, see also Table 10.3.

For the other countries, this would in principle suggest absence of market power use, that is, perfect competition or in any case a high degree of competition. In Germany, Portugal, Spain, Sweden and the UK we find non-perfect competition, but only limited use of market power. For Germany, Portugal, Spain and Sweden, the value of λ appears to be significantly smaller than it would be under Cournot equilibrium ($\lambda = 1/n$), which we therefore reject for these countries. For the UK, λ appears to be equal to $1/n$, so that we cannot reject Cournot equilibrium there. Apparently, banks in the UK do not expect other banks to retaliate against changes in their own lending output. For the other countries, a Cournot equilibrium is less likely. With certain reservations, we draw the conclusion that the loans markets in the EU countries investigated are most probably quite highly (if not perfectly) competitive, as we found also for the EU-wide sample.

Earlier applications of Bresnahan in the literature

Empirical applications of the Bresnahan model are rather scarce.[7] Shaffer (1989) rejects the collusive conduct hypothesis for a sample of U.S. banks, and Shaffer (1993) finds that the Canadian banks were competitive for the period 1965-1989, despite a relatively concentrated market. Berg and Kim (1994) show that Cournot behavior is rejected in the Norwegian banking system. Suominen (1994) finds estimates for λ not significantly different from zero at the 5 percent level (indicating strong competition) for the period 1960–1984 amid tightly regulated interest rates. Using an adapted two-product version of the Bresnahan model, he observes values of λ indicating the use of market power after the deregulation of the Finnish loan market (September 1986–December 1989). Swank (1995) estimates the degree of competition in the Dutch loan and deposit markets over the period 1957–1990, and found that both markets were significantly more oligopolistic than in Cournot equilibrium. Zardkoohi and Fraser (1998) use the model to test whether geographical deregulation in the U.S. had affected the market structure in the individual states. They find perfect competition in most states, but imperfect competition in others. Fuentes and Satre (1998) find that bank consolidation in Spain did not lower the competition level. Ribon and Yosha (1999) investigated the highly concentrated Israeli banking market and found significant – if declining – market power in both the deposit and loan markets. Angelini and Cetorelli (2000) conclude that despite increasing market concentration in Italy, the degree of competition has not been weakened. Toolsema (2002) employs monthly consumer credit market data over the 1993–1999 period. None of the various specifications she tries provide significant values for λ. She therefore concludes that Dutch banks do not use market power on the consumer credit market. Gruben and McComb (2003), investigating Mexican banks before 1995, find that marginal prices were set below marginal costs. They conclude that the Mexican market is super-competitive. Based on aggregate monthly data across 1996-2002, Kim (2003) finds that the pricing behavior of Korean banks is consistent with perfect competition and that they behaved even more competitively after the consolidation wave following the 1998-1999 crisis.

Conclusion

Earlier we observed that the employed Bresnahan approach favors the perfect competition hypothesis, as it is the null hypothesis. More importantly, the Bresnahan model may suffer from an insufficiency of (annual) data points, while such series often undergo structural breaks as well. The presented results raise the suspicion that, due to these problems, the Bresnaham model may be less powerful than other model-based measures of competition, resulting in a bias towards perfect competition. This view is also supported when one surveys the literature where perfect competition is observed much more frequently than under other measurement approaches.

11 The Panzar–Rosse model

Theoretical framework

Rosse and Panzar (1977) and Panzar and Rosse (1987) formulate simple models for monopolistic, oligopolistic and perfectly competitive markets, and develop a test to discriminate between these market structures. This test is based on properties of a reduced-form revenue equation at the firm or bank level and uses a test statistic H, which, under certain assumptions, can serve as a measure of the competitive behavior of banks. The test is derived from a general banking market model, which determines equilibrium output and the equilibrium number of banks by maximizing profits at both the bank level and the industry level. This implies, first, that bank i maximizes its profits, where marginal revenue equals marginal cost:

$$R_i'(Y_i, n, Z_i) - C_i'(Y_i, w_i, T_i) = 0 \tag{11.1}$$

R_i refers to revenues, C_i to costs, Y_i to output, w_i to a vector of m factor input prices, and Z_i and T_i to vectors of exogenous variables that shift the bank's revenue and cost functions, respectively; the subindex i refers to bank i; n is the number of banks; and the prime denotes first derivative with respect to output. Second, at the market level, it means that, in equilibrium, the zero profit constraint holds:

$$R_i^*(Y^*, n^*, Z) - C^*(Y^*, w, T) = 0 \tag{11.2}$$

Variables marked with an asterisk (*) represent equilibrium values. Market power is measured by the extent to which a change in factor input prices ($dw_{k,i}$) for $k = 1, \ldots, m$ is reflected in the equilibrium revenues (dR_i^*), earned by bank i. Panzar and Rosse (P–R) define a measure of competition H as the sum of the elasticities of the reduced-form revenues with respect to factor prices:

$$H = \sum_{k=1}^{m} \frac{\partial R_i^*}{\partial w_{k,i}} \frac{w_{k,i}}{R_i^*} \tag{11.3}$$

The first market model of Panzar and Rosse (P–R) investigates monopoly. In their analysis, monopoly includes the case of price-taking competitive banks, as long as the prices they face are truly exogenous, that is, as long as their equilibrium values are unaffected by changes in the other exogenous variables in the model. The empirical refutation of 'monopoly' constitutes a rejection of the assumption that the revenues of the banks in question are independent of the decisions made by their actual or potential rivals. P–R prove that under monopoly, an increase in input prices will increase marginal costs, reduce equilibrium output and subsequently reduce revenues; hence H will be zero or negative. This is a highly generalized result, requiring little beyond the profit maximization hypothesis itself. Along similar lines, Vesala (1995) proves that the same result holds for monopolistic competition without the threat of entry, that is, with a fixed number of banks. Thus, this case also falls under what we call monopoly or perfect collusion.

Three other commonly employed models for an industrial market investigated by P–R are monopolistic competition, perfect competition and conjectural variation oligopoly, all of which happen to be consistent with positive values for H. In these models, the revenue function of an individual bank depends upon the decisions made by its actual or potential rivals. For monopolistic and perfect competition, the analysis is based on the comparative static properties of the Chamberlinian equilibrium model. This model introduces interdependence into banks' structural revenue equations via the hypothesis that, in equilibrium, free entry and exit results in zero profits. Under a set of general assumptions, it can be proved that under monopolistic competition, $H \leq 1$. Positive values of H indicate that the data are consistent with monopolistic competition, but not with individual profit maximization as under monopoly conditions. In other words, banks produce more and at lower prices than would be optimal in each individual case. A priori, monopolistic competition is the most plausible characterization of the interaction between banks, as it recognizes the existence of product differentiation and is consistent with the observation that banks tend to differ with respect to product quality variables and advertising, although their core business is fairly homogeneous.

In the limit case of the monopolistic competition model, where banks' products are regarded as perfect substitutes of one another, the Chamberlinian model produces the perfectly competitive solution, as demand elasticity approaches infinity. In this perfect competition case, $H = 1$. An increase in input prices raises both marginal and average costs without – under certain conditions – altering the optimal output of any individual firm. Exit of some firms increases the demand faced by each of the remaining firms, leading to an increase in prices and revenues equivalent to the rise in costs.

Finally, analyzing the conjectural variation oligopoly case, P–R show that strategic interactions among a fixed number of banks may also be consistent with positive values of H. In general, the value of H is not restricted. In the special case of perfect collusion oligopoly or a perfect cartel, the value of H is non-positive, similar to the monopoly model. Table 11.1 summarizes the discriminatory power of H.

The Chamberlinian equilibrium model described above provides a simple link between H and the number of banks, so between market behavior and market structure. The model is based on free entry of banks and determines not only

Table 11.1 Discriminatory power of H

Values of H	Competitive environment
$H \leq 0$	Monopoly equilibrium: each bank operates independently as under monopoly profit maximization conditions (H is a decreasing function of the perceived demand elasticity) or perfect cartel
$0 < H < 1$	Monopolistic competition free entry equilibrium (H is an increasing function of the perceived demand elasticity); conjectural variation oligopoly
H = 1	Perfect competition. Free entry equilibrium with full efficient capacity utilization

the output level but also the equilibrium number of banks. Vesala (1995) proves that H is an increasing function of the demand elasticity η, that is, the less market power is exercised on the part of banks, the higher H becomes. This implies that H is not used solely to reject certain types of market behavior, but that its magnitude serves as a measure of competition. One of the general assumptions underlying the Chamberlinian equilibrium model mentioned above is that the elasticity of perceived demand facing the individual firm, $\eta(Y, n, w)$, is a non-decreasing function of the number of rival banks. Panzar and Ross (1987) call this a standard assumption, eminently plausible and almost a truism. Vesala's result and this assumption together provide a positive (theoretical) relationship between H and the number of banks.

Empirical P–R model

The empirical application of the P–R approach assumes a log-linear marginal cost function (dropping subscripts referring to bank i):

$$\ln MC = \alpha_0 + \alpha_1 \ln Y + \sum_{k=1}^{m} \beta_k \ln w_k + \sum_{j=1}^{p} \gamma_j \ln T_j \qquad (11.4)$$

where Y is output of the bank, w is the vector of factor input prices (for example regarding funding, personnel expenses and other non-interest expenses) and T is a vector of are other variables, exogenous to the cost function C_i. Equally, the underlying marginal revenue function has been assumed to be log-linear of the form:

$$\ln MR = \delta_0 + \delta_1 \ln Y + \sum_{j=1}^{q} \zeta_j \ln Z_j \qquad (11.5)$$

where Z is a vector of variables related to the bank-specific demand function. For a profit-maximizing bank, marginal costs equal marginal revenues in equilibrium, yielding the equilibrium value for output (denoted by an asterisk):

$$\ln Y^* = (\alpha_0 - \delta_0 + \sum_{k=1}^{m} \beta_k \ln w_k + \sum_{j=1}^{p} \gamma_j \ln T_j - \sum_{j=1}^{q} \zeta_j \ln Z_j) / (\delta_1 - \alpha_1) \qquad (11.6)$$

The reduced-form equation for revenues of bank i is the product of the equilibrium output values of bank i and the common output price level (p), determined by the inverse-demand equation, which reads, in logarithms, as: $\ln p = \varepsilon + \theta \ln(\sum_i Y_i^*)$.

We use the following operationalization of the reduced-form revenue equation:

$$\begin{aligned}\ln IR_{i,t} = \alpha + \beta \ln AFR_{i,t} + \gamma \ln PPE_{i,t} + \delta \ln PCE_{i,t} \\ + \sum_j \zeta_j \ln BSF_{i,j,t} + \phi\,(OI_{i,t}/IR_{i,t}) + e_{i,t}\end{aligned} \tag{11.7}$$

where $IR_{i,t}$ is the ratio of total interest revenue to the balance sheet total of bank i in year t. *AFR* is the ratio of annual interest expenses to total funds, or the Average Funding Rate. *PPE* is the ratio of personnel expenses to the balance sheet total, or the (approximated) Price of Personnel Expenses. *PCE* is the ratio of physical capital expenditure and other expenses to fixed assets, or the (approximated) Price of Capital Expenditure. *AFR*, *PPE* and *PCE* are the bank unit input prices: funding, labor and capital, or proxies of these prices. *BSF* are Bank-Specific exogenous Factors, without explicit reference to their origin from the cost or revenue function. Furthermore, to take into account the increasing role of banking activities other than financial intermediation, which draw partially on the same inputs, we complement the analysis by the inclusion of the ratio of other income to interest income (OI/II). The specification of this explanatory variable uses the fact that all inputs are used to generate total income (TI), so that $\ln(TI) = \ln(II + OI) \approx \ln(II) + OI/II$. Using OI/II as an additional explanatory variable with coefficient ϕ, this equation by approximation encompasses the models explaining only $II\,(\phi = 0)$, or merely $TI\,(\phi = 1)$. Finally, e is a stochastic error term. In the notation of Equation 11.7, a so-called H-statistic is defined by $\beta + \gamma + \delta$, representing the sum of all input price elasticities.

Table 11.2 presents estimates for all 25 EU countries, all OECD countries (adding eleven non-EU countries to the sample) and ten large emerging countries, 46 countries in total. The first column shows the number of observations per country, varying from big numbers such as 14,843 for Germany, 5,992 for the U.S. and 4,706 for Italy to such small numbers as 41 for Bulgaria and the People's Republic of China and 40 for Malta. The total number of observations is 43,271 and the average number per country is 941. The second column provides estimates of H for all banks.

For four national banking markets, namely Bulgaria, Cyprus, Finland and Portugal, we obtain negative H values, representing a pure monopoly or cartel. Apart from Portugal, these country estimates are based on a rather small sample of less than 100 observations, reflected in large standard deviations. Six countries have H values above 1:[1] Chile, the Czech Republic, China, Iceland, the Netherlands and Mexico. Results of China, Iceland and Mexico are based on quite small samples. Most countries have H values between 0 and 1, quite evenly distributed over this range. Figure 11.1 presents these values, indicated by a 'correctly' specified P–R model with countries ordered according to the size of their H statistics.

Table 11.2 Panzar-Rosse results for several countries

Country	N	H	st. dev.	R^2	Wald $H \leq 0$	Wald $H = 1$	Equilibrium test
Argentina	323	0.419	0.175	0.896	0.008	0.000	0.016
Austria	177	0.266	0.613	0.755	0.332	0.023	0.804
Australia	1035	0.263	0.127	0.858	0.019	0.000	0.000
Belgium	414	0.489	0.177	0.892	0.003	0.000	0.457
Brazil	575	0.420	0.139	0.829	0.001	0.000	0.024
Bulgaria	41	-0.421	0.572	0.832	0.769	0.000	0.024
Canada	365	0.230	0.249	0.805	0.178	0.000	0.000
Chile	155	1.104	0.171	0.986	0.000	0.164	0.504
China People's Rep.	45	1.480	0.298	0.991	0.000	0.085	0.114
Croatia	72	0.960	0.343	0.567	0.003	0.903	0.000
Cyprus	88	-0.019	0.343	0.871	0.522	0.011	0.870
Czech Republic	155	1.202	0.298	0.848	0.000	0.270	0.007
Denmark	782	0.333	0.065	0.978	0.000	0.000	0.977
Estonia	43	0.385	0.298	0.984	0.098	0.000	0.451
Finland	67	-0.485	0.470	0.918	0.849	0.000	0.355
France	2302	0.725	0.082	0.801	0.000	0.001	0.000
Germany	14843	0.860	0.068	0.909	0.000	0.000	0.019
Greece	120	0.575	0.134	0.979	0.000	0.000	0.517
Hungary	113	0.422	0.323	0.856	0.096	0.000	0.625
Iceland	41	1.522	0.734	0.919	0.019	0.462	0.577
India	469	0.604	0.123	0.966	0.000	0.001	0.047
Indonesia	387	0.383	0.189	0.897	0.021	0.000	0.407
Ireland	145	0.945	0.228	0.797	0.000	0.738	0.917
Italy	4706	0.427	0.092	0.953	0.000	0.000	0.010
Japan	2504	0.530	0.051	0.97	0.000	0.000	0.000
Korea, Rep. of	72	0.960	0.343	0.567	0.003	0.903	0.000
Latvia	100	0.614	0.133	0.915	0.000	0.000	0.1100
Lithuania	47	0.264	0.298	0.981	0.188	0.000	0.360
Luxembourg	823	0.306	0.132	0.899	0.010	0.000	0.908
Malta	40	0.771	0.11	0.998	0.000	0.000	0.942
Mexico	60	1.057	0.481	0.914	0.014	0.836	0.282
Netherlands	262	1.078	0.190	0.867	0.000	0.505	0.878
New Zealand	49	0.180	0.403	0.891	0.327	0.000	0.423
Norway	290	0.660	0.081	0.987	0.000	0.000	0.350
Poland	239	0.089	0.265	0.822	0.368	0.000	0.527
Portugal	190	-0.156	0.412	0.898	0.648	0.000	0.119
Romania	105	0.672	0.211	0.974	0.001	0.000	0.132
Russian Federation	372	0.534	0.089	0.870	0.000	0.000	0.146
Slovakia	70	0.242	0.150	0.961	0.053	0.000	0.060
Slovenia	90	0.413	0.226	0.953	0.034	0.000	0.499
Spain	944	0.555	0.202	0.814	0.003	0.000	0.177
Sweden	286	0.468	0.078	0.997	0.000	0.000	0.004
Switzerland	1920	0.812	0.098	0.869	0.000	0.000	0.892
Turkey	119	0.690	0.284	0.936	0.008	0.060	0.166
United Kingdom	333	0.580	0.191	0.902	0.001	0.000	0.618
U.S.	5992	0.434	0.101	0.948	0.000	0.000	0.000

Note: The table provides p-values of the Wald tests.

(The estimates of the traditionally specified P–R model are discussed below.) The country codes are listed in Table 9.1. The average value of H is 0.54. The average value of H for the EU countries (both EU15 and EU25) is, at 0.46, somewhat below the worldwide average, whereas emerging countries show a higher H value of 0.60. OECD countries take an intermediate position.

Generally speaking, the standard deviation of H is quite large. Therefore, testing is the best way to characterize the bank market structure of the investigated countries. The last two columns of Table 11.2 provide test results in terms of p-values for two tests, $H \leq 0$ (monopoly) and $H = 1$ (perfect competition),

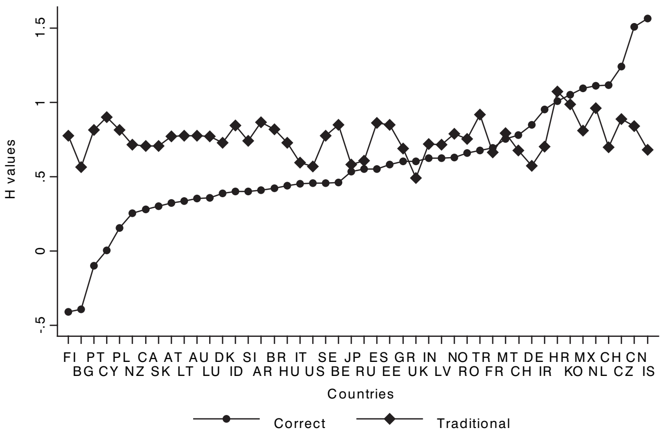

Figure 11.1 *H*-values for the correct and traditional specification

respectively. The first test is a one-sided test, the second is two-sided. For eleven countries, we cannot reject monopoly at the 95 percent confidence level. Apart from the four countries with a negative *H* estimate mentioned above, this holds also for three Commonwealth countries, Australia, Canada and New Zealand, and for four East and Central European countries, Hungary, Lithuania, Poland and Slovakia. For another eight countries, we cannot reject perfect competition. Apart from the six countries with *H* estimates of above 1, mentioned above, this concerns Ireland and Turkey. Hence, we have monopolistic competition or conjectural variation oligopoly for the remaining 27 countries.

Bikker *et al.* (2006a) provide a survey on the empirical literature on the P–R approach, starting with Shaffer (1982), encompassing some thirty articles. This overview includes information on the countries analyzed, the observation period and the average value of the estimated *H* statistic in each study. Bikker *et al.* (2006a) demonstrated both theoretically and empirically that taking the interest income as share of total assets (the ‘price’) as the dependent variable in the P–R model, instead of the unscaled variable interest income (the ‘revenue’), leads to serious overestimation of the degree of competition in the banking industry. Inclusion of total assets or other capacity or size variables as explanatory variables causes a similar kind of overestimation. All P–R articles in the literature apply either scaling with total assets or include total assets or other capacity or size measures as explanatory variables, so that misspecification, or serious overestimation of the degree of competition, is indeed widespread.

Figure 11.1 illustrates the impact of misspecification for our sample of 46 countries by comparing estimates of *H* of the ‘correctly’ and the ‘traditionally’ specified P–R model. Note that the *H* values of the ‘wrongly specified model all range between 0.6 and 0.9 and hardly correlate with the ‘true’ *H* estimates. Apparently there is a strong upward bias. Monopoly would be rejected for all countries, whereas in the ‘true’ model, it could not be rejected for eleven countries, which underlines the upward bias. Perfect competition would be accepted for only five countries, against eight under the correct specification.

One issue remains to be investigated. As elaborated in the literature, a critical feature of the H statistic is that the P–R approach must be applied on the basis of observations that are in long-run equilibrium. An equilibrium test uses the fact that in competitive capital markets, risk-adjusted rates of return will be equalized across banks. In such a case, the rates of return will not be correlated with input prices. An equilibrium test is provided by model (11.7), after replacement of the dependent variable by the rate of return on total equity (ROE) or return on assets (ROA). $H = 0$ would then indicate equilibrium, whereas $H < 0$ would point to disequilibrium. Using ROE, we find that, for 31 out of 46 countries, the hypothesis of equilibrium ($H = 0$) cannot be rejected at the 95 percent significance level, see the p-values of this test in the last column of Table 11.2. The same result is obtained when the test is based on ROA. This outcome implies that the H estimates for the 15 countries where $p < 0.05$, should be interpreted with great caution, as they may be based on observation from a disequilibrium situation.

The impact of bank size

The banking market breaks down into several partial markets, distinguished by customer type (private consumers and small and medium-sized enterprises versus large, international concerns), by product range (savings, mortgage loans, business credit and capital market services), and by service area (local, national and international). Table 11.3 takes a first step towards segmentation of the banking market by size, distinguishing small banks, operating mostly locally and targeting the retail market, and large banks operating internationally and mostly targeting large companies. Medium-sized banks take up an intermediate position. Obviously, this distinction provides only an approximative understanding of competitive conditions in the submarkets. Following Bikker and Haaf (2002a), we have split each country sample into small banks (50 percent of all banks), medium-sized banks (40 percent) and large banks (10 percent). For only 17 of the 46 countries we end up with size-dependent samples that are large enough to obtain reliable estimates. Hence, we restrict our further investigation to these countries.

One important result is that, on average, small and medium-sized banks, with H levels of 0.56-0.58, wield less market power than large banks, where the average H value is 0.43. This is in line with earlier observations (see Bikker *et al.*, 2006b). Apparently, large banks are better able to set higher markups on their marginal costs, which reflects less competitive pressure. Large banks may also be in a better position to collude with other banks. Reputation is likely to be related to size and may help to exert market power to increase margins. Large banks are expected to be more successful in creating fully or partly new banking products and services than small banks, for example. because of economies of scale in product development. This enables them to exploit monopolistic power. A second explanation is that large banks tend to operate in different product and geographical submarkets. The wholesale market is characterized by tailor-made products and services supplied by a limited number of large banks only, which enables them to exploit their monopolistic position.

Table 11.3 Panzar-Rosse results for several bank size classes

Country	N (small)	H	st. dev.	R^2	Wald $H \leq 0$	Wald $H = 1$	Equilibrium test
Austria	517	0.878	0.153	0.538	0.000	0.261	0.058
Belgium	207	0.422	0.190	0.598	0.013	0.000	0.531
Brazil	287	0.430	0.144	0.579	0.001	0.000	0.011
Canada	182	-0.033	0.259	0.552	0.551	0.000	0.000
Denmark	391	0.720	0.051	0.962	0.000	0.000	0.351
France	1151	0.569	0.078	0.586	0.000	0.000	0.000
Germany	7421	0.979	0.074	0.856	0.000	0.613	0.000
India	234	0.736	0.107	0.945	0.000	0.065	0.332
Indonesia	193	0.314	0.208	0.542	0.066	0.000	0.466
Italy	2353	0.881	0.043	0.921	0.000	0.000	0.213
Japan	1252	0.640	0.025	0.929	0.000	0.000	0.000
Luxembourg	411	0.422	0.146	0.673	0.002	0.000	0.831
Russian Federation	186	0.494	0.120	0.581	0.000	0.000	0.558
Spain	472	0.589	0.186	0.579	0.001	0.000	0.094
Switzerland	960	0.743	0.108	0.675	0.000	0.000	0.798
U.S.	2996	0.515	0.070	0.900	0.000	0.000	0.000

Country	N (medium)	H	st. dev.	R^2	Wald $H \leq 0$	Wald $H = 1$	Equilibrium test
Austria	415	0.158	0.167	0.541	0.173	0.000	0.028
Belgium	166	0.721	0.146	0.901	0.000	0.036	0.355
Brazil	231	0.796	0.191	0.594	0.000	0.117	0.170
Canada	147	0.623	0.454	0.687	0.085	0.118	0.165
Denmark	313	0.336	0.070	0.826	0.000	0.000	0.995
France	921	0.900	0.076	0.419	0.000	0.178	0.033
Germany	5938	0.848	0.065	0.582	0.000	0.000	0.764
India	188	0.559	0.065	0.949	0.000	0.000	0.813
Indonesia	156	0.631	0.217	0.852	0.002	0.002	0.567
Italy	1883	0.396	0.146	0.778	0.003	0.000	0.031
Japan	1002	0.434	0.112	0.852	0.000	0.000	0.019
Luxembourg	330	0.217	0.164	0.762	0.092	0.000	0.806
Russian Federation	149	0.539	0.146	0.616	0.000	0.000	0.584
Spain	378	0.564	0.252	0.655	0.012	0.000	0.763
Switzerland	768	0.719	0.107	0.557	0.000	0.000	0.884
U.S.	2397	0.492	0.068	0.768	0.000	0.000	0.000

Country	N (large)	H	st. dev.	R^2	Wald $H \leq 0$	Wald $H = 1$	Equilibrium test
Austria	103	0.749	0.281	0.938	0.004	0.107	0.989
Belgium	41	0.548	0.114	0.977	0.000	0.000	0.567
Brazil	57	0.604	0.222	0.893	0.003	0.000	0.399
Canada	36	0.331	0.201	0.652	0.049	0.000	0.031
Denmark	78	0.239	0.127	0.990	0.030	0.000	0.889
France	230	0.464	0.235	0.816	0.024	0.002	0.662
Germany	1484	0.533	0.120	0.751	0.000	0.000	0.752
India	47	0.432	0.180	0.910	0.008	0.071	0.000
Indonesia	38	0.591	0.237	0.813	0.006	0.012	0.808
Italy	470	0.264	0.161	0.821	0.051	0.000	0.009
Japan	250	-0.177	0.209	0.962	0.801	0.000	0.223
Luxembourg	82	0.584	0.217	0.874	0.004	0.000	0.916
Russian Federation	37	0.562	0.142	0.971	0.000	0.014	0.221
Spain	94	0.410	0.347	0.980	0.119	0.000	0.517
Switzerland	192	0.640	0.290	0.931	0.014	0.019	0.983
U.S.	599	0.161	0.259	0.609	0.267	0.000	0.188

If we compare the H values of the countries' various size-based submarkets, we observe that competitive pressure may vary strongly across these submarkets, again illustrating that banks of different size operate under different competitive conditions, either due to their size or to the distinct product or customer markets they operate in.

The equilibrium test indicates equilibrium for 11 to 14 out of our 17 countries. The H estimates for the other countries should again be interpreted with caution, as the banking sub-markets of these countries may be in disequilibrium.

12 The Structure–Conduct–Performance model

Tables 12.1 and 12.2 present estimates of the SCP model based on Equation 5.8 with, respectively, the C_3 ratio and the Herfindahl–Hirschman Index (*HHI*).

We include a number of control variables, in line with the Panzar–Rosse model estimated previously. The fit of both specifications is roughly similar, with an adjusted R^2 between 23 percent (for Argentina) and 97 percent (for Sweden). For most countries, the concentration ratio and the control variables explain roughly 80 percent of the variation in the banks' price markups. The funding rate's coefficient (IE/FUN) has the expected negative sign and is highly significant. The wage rate (PE/TA) has a positive significant sign: banks that offer higher wages in order to attract more qualified personnel are rewarded with higher profitability.

The coefficient for the price of other non-interest expenses (ONIE/FA) is also positive and significant. Banks that incur these costs typically engage in frequent off-balance sheet operations and other non-intermediation activities. As a result, the positive sign for this variable may reflect the ability of banks to charge high margins on the products they supply after incurring these costs. In this respect, our results are in line with the Panzar–Rosse model, which also found that banks are able to pass a large portion of these costs on to customers. Likewise, banks that provide relatively many services compared to traditional intermediation (OI/II) benefit by having higher profitability.

Better capitalization, reflected in higher equity ratios (EQ/TA), is costly, but can also reduce financing costs. Capitalization may also reflect leverage, as more capital is required when more risks are taken. Apparently, the latter phenomenon dominates, as the coefficient for EQ/TA is positive and significant as well.

Finally, the coefficients for C_3 and *HHI* are mostly insignificant. For the specification with the C_3 ratio in Table 12.1, concentration has a positive and significant effect for Brazil, Italy, Korea, Luxembourg, Portugal and Switzerland. The results are strongest for Italy, where we have a large sample, and the coefficient is not significantly different from 0 even at the 99 percent confidence level. For the specification with the *HHI* in Table 12.2, concentration has a positive and significant effect in India, Italy, Luxembourg, Portugal and Switzerland. For a number of countries, we observe significant negative coefficients. Generally, for most countries the impact of market structure on performance is limited.

As explained in our theoretical framework, the SCP model may yield biased results due to aggregation bias: its competition test is highly restrictive and geared to testing for collusion. If, however, banks react differently to an increase in market concentration, then our coefficients for C_3 and *HHI* are biased, and we may indeed find negative coefficients (see also Bos, 2004).

Summing up, we observe that collusion cannot be rejected in a number of countries. For other countries, we find no evidence of collusive behavior.

Table 12.1 SCP results with C_3 ratio for several countries

SCP model (C_3)	N	constant		C_3		IE/FUN		PE/TA		ONIE/FA		OI/II		EQ/TA		ONEA/TA		$\bar{R}^2$
Argentina	325	0.296		-1.150	***	-0.243	***	0.119	***	0.118	***	-0.008		0.148	***	-0.006		0.233
Austria	191	0.227	***	-0.577	***	-0.213	***	0.030	***	0.047	***	0.084	***	0.068	***	0.012	***	0.834
Australia	1044	0.243	***	0.017		-0.187	***	0.100	***	0.030	***	0.032	***	0.075	***	0.005	***	0.893
Belgium	418	-0.074		0.018		-0.205	***	0.062	***	0.061	***	0.034	***	0.062	***	-0.014	***	0.815
Brazil	578	-0.358	***	0.476	*	-0.192	***	0.058	***	0.081	***	-0.016		0.139	***	-0.002		0.594
Bulgaria	41	0.341	***	-0.176		-0.119	***	0.056	***	0.015		0.018		0.084	***	-0.011		0.881
Canada	375	0.104		-0.046		-0.211	***	0.084	***	0.072	***	0.044	***	0.086	***	0.015	***	0.923
Chile	155	-0.010		-0.090	***	-0.220	***	0.059	***	0.107	***	0.002	***	0.071	***	0.001		0.852
China People's Rep.	45	-0.341		0.043		-0.192	***	0.000		0.052	***	0.240		0.039	**	-0.019		0.815
Croatia	232	-0.085		0.022		-0.195	***	0.039	***	0.029	***	0.073	***	0.097	***	0.005		0.751
Cyprus	88	0.884	***	-0.514	***	-0.108	***	0.133	***	0.094	***	0.526	***	0.040		-0.022		0.747
Czech Republic	156	0.055		-0.233	**	-0.158	***	0.022	**	0.102	***	0.150	***	0.081	***	0.002		0.910
Denmark	782	0.440	***	-0.038		-0.161	***	0.124	***	0.023	***	0.058	***	0.075	***	-0.003		0.885
Estonia	43	0.427	***	-0.224	***	-0.169	***	0.057	***	0.005		0.103	***	0.056	***	0.012		0.868
Finland	67	0.189	***	-0.166	***	-0.206	***	0.090	***	0.039	***	0.053	***	0.105	***	-0.003		0.965
France	2307	0.244	***	-0.098		-0.197	***	0.092	***	0.047	***	-0.009	***	0.080	***	0.018	***	0.824
Germany	14874	0.224	***	-0.099	***	-0.212	***	0.106	***	0.037	***	0.070	***	0.043	***	-0.003	***	0.829
Greece	120	-0.137		0.069		-0.202	***	0.041	***	0.078	***	0.040	***	0.062	***	-0.002		0.855
Hungary	114	-0.237		0.081		-0.226	***	0.045	***	0.098	***	0.039		0.106	***	0.004		0.826
Iceland	43	0.451	*	-0.075		-0.091	***	0.113	***	0.016		0.361	***	0.110	***	-0.004		0.874
India	475	-0.150	***	0.024		-0.260	***	0.044	***	0.046	***	0.000		0.068	***	0.012	**	0.748
Indonesia	387	-0.310	***	0.007		-0.207	***	0.028	***	0.042	***	0.329	***	0.080	***	-0.031	***	0.784
Ireland	152	0.326	***	-0.122		-0.125	***	0.054	***	0.058	***	0.085	***	0.055	***	-0.003		0.897
Italy	4707	-0.038	*	0.946	***	-0.157	***	0.073	***	0.024	***	0.042	***	0.054	***	-0.006	***	0.817
Japan	2504	0.727	***	-0.393	***	-0.080	***	0.063	***	0.016	***	0.031	***	0.012	***	-0.013	***	0.812
Korea, Rep. of	98	-0.271	***	0.162	**	-0.186	***	0.025	***	0.030	***	0.313	***	0.056	***	-0.021	**	0.885
Latvia	100	0.075		0.035		-0.154	***	0.026	*	0.067	***	0.038	***	0.070	***	0.009		0.755
Lithuania	47	0.158		0.045		-0.153	***	0.071	***	0.028		0.047	***	0.062	***	-0.014		0.757
Luxembourg	835	0.171	***	0.552	***	-0.133	***	0.084	***	0.014	**	0.047	***	0.053	***	0.001		0.862
Malta	40	1.112	*	-0.965		-0.230	***	0.120	***	0.050	***	0.153	***	0.034		-0.007		0.922
Mexico	62	-0.043		-0.015		-0.168	***	0.022		0.086	***	0.109	*	0.040	***	0.009		0.627
Netherlands	264	0.088		0.114		-0.153	***	0.069	***	0.061	***	0.053	***	0.041	***	-0.002		0.880
New Zealand	49	-0.452	*	0.049		-0.121		-0.065		0.039		0.416		0.091		0.008		0.521
Norway	290	0.051		0.075		-0.208	***	0.072	***	0.020	***	0.195	***	0.015		-0.008	*	0.889
Poland	239	0.129		0.079		-0.198	***	0.098	***	0.049	***	0.009		0.080	***	-0.001		0.734
Portugal	190	-0.214		0.163	***	-0.181	***	-0.022		0.069	***	0.037	***	0.109	***	0.066	***	0.718
Romania	105	-0.137		0.086		-0.177	***	0.022		0.077	***	0.137	***	0.076	***	0.002		0.844
Russian Federation	372	0.189	**	-0.161		-0.181	***	0.048	***	0.028	***	0.012		0.087	***	0.006		0.628
Slovakia	70	-0.201		-0.012		-0.230	***	0.009		0.025		0.057	***	0.073	***	0.026	***	0.869
Slovenia	90	0.098		-0.181	**	-0.192	***	0.043	**	0.055	***	0.080	***	0.071	***	0.007		0.838
Spain	981	0.155	***	0.083		-0.215	***	0.105	***	0.021	***	-0.001		0.083	***	0.015	***	0.878
Sweden	286	0.125	***	-0.125	***	-0.174	***	0.046	***	0.016	***	0.121	***	0.077	***	-0.002		0.971
Switzerland	1924	-0.175	*	0.710	***	-0.120	***	0.088	***	0.057	***	0.004		0.040	***	-0.014	***	0.873
Turkey	122	-0.034		0.044		-0.221	***	0.066	***	0.018		0.092	*	0.111	***	0.015	***	0.849
United Kingdom	336	0.250	***	-0.028		-0.210	***	0.103	***	0.062	***	0.000		0.040	***	0.001		0.838
U.S.	6046	0.031	*	-0.061	***	-0.205	***	0.068	***	0.066	***	0.043	***	0.063	***	-0.005	***	0.851

Notes: N is the number of bank-year observations. IE/FUN (average funding rate), PE/TA (wage rate), ONIE/FA (price of other non-interest expenses), OI/II (intermediation balance), EQ/TA (equity ratio), ONEA/TA (price of other costs (including premises)). The asterisks refer to confidence levels of 90% (*), 95% (**) and 99% (***), respectively.

Table 12.2 SCP results with HHI ratio for several countries

SCP Model (HHI)	N	constant	*HHI*	IE/FUN	PE/TA	ONIE/FA	OI/II	EQ/TA	ONEA/TA	$\bar{R}^2$
Argentina	325	-0.024	-0.760	-0.249 ***	0.135 ***	0.097 ***	-0.010	0.145 ***	0.000	0.227
Austria	191	0.080	-1.296 ***	-0.216 ***	0.030 ***	0.046 ***	0.084 ***	0.067 ***	0.013 ***	0.837
Australia	1044	0.243 ***	0.043	-0.188 ***	0.100 ***	0.030 ***	0.032 ***	0.075 ***	0.005 ***	0.893
Belgium	418	-0.071	0.039	-0.205 ***	0.062 ***	0.061 ***	0.034 ***	0.062 ***	-0.014 ***	0.815
Brazil	578	-0.196 **	0.580	-0.192 ***	0.057 ***	0.082 ***	-0.017	0.141 ***	-0.003	0.591
Bulgaria	41	0.314 ***	-0.520	-0.119 ***	0.055 ***	0.014	0.017	0.084 ***	-0.011	0.879
Canada	375	0.110	-0.209	-0.211 ***	0.084 ***	0.072 ***	0.044 ***	0.086 ***	0.015 ***	0.923
Chile	155	-0.009	-0.377 ***	-0.217 ***	0.058 ***	0.108 ***	0.002 ***	0.073 ***	-0.001	0.854
China People's Rep.	45	-0.281	-0.085	-0.186 ***	-0.002	0.056 ***	0.241	0.041 **	-0.020	0.815
Croatia	232	-0.072	0.025	-0.194 ***	0.040 ***	0.029 ***	0.073 ***	0.097 ***	0.006	0.750
Cyprus	88	0.555 ***	-0.468 *	-0.107 ***	0.126 ***	0.097 ***	0.528 ***	0.040	-0.021	0.738
Czech Republic	156	-0.019	-0.488	-0.153 ***	0.020 *	0.104 ***	0.148 ***	0.083 ***	0.002	0.909
Denmark	782	0.420 ***	0.020	-0.157 ***	0.125 ***	0.023 ***	0.056 ***	0.075 ***	-0.003	0.885
Estonia	43	0.274 ***	-0.122 ***	-0.175 ***	0.060 ***	-0.001	0.105 ***	0.052 ***	0.012	0.858
Finland	67	0.050	-0.049 *	-0.208 ***	0.087 ***	0.040 ***	0.058 ***	0.102 ***	-0.003	0.963
France	2307	0.254 ***	-0.647 **	-0.197 ***	0.092 ***	0.047 ***	-0.009 ***	0.080 ***	0.017 ***	0.824
Germany	14874	0.200 ***	-0.400 ***	-0.214 ***	0.106 ***	0.037 ***	0.070 ***	0.044 ***	-0.003 ***	0.830
Greece	120	-0.107	0.097	-0.202 ***	0.041 ***	0.077 ***	0.040 ***	0.061 ***	-0.002	0.855
Hungary	114	-0.206	0.116	-0.225 ***	0.045 ***	0.098 ***	0.038	0.107 ***	0.004	0.826
Iceland	43	0.413 *	-0.079	-0.096 ***	0.118 ***	0.013	0.365 ***	0.109 ***	-0.005	0.872
India	475	-0.139 ***	0.124 *	-0.256 ***	0.044 ***	0.046 ***	0.000	0.067 ***	0.012 **	0.749
Indonesia	387	-0.309 ***	-0.014	-0.208 ***	0.028 ***	0.042 ***	0.331 ***	0.080 ***	-0.031 ***	0.784
Ireland	152	0.285 ***	-0.204	-0.124 ***	0.055 ***	0.058 ***	0.085 ***	0.056 ***	-0.003	0.897
Italy	4707	-0.015	3.186 ***	-0.173 ***	0.062 ***	0.020 ***	0.048 ***	0.050 ***	-0.012 ***	0.798
Japan	2504	0.729 ***	-2.378 ***	-0.075 ***	0.059 ***	0.017 ***	0.029 ***	0.009 ***	-0.014 ***	0.828
Korea,Rep. of	98	-0.251 ***	0.431 *	-0.189 ***	0.026 ***	0.030 ***	0.314 ***	0.054 ***	-0.022 **	0.882
Latvia	100	0.125	-0.094	-0.149 ***	0.025 *	0.072 ***	0.036 ***	0.073 ***	0.008	0.757
Lithuania	47	0.204 *	0.008	-0.149 ***	0.072 ***	0.029	0.047 ***	0.064 ***	-0.015	0.756
Luxembourg	835	0.206 ***	2.055 ***	-0.135 ***	0.083 ***	0.015 **	0.047 ***	0.053 ***	0.001	0.862
Malta	40	0.522 ***	-0.734 **	-0.224 ***	0.122 ***	0.051 ***	0.150 ***	0.036	-0.008	0.925
Mexico	62	-0.063	0.036	-0.167 ***	0.022	0.088 ***	0.108 *	0.040 ***	0.007	0.627
Netherlands	264	0.134 *	0.149	-0.154 ***	0.068 ***	0.061 ***	0.053 ***	0.041 ***	-0.002	0.880
New Zealand	49	-0.436 *	0.109	-0.119	-0.065	0.038	0.418	0.091	0.008	0.521
Norway	290	0.086	0.031	-0.209 ***	0.071 ***	0.020 ***	0.202 ***	0.015	-0.008 *	0.889
Poland	239	0.158 ***	0.105	-0.196 ***	0.098 ***	0.049 ***	0.008	0.080 ***	-0.002	0.733
Portugal	190	-0.181	0.509 ***	-0.178 ***	-0.021	0.069 ***	0.037 ***	0.109 ***	0.067 ***	0.719
Romania	105	-0.158	0.087	-0.175 ***	0.013	0.085 ***	0.138 ***	0.082 ***	0.001	0.846
Russian Federation	372	0.124 ***	-0.165	-0.184 ***	0.049 ***	0.026 ***	0.012	0.087 ***	0.005	0.631
Slovakia	70	-0.199	-0.038	-0.228 ***	0.007	0.025	0.058 ***	0.072 ***	0.026 ***	0.869
Slovenia	90	-0.044	0.085	-0.199 ***	0.043 **	0.052 ***	0.087 ***	0.069 ***	0.007	0.833
Spain	981	0.184 ***	0.122	-0.215 ***	0.105 ***	0.021 ***	-0.001	0.083 ***	0.015 ***	0.878
Sweden	286	0.094 **	-0.277 ***	-0.174 ***	0.046 ***	0.017 ***	0.121 ***	0.077 ***	-0.001	0.971
Switzerland	1924	0.410 ***	0.126 ***	-0.111 ***	0.092 ***	0.053 ***	0.005 *	0.041 ***	-0.014 ***	0.877
Turkey	122	-0.056	0.154	-0.224 ***	0.065 ***	0.021	0.091 *	0.111 ***	0.012 **	0.850
United Kingdom	336	0.258 ***	-0.175	-0.210 ***	0.103 ***	0.062 ***	0.000	0.040 ***	0.001	0.838
U.S.	6046	0.025	-0.330 **	-0.206 ***	0.068 ***	0.066 ***	0.043 ***	0.063 ***	-0.005 ***	0.851

Notes: N is the number of bank-year observations. IE/FUN (average funding rate), PE/TA (wage rate), ONIE/FA (price of other non-interest expenses), OI/II (intermediation balance), EQ/TA (equity ratio), ONEA/TA (price of other costs (including premises)). The asterisks refer to confidence levels of 90% (*), 95% (**) and 99% (***), respectively.

13 The Cournot model

Table 13.1 reports estimations of our standard Cournot model based on Equation (5.9), with market share (*MS*) as the most important explanatory variable. A coefficient for *MS* higher than zero points to market power, whereas a coefficient not significantly different from one indicates monopoly.

Our control variables have the expected signs, as in the previous chapter's SCP model estimations. The fit of the Cournot model, at around 0.80, is also comparable to what we found for the SCP model.

The coefficient for *MS* has the expected sign in most countries. An exception is Japan, where we find a highly negative and significant coefficient. The existence of market power cannot be rejected in Austria, Brazil, Bulgaria, Iceland, Ireland, Korea, Latvia, Lithuania, Mexico, the Netherlands, Portugal, Spain, Switzerland and the United Kingdom.

The theoretical framework explained that the coefficient of *MS* is an ordinal measure of competition: across countries we can compare its rank, but not its level. Put differently, the fact that the coefficient for China is 50 percent higher than that of Austria does not mean that market power in China is 50 percent higher. In fact, even in comparing ranks across countries we implicitly assume that price elasticities of demand are equal across countries, which is a rather bold assumption.

Summing up, in comparing the Cournot results to those of the SCP model, we conclude that: (i) countries characterized by the SCP model as having market power are similarly characterized by the Cournot model; (ii) the Cournot model appears to have higher granularity in measuring market power, witness the larger number of countries for which we find positive and significant coefficients; (iii) aggregation issues (and the resulting negative signs) are less important for the Cournot model than for the SCP model, as in the Cournot model fewer countries have negative coefficients for the market structure variable, and few of these coefficients are significantly different from zero.

Table 13.1 Cournot results for different countries

Cournot model	N	constant		*MS*		IE/FUN		PE/TA		ONIE/FA		OI/II		EQ/TA		ONEA/TA		$\bar{R}^2$
Argentina	325	-0.080		0.328		-0.252	***	0.144	***	0.088	***	-0.009		0.151	***	0.001		0.228
Austria	191	-0.146	*	0.350	***	-0.177	***	0.024	***	0.053	***	0.096	***	0.059	***	-0.006		0.842
Australia	1044	0.253	***	-0.005		-0.187	***	0.100	***	0.030	***	0.032	***	0.075	***	0.005	***	0.893
Belgium	418	-0.060		-0.126	***	-0.212	***	0.062	***	0.061	***	0.032	***	0.060	***	-0.010		0.816
Brazil	578	-0.149	***	0.273	***	-0.188	***	0.057	***	0.079	***	-0.019		0.146	***	-0.004		0.593
Bulgaria	41	0.330	***	0.239	**	-0.120	***	0.068	***	-0.012		0.026	***	0.081	***	-0.010		0.891
Canada	375	0.088	*	-0.053		-0.213	***	0.086	***	0.072	***	0.043	***	0.085	***	0.016	***	0.923
Chile	155	-0.040		0.105		-0.218	***	0.064	***	0.095	***	0.002	***	0.077	***	0.004		0.849
China People's Rep.	45	-0.092		-0.117	*	-0.182	***	0.018		0.034	*	0.252	*	0.030	*	-0.004		0.826
Croatia	232	-0.064		-0.090	*	-0.195	***	0.038	***	0.032	***	0.071	***	0.094	***	0.006		0.754
Cyprus	88	0.348	*	-0.060		-0.110	***	0.107	*	0.107	***	0.541	***	0.035		-0.020		0.732
Czech Republic	156	-0.114		0.017		-0.162	***	0.024	**	0.096	***	0.147	***	0.082	***	0.003		0.908
Denmark	782	0.399	***	0.106	***	-0.161	***	0.127	***	0.023	***	0.058	***	0.079	***	-0.005	*	0.887
Estonia	43	0.313	***	0.060	***	-0.153	***	0.060	***	-0.001		0.145	***	0.025	*	0.010		0.837
Finland	67	0.019		0.013		-0.205	***	0.084	***	0.040	***	0.066	***	0.099	***	-0.006		0.962
France	2307	0.210	***	-0.214	***	-0.197	***	0.091	***	0.047	***	-0.009	***	0.079	***	0.018	***	0.824
Germany	14874	0.253	***	-0.011		-0.197	***	0.110	***	0.037	***	0.070	***	0.039	***	-0.005	***	0.822
Greece	120	-0.073		0.041		-0.198	***	0.045	***	0.078	***	0.041	***	0.065	***	-0.003		0.855
Hungary	114	-0.175		-0.013		-0.222	***	0.043	**	0.098	***	0.036		0.107	***	0.006		0.825
Iceland	43	0.057		0.217	***	-0.073	***	0.074	***	0.027		0.513	***	0.157	***	-0.014		0.919
India	475	-0.145	***	-0.091		-0.263	***	0.044	***	0.047	***	0.000		0.068	***	0.012	**	0.749
Indonesia	387	-0.304	***	0.039		-0.208	***	0.029	***	0.040	***	0.330	***	0.081	***	-0.031	***	0.784
Ireland	152	0.195	***	0.108	**	-0.128	***	0.051	***	0.057	***	0.086	***	0.057	***	-0.005		0.898
Italy	4707	0.151	***	-0.187	**	-0.176	***	0.062	***	0.015	***	0.052	***	0.051	***	-0.010	***	0.789
Japan	2504	0.640	***	-1.738	***	-0.076	***	0.056	***	0.018	***	0.027	***	0.013	***	-0.008	***	0.816
Korea,Rep. of	98	-0.225	***	0.142	*	-0.198	***	0.029	***	0.029	***	0.312	***	0.045	***	-0.026	***	0.882
Latvia	100	0.074		0.150	***	-0.153	***	0.023	*	0.058	***	0.042	***	0.072	***	0.009		0.773
Lithuania	47	0.317	***	0.084	***	-0.153	***	0.097	***	-0.004		0.063	***	0.052	***	-0.012		0.788
Luxembourg	835	0.230	***	-0.146	*	-0.150	***	0.075	***	0.024	***	0.045	***	0.057	***	0.005		0.856
Malta	40	0.060		0.013		-0.248	***	0.105	***	0.054	***	0.133	*	0.041		-0.003		0.917
Mexico	62	-0.088		0.141	*	-0.164	***	0.022		0.087	***	0.102		0.047	***	0.005		0.642
Netherlands	264	0.165	***	0.041	*	-0.155	***	0.067	***	0.062	***	0.053	***	0.043	***	-0.002		0.880
New Zealand	49	-0.405		0.036		-0.107		-0.068		0.038		0.423		0.092		0.006		0.517
Norway	290	0.088		-0.004		-0.209	***	0.071	***	0.020	***	0.207	***	0.015		-0.008		0.889
Poland	239	0.168	***	0.088		-0.192	***	0.098	***	0.046	***	0.009		0.082	***	-0.004		0.734
Portugal	190	-0.205		0.331	***	-0.191	***	-0.014		0.057	***	0.040	***	0.123	***	0.051	***	0.729
Romania	105	-0.066		0.010		-0.167	***	0.017		0.072	***	0.152	***	0.076	***	0.004		0.843
Russian Federation	372	0.133	***	-0.477		-0.175	***	0.048	***	0.038	***	0.009		0.071	***	0.002		0.669
Slovakia	70	-0.256	**	0.057		-0.228	***	0.005		0.023		0.061	***	0.085	***	0.025	***	0.871
Slovenia	90	-0.064		-0.091		-0.195	***	0.029		0.070	***	0.074	***	0.073	***	0.010		0.836
Spain	981	0.186	***	0.090	**	-0.217	***	0.105	***	0.020	***	-0.001		0.083	***	0.015	***	0.879
Sweden	286	0.131	***	-0.147	***	-0.157	***	0.048	***	0.011		0.127	***	0.075	***	0.005		0.971
Switzerland	1924	0.412	***	-0.049	**	-0.126	***	0.086	***	0.060	***	0.004		0.038	***	-0.014	***	0.870
Turkey	122	0.014		0.084		-0.219	***	0.071	***	0.010		0.086	*	0.114	***	0.015	***	0.850
United Kingdom	336	0.173	*	0.428	***	-0.204	***	0.096	***	0.068	***	0.000		0.052	***	-0.003		0.847
US	6046	0.026		-0.204	**	-0.202	***	0.068	***	0.068	***	0.043	***	0.062	***	-0.005	***	0.851

Notes: N is the number of bank-year observations. IE/FUN (average funding rate), PE/TA (wage rate), ONIE/FA (price of other non-interest expenses), OI/II (intermediation balance), EQ/TA (equity ratio), ONEA/TA (price of other costs (including premises)). The asterisks refer to confidence levels of 90% (*), 95% (**) and 99% (***), respectively.

14 X-efficiency

Cost efficiency

Cost efficiency has been estimated in two ways. First, we estimate a country-specific translog cost frontier:

$$\begin{aligned}tc = {} & \beta_0 + \beta_1 w_1 + \beta_2 w_2 + \beta_3 y_1 + \beta_4 y_2 + \beta_5 y_3 + \beta_6 z + \frac{1}{2}\beta_7 w_1^2 + \\ & \beta_8 w_1 w_2 + \frac{1}{2}\beta_9 w_2^2 + \frac{1}{2}\beta_{10} y_1^2 + \beta_{11} y_1 y_2 + \beta_{12} y_1 y_3 + \frac{1}{2}\beta_{13} y_2^2 + \\ & \beta_{14} y_2 y_3 + \frac{1}{2}\beta_{15} y_3^2 + \frac{1}{2}\beta_{16} z^2 + \beta_{17} y_1 w_1 + \beta_{18} y_1 w_2 + \beta_{19} y_2 w_1 + \\ & \beta_{20} y_2 w_2 + \beta_{21} y_3 w_1 + \beta_{22} y_3 w_2 + \beta_{23} y_1 z + \beta_{24} y_2 z + \beta_{25} y_3 z + \\ & \beta_{26} w_1 z + \beta_{27} w_2 z + \beta_{28} t + \frac{1}{2}\beta_{29} t^2 + \beta_{30} y_1 t + \beta_{31} y_2 t + \beta_{32} y_3 t + \\ & \beta_{33} w_1 t + \beta_{34} w_2 t + \beta_{35} z t + v + u\end{aligned} \tag{14.1}$$

Second, we apply a so-called true fixed-effects frontier (Greene, 2005) to all banks in our sample, with country-specific fixed effects and (again) a translog specification.

We include only countries with at least 200 observations in order to obtain reliable estimation outcomes. In addition, we drop those observations for which we miss one or more of our variables, as in the case of Romania.

Table 14.1 first reports the results for the country-specific ('single') frontiers. The average level of cost efficiency (*CE*), at around 80 percent, is in line with the literature. Banks in Canada, Denmark, India and Sweden have, on average, cost efficiencies of more than 90 percent and operate fairly close to these countries' own frontiers. Banks in Argentina, Belgium, Brazil, France, the United Kingdom and the U.S. have, on average, efficiencies below 80 percent. Also, in most of these countries, the spread in efficiency is also much wider, whereas a smaller proportion of banks determines the country-specific frontier.

Comparing these efficiency levels across countries is, again, prohibitively difficult: each bank's efficiency has been benchmarked against a local, country-specific frontier. In order to be able to compare the resulting efficiency scores across countries we need to know the location of each country's frontier.

In other words, we would have to benchmark every frontier. An example of such an approach is given by Bos and Schmiedel (2007), who estimate so-called meta-frontiers for European countries.

In this book, we opt for a somewhat different approach, and estimate a fixed-effects specification. This means that while each country's frontier may have its own location, differences between countries' frontiers are constant across a country's banks. Graphically speaking, we allow for parallel shifts of the countries' cost frontiers.

The last four columns of Table 14.1 summarize results for the latter specification. Note that this approach allows us to also include countries with less than 200 observations. Remarkably, once we control for country-specific fixed effects, the average cost-efficiency estimates are remarkably similar across the countries in our sample. The difference between the most efficient country (Iceland with 87 percent) and the least efficient country (Portugal with 74 percent) is only 13 percent.

Intra-national variations in efficiency continue to differ widely across countries. In Iceland and New Zealand, the standard deviation of *CE* is only 5 percent, whereas it is 16 percent in Portugal.

Summing up, most of the differences in cost efficiency across countries appears to be country-specific, as captured by the fixed effects. This result has important policy implications. It suggests, for example, that a bank operating close to the efficient frontier of its home country may – after a move – prove less efficient in another country. There such a bank would find itself operating in a markedly different environment with respect to regulatory, economic, and political conditions. The difference in environment may wipe out the efficiency edge the bank had at home.

Profit efficiency

Table 14.2 shows results for estimations of a translog stochastic profit frontier (Equation 14.1 where profits replace the dependent variable total costs (*tc*)), both for country-specific – single – frontiers, and for estimations with country-specific fixed effects. When we compare country-specific profit results with the cost frontier results from the previous section, we observe a number of interesting differences.

First, profit efficiency (*PE*) scores are on average much lower than cost efficiency scores. This result is in line with the literature, but it deserves some further explanation. Consider the following example: a bank has optimal costs 80, and actual costs are 100. Thus, it is 80 percent cost efficient. Let us further assume that revenues amount to 120. Hence, actual profits are 20. If the bank indeed manages to lower costs to 80, profits would double to 40. So, under the assumption that revenues remain unaffected, the bank is 50 percent profit efficient. Summing up, *economically speaking*, the observed profit efficiency scores seem to be in line with the cost efficiency scores.

Second, the intra-country spread of profit efficiency scores is quite a bit higher than the cost efficiency spread. The difference between the most profit efficient country (Portugal, 83.0 percent efficient), and the least profit efficient country

(Argentina, 47.5 percent) is 35.5 percent. For the cost model, this difference was only 24.5 percent (Canada is 99.0 percent cost efficient, and Brazil is 74.5 percent cost efficient).

Third, we find also that at the country level the standard deviations of *PE* scores are, on average, twice the standard deviations of *CE* scores. A likely explanation again follows from the above example with which we started. Remember that, in our example we *assumed* that revenues remained constant. Obviously, this assumption may not hold. In particular, if competition is less than perfect, our alternative profit model assumes that firms can set their output prices, depending on the amount of market power they have. In Chapter 16, we will return to this issue.

For the fixed-effect frontier results, we also observe that standard deviations of profit efficiency are relatively high. At the same time, as in the case of the cost frontiers, most of the intra-country differences disappear once we control for country-specific fixed effects.[1] Now, profit *in*efficiency is at roughly 60 percent. But the average minimum inefficiency is roughly 40 percent.

Although the methodology is rather different, these results resemble what Bos and Schmiedel (2007) find when they estimate so-called meta-frontiers: in each country, some banks operate on the common, efficient frontier of the countries under consideration. But average efficiency scores suggest that country frontiers remain rather far apart.

In Figure 14.1, we compare average cost and profit efficiency per country, using the fixed effect estimation results. Our results largely confirm the simple example given above: a cost efficiency of 80 percent translates into a profit efficiency of approximately 50 percent. Of course, individual banks may deviate from this pattern, for example because their market power enables them to increase revenues.

Looking at country scores, we observe the following. First, it appears that the banking crisis that hit Scandinavia in the late 1980s resulted in a significant shake-out: Finland (FI), Norway (NO), Sweden (SE) and Denmark (DK) are among the countries with the highest cost and profit efficiency. The U.S. (US), Canada (CA) and Australia (AU) are also contenders for top profit efficiency performance, although cost efficiency in these countries is significantly lower. Japan (JP) and Germany (DE) also perform rather well, both in terms of profit efficiency and in terms of cost efficiency.

Most of the countries in Eastern Europe lag behind in terms of efficiency. Hungary (HU), the Czech Republic (CZ), Latvia (LV), Slovakia (SK) and Russia (RU) have below average cost and profit efficiency. When considering Figure 14.1, the question arises whether the country rankings are related to competition. For example, do countries that have relatively high profit efficiency but rather low cost efficiency also have relatively low levels of competition? Put differently, is the positive gap that exists in some countries between profit and cost efficiency due to succesful rent seeking of their banks? We return to this question in Chapter 16, when we compare results across all models estimated.

Table 14.1 Cost frontier results

Country		Single frontiers											Fixed effect frontier			
		nobs	mean	sd	min	max	μ	σ_u^2	σ_ν^2	λ	logl	lmstat	mean	sd	min	max
Argentina	AR	247	0.786	0.109	0.527	0.959	11.137	0.102	1.349	13.281	58	301	0.778	0.138	0.571	0.980
Austria	AT												0.793	0.133	0.571	0.978
Australia	AU	975	0.848	0.083	0.647	0.981	5.359	0.068	0.735	10.779	641	314	0.845	0.093	0.571	0.975
Belgium	BE	406	0.791	0.113	0.550	0.962	3.441	0.092	0.770	8.374	95	54	0.788	0.135	0.571	0.975
Brazil	BR	429	0.745	0.125	0.421	0.933	0.950	0.124	0.459	3.705	2	145	0.795	0.128	0.571	0.981
Bulgaria	BG												0.805	0.137	0.571	0.958
Canada	CA	308	0.990	0.002	0.990	0.997	7.642	0.002	1.297	727.192	175	8729	0.822	0.118	0.571	0.967
Chile	CL												0.827	0.111	0.571	0.952
China People's Rep.	CN												0.785	0.149	0.571	0.964
Croatia	HR	225	0.868	0.084	0.596	0.979	0.043	0.076	0.113	1.490	134	20	0.793	0.116	0.571	0.981
Cyprus	CY												0.803	0.133	0.571	0.970
Czech Republic	CZ												0.788	0.133	0.571	0.973
Denmark	DK	781	0.903	0.056	0.775	0.985	0.012	0.036	0.110	3.042	756	29	0.858	0.071	0.571	0.971
Estonia	EE												0.850	0.092	0.571	0.954
Finland	FI												0.826	0.102	0.571	0.967
France	FR	2229	0.779	0.111	0.516	0.982	81.529	0.109	4.095	37.477	244	4170	0.827	0.109	0.571	0.985
Germany	DE	15042	0.866	0.073	0.688	0.990	40.135	0.062	1.991	32.324	11722	1571	0.857	0.077	0.571	0.985
Greece	GR												0.811	0.122	0.571	0.965
Hungary	HU												0.777	0.135	0.571	0.981
Iceland	IS												0.872	0.054	0.723	0.942
India	IN	459	0.918	0.033	0.892	0.994	47.252	0.019	3.015	156.837	253	295673	0.807	0.139	0.571	0.965
Indonesia	ID	368	0.826	0.092	0.686	0.980	0.009	0.055	0.239	4.379	123	196	0.807	0.120	0.571	0.977
Ireland	IE												0.786	0.139	0.571	0.974
Italy	IT	4658	0.845	0.079	0.634	0.978	28.768	0.074	1.684	22.697	3151	581	0.850	0.084	0.571	0.970
Japan	JP	2419	0.874	0.070	0.724	0.985	27.313	0.053	1.722	32.414	1898	5703	0.854	0.082	0.571	0.968
Korea, Rep. of	KR												0.789	0.145	0.571	0.958
Latvia	LV												0.766	0.152	0.571	0.983
Lithuania	LT												0.830	0.111	0.571	0.963
Luxembourg	LU	810	0.830	0.098	0.614	0.977	0.160	0.070	0.247	3.549	286	83	0.798	0.118	0.571	0.985
Malta	MT												0.856	0.084	0.652	0.934
Mexico	MX												0.804	0.131	0.571	0.964
Netherlands	NL	220	0.838	0.093	0.586	0.958	0.240	0.077	0.279	3.648	69	180	0.805	0.125	0.571	0.974
New Zealand	NZ												0.864	0.054	0.765	0.941
Norway	NO	277	0.832	0.091	0.457	0.971	0.000	0.113	0.189	1.680	169	12478	0.843	0.080	0.571	0.976
Poland	PL	203	0.866	0.069	0.622	0.970	0.000	0.079	0.136	1.727	92	2	0.808	0.120	0.571	0.985
Portugal	PT												0.738	0.159	0.571	0.980
Russian Federation	RU	341	0.574	0.125	0.201	0.795	0.000	0.226	0.492	2.177	-121	75	0.767	0.142	0.571	0.982
Slovakia	SK												0.776	0.128	0.571	0.984
Slovenia	SI												0.843	0.087	0.571	0.966
Spain	ES	941	0.873	0.071	0.721	0.984	19.520	0.054	1.504	28.096	685	2433	0.842	0.099	0.571	0.985
Sweden	SE	276	0.902	0.058	0.736	0.988	0.060	0.043	0.123	2.838	252	13	0.838	0.098	0.571	0.968
Switzerland	CH	1864	0.871	0.069	0.625	0.982	0.093	0.066	0.152	2.302	1133	88	0.834	0.095	0.571	0.977
Turkey	TR												0.799	0.129	0.571	0.978
United Kingdom	GB	656	0.762	0.126	0.529	0.974	7.787	0.101	1.356	13.415	15	170	0.794	0.131	0.571	0.985
U.S.	US	3916	0.776	0.116	0.518	0.972	17.822	0.105	1.744	16.534	790	255	0.814	0.119	0.571	0.984

Table 14.2 Profit frontier results

Country		Single frontiers											Fixed effect frontier			
		nobs	mean	sd	min	max	μ	σ_u^2	σ_v^2	λ	logl	lmstat	mean	sd	min	max
Argentina	AR	247	0.475	0.194	0.041	0.838	-1.022	0.450	1.221	2.714	-331	1291331	0.433	0.267	0.103	0.904
Austria	AT												0.533	0.192	0.103	0.895
Australia	AU	975	0.581	0.218	0.144	0.926	-30.264	0.308	4.391	14.254	-996	27182	0.511	0.216	0.103	0.919
Belgium	BE	406	0.556	0.188	0.386	0.956	-4.103	0.152	2.242	14.771	-447	709115	0.481	0.238	0.103	0.917
Brazil	BR	429	0.551	0.221	0.119	0.904	-36.263	0.339	5.135	15.136	-482	17705	0.486	0.239	0.103	0.917
Bulgaria	BG												0.521	0.217	0.103	0.829
Canada	CA	308	0.567	0.215	0.118	0.900	-14.104	0.331	3.018	9.128	-327	32512	0.496	0.230	0.103	0.917
Chile	CL												0.544	0.204	0.103	0.802
China People's Rep.	CN												0.535	0.192	0.223	0.832
Croatia	HR	225	0.561	0.217	0.173	0.901	-1.314	0.254	1.109	4.357	-217	162274	0.489	0.242	0.103	0.897
Cyprus	CY												0.450	0.251	0.103	0.906
Czech Republic	CZ												0.485	0.241	0.103	0.906
Denmark	DK	781	0.716	0.169	0.229	0.961	-18.428	0.231	2.499	10.820	-432	1289	0.538	0.176	0.103	0.932
Estonia	EE												0.476	0.250	0.103	0.830
Finland	FI												0.519	0.216	0.103	0.867
France	FR	2229	0.573	0.219	0.144	0.948	-120.418	0.318	9.171	28.841	-2361	9239	0.507	0.219	0.103	0.940
Germany	DE	15042	0.607	0.212	0.192	0.956	-251.312	0.274	12.570	45.864	-13934	30968	0.531	0.204	0.103	0.936
Greece	GR												0.438	0.262	0.103	0.903
Hungary	HU												0.466	0.259	0.103	0.875
Iceland	IS												0.490	0.225	0.103	0.884
India	IN	459	0.642	0.171	0.468	0.963	-13.118	0.124	3.068	24.736	-364	118997	0.509	0.221	0.103	0.924
Indonesia	ID	368	0.648	0.190	0.184	0.945	-31.759	0.270	4.002	14.826	-301	3762	0.520	0.197	0.103	0.908
Ireland	IE												0.522	0.200	0.103	0.890
Italy	IT	4658	0.671	0.178	0.140	0.947	-100.313	0.319	6.591	20.667	-3737	6406	0.545	0.179	0.103	0.939
Japan	JP	2419	0.660	0.150	0.094	0.927	-1.667	0.332	0.809	2.435	-2097	34985	0.519	0.202	0.103	0.928
Korea,Rep. of	KR												0.345	0.311	0.103	0.877
Latvia	LV												0.477	0.247	0.103	0.873
Lithuania	LT												0.520	0.210	0.103	0.810
Luxembourg	LU	810	0.541	0.220	0.105	0.904	-9.940	0.344	2.665	7.759	-916	16753	0.487	0.237	0.103	0.896
Malta	MT												0.597	0.109	0.267	0.782
Mexico	MX												0.476	0.237	0.103	0.900
Netherlands	NL	220	0.660	0.195	0.294	0.942	-12.003	0.194	2.460	12.696	-154	9692	0.522	0.197	0.103	0.913
New Zealand	NZ												0.543	0.190	0.169	0.797
Norway	NO	277	0.721	0.139	0.555	0.964	-25.949	0.097	3.755	38.583	-155	56838	0.549	0.185	0.103	0.837
Poland	PL	203	0.830	0.056	0.797	0.966	-6.495	0.038	2.696	71.221	-187	1001314	0.487	0.239	0.103	0.892
Portugal	PT												0.509	0.216	0.103	0.893
Russian Federation	RU	341	0.492	0.225	0.164	0.919	-0.828	0.265	1.327	5.002	-402	708887	0.472	0.249	0.103	0.887
Slovakia	SK												0.481	0.230	0.103	0.911
Slovenia	SI												0.491	0.236	0.103	0.857
Spain	ES	941	0.664	0.191	0.272	0.951	-118.954	0.215	7.828	36.427	-680	15994	0.540	0.194	0.103	0.928
Sweden	SE	276	0.712	0.162	0.168	0.945	-34.195	0.281	3.436	12.228	-180	5926	0.543	0.175	0.103	0.935
Switzerland	CH	1864	0.662	0.174	0.107	0.941	-30.176	0.349	3.548	10.180	-1641	4829	0.530	0.186	0.103	0.940
Turkey	TR												0.482	0.248	0.103	0.861
United Kingdom	GB	656	0.537	0.212	0.198	0.943	-0.762	0.238	1.174	4.945	-686	2871505	0.502	0.224	0.103	0.936
U.S.	U.S.	3916	0.697	0.173	0.206	0.958	-169.038	0.260	8.373	32.174	-2582	7886	0.554	0.173	0.103	0.922

Notes: Nobs refers to the number of observations and sd to standard deviation. For the fixed effect frontier: $\mu = -1.767$; $\sigma_u^2 = 0.375$; $\sigma_v^2 = 12.552$; $\lambda = 33.481$; logl (loglikelihood value) = -41377; lmstat (log likelihood test on joint significance of parameters) = 5094.2. There are no results for Romania, since data on Y_3 are absent.

Table 14.3 Testing the efficiency hypothesis

Country	N	constant	MS	CE	IE/FUN	PE/TA	ONIE/FA	OI/II	EQ/TA	ONEA/TA	$\bar{R}^2$
Argentina	325	-0.056	0.336	-0.018	-0.252 ***	0.145 ***	0.087 ***	-0.010	0.151 ***	0.001	0.225
Austria											
Australia	1044	0.262 ***	-0.004	-0.010	-0.187 ***	0.100 ***	0.030 ***	0.032 ***	0.075 ***	0.005 ***	0.893
Belgium	418	-0.058	-0.126 ***	-0.006	-0.212 ***	0.062 ***	0.061 ***	0.032 ***	0.060 ***	-0.010	0.816
Brazil	578	-0.191 **	0.280 ***	0.059	-0.187 ***	0.056 ***	0.080 ***	-0.017	0.146 ***	-0.004	0.594
Bulgaria											
Canada	375	-0.404	-0.061	0.513	-0.211 ***	0.086 ***	0.071 ***	0.043 ***	0.084 ***	0.017 ***	0.923
Chile											
China People's Rep.											
Croatia	232	-0.100	-0.091 *	0.038	-0.195 ***	0.038 ***	0.032 ***	0.071 ***	0.094 ***	0.006	0.754
Cyprus											
Czech Republic											
Denmark	782	0.430 ***	0.110 ***	-0.035	-0.162 ***	0.127 ***	0.024 ***	0.058 ***	0.079 ***	-0.005 *	0.887
Estonia											
Finland											
France	2307	0.200 ***	-0.216 ***	0.011	-0.197 ***	0.091 ***	0.047 ***	-0.009 ***	0.079 ***	0.018 ***	0.824
Germany	14874	0.253 ***	-0.011	0.001	-0.197 ***	0.110 ***	0.037 ***	0.070 ***	0.039 ***	-0.005 ***	0.822
Greece											
Hungary											
Iceland											
India	475	-0.128 *	-0.093	-0.020	-0.263 ***	0.044 ***	0.047 ***	0.000	0.068 ***	0.012 **	0.749
Indonesia	387	-0.276 ***	0.040	-0.033	-0.208 ***	0.029 ***	0.040 ***	0.329 ***	0.081 ***	-0.031 ***	0.784
Ireland											
Italy	4707	0.175 ***	-0.189 **	-0.028 ***	-0.176 ***	0.063 ***	0.015 ***	0.052 ***	0.051 ***	-0.010 ***	0.789
Japan	2504	0.640 ***	-1.735 ***	-0.007	-0.076 ***	0.056 ***	0.018 ***	0.027 ***	0.013 ***	-0.008 ***	0.816
Korea, Rep of											
Latvia											
Lithuania											
Luxembourg	835	0.217 ***	-0.142	0.014	-0.151 ***	0.075 ***	0.024 ***	0.045 ***	0.057 ***	0.005	0.856
Malta											
Mexico											
Netherlands	264	0.163 **	0.041 *	0.004	-0.155 ***	0.067 ***	0.062 ***	0.053 ***	0.043 ***	-0.002	0.879
New Zealand											
Norway	290	0.057	-0.003	0.034	-0.209 ***	0.070 ***	0.019 ***	0.207 ***	0.015	-0.008	0.890
Poland	239	0.176 **	0.089	-0.006	-0.192 ***	0.098 ***	0.046 ***	0.009	0.082 ***	-0.003	0.733
Portugal											
Romania											
Russian Federation	372	0.142 ***	-0.476	-0.024	-0.176 ***	0.048 ***	0.038 ***	0.009	0.071 ***	0.002	0.668
Slovakia											
Slovenia											
Spain	981	0.168 ***	0.089 **	0.022	-0.217 ***	0.106 ***	0.020 ***	0.000	0.083 ***	0.015 ***	0.879
Sweden	286	0.112 ***	-0.149 ***	0.017	-0.157 ***	0.048 ***	0.011	0.128 ***	0.074 ***	0.005	0.971
Switzerland	1924	0.408 ***	-0.049 **	0.005	-0.126 ***	0.086 ***	0.060 ***	0.004	0.038 ***	-0.014 ***	0.870
Turkey											
United Kingdom	336	0.136	0.421 ***	0.040	-0.205 ***	0.095 ***	0.069 ***	0.000	0.053 ***	-0.002	0.847
U.S.	6046	0.013	-0.203 **	0.016 ***	-0.202 ***	0.068 ***	0.068 ***	0.043 ***	0.062 ***	-0.005 ***	0.851

Notes: N is the number of bank-year observatoins. The asterisks refer to confidence levels of 90% (*), 95% (**) and 99% (***), respectively

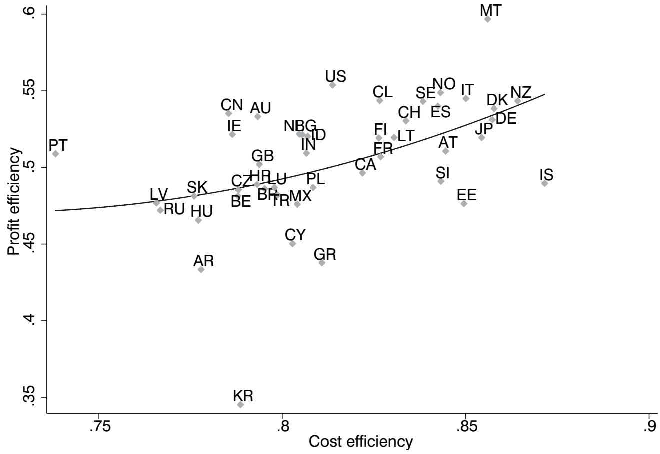

Figure 14.1 Average efficiency per country based on fixed effects estimations

Efficiency hypothesis

In Chapter 6 we argued that X-efficiency scores can be used to test the efficiency hypothesis. More particularly, we argued that it could be used to solve the identification problem that exists when we test this hypothesis jointly with the market power hypothesis.

In Table 14.3, we test the efficiency hypothesis and the market power hypothesis for the Cournot model. As explained in Chapter 6, we regress market share on cost X-efficiency (from the country-specific cost frontier estimations), and use the residual from this regression when we test for market power. The results in Table 14.3 indicate that market power cannot be rejected for Brazil, Croatia, Denmark, Spain and the United Kingdom. On the other hand, the efficiency hypothesis cannot be rejected for the U.S. Overall, however, results are not very significant, suggesting that it is far from easy to distinguish between efficiency-related and market power-related differences in bank performance.

In fact, the relationship between bank performance on the one hand, and market power and efficiency on the other hand, may turn out to be much more complicated. For example, consider the possibility that today's efficiency (improvement) is related to tomorrow's market power. In such a dynamic process, a bank may decide to invest in a superior technology. As a result, its efficiency may temporarily worsen as it attempts to recoup (fixed) costs. Eventually, however, it can undercut its rivals' prices, or charge the same prices, and realize higher profits.

Empirically, we can try to model this type of relationship using dynamic panel estimators or panel vector auto regression (VAR) models. However, we leave these explorations for further research.

15 Scale and scope economies

Now that we have estimated frontiers for all countries in our data set (see the previous chapter), we can also calculate scale and scope economies using Equations (6.3) and (6.4). We report scale and scope economies *per country*, based on fixed-effect frontier estimations and focus on output-specific and total results.[1]

Scale economies

In principle, when we estimate a stochastic cost or profit frontier, we may choose among three types of functional forms. First, we can choose a non-flexible form, for example a Cobb–Douglas specification. Second, we can choose a semi-flexible forms, and e.g. a translog functional form. Third, we may opt for a fully flexible form, such as a Fourier specification. Conveniently, each of these three suggested specifications is nested within the next one. Hence, econometrically speaking we can test for the joint significance of additional parameters (going from the first to the second specification and from the second to the third specification) so as to find the preferred specification. However, Swank (1996) has demonstrated that the choice between the translog specification and the Fourier does not significantly affect efficiency measurement.[2]

When we reconsider the translog cost specification in Chapter 14, we observe that it has a crucial property: when comparing it to the Cobb–Douglas specification, we notice that in the translog, the production of each output is *non-separable* from the production of the other outputs. Put differently, the significance of the interaction terms in our preferred translog specification reveals a production technology where the cost of producing one output depends on the other outputs produced.

Cost scale economies

We can use Equation (14.1) to calculate output-specific scale economies. For example, for output Y_1, loans, we take the partial derivative and calculate:[3]

$$\frac{\partial tc}{\partial y_1} = \beta_3 + \beta_{10}\, y_1 + \beta_{11}\, y_2 + \beta_{12}\, y_3 + \beta_{17} w_1 + \beta_{18} w_2 + \beta_{23} z + \beta_{30} t \qquad (15.1)$$

Table 15.1 contains the scale economy calculations based on our fixed effect frontier estimation. Total scale economies are the sum of output-specific scale economies. Recall that cost scale economies are increasing if output elasticities of costs are smaller than 1, and decreasing if they are larger than 1. Clearly, on average cost economies decrease: an increase in all outputs by 1 percent more than proportionally increases total cost. Decreasing scale economies are significant for the largest banks in each country (as cost curves – not reported here – are U-shaped). For example, the highest value (not reported here) for Argentina is 1.08, indicating that an increase of all outputs by 10 percent results in an increase of total cost by almost 11 percent.

On the other hand, in nearly all countries in our data set, there exist banks that operate with increasing returns to scale. In Luxembourg, for example, the minimum value (not reported here) for total scale economies is 0.84, signifying that a 10 percent increase in all outputs only increases total cost with 8.4 percent. The bulk of the total scale economies can be attributed to Y_1, loans, whereas Y_3, total investments, contributes the least.

Of course, the difference between minimum and maximum scale economies can be due to increases in average bank size over the course of our eleven-year sample period. We will explore this issue later on.

Profit scale economies

The right-hand side of Table 15.1 contains our profit scale economies. Here, an output elasticity of profits larger than 1 signifies increasing scale economies, whereas decreasing scale economies result in elasticities smaller than 1.

Contrary to what we found for the cost frontier, we observe significant and increasing total profit scale economies in most countries. Of course, as mentioned in the previous chapter, it is interesting to see whether those positive scores correspond to our market power measures. We will investigate this in the next chapter, where we will bring together all results.

For now, we record that the distribution of profit scale economies across outputs is similar to what we found for our cost frontier results. Scale economies for output Y_3 are mostly negative, with very high standard deviations. This may reflect the relatively volatile nature of off-balance sheet operations, which are less 'structural' than other outputs and may vary with, for example, the stock market rather than with size.

Combined cost and profit scale economies

Having assessed cost and profit scale economies, we can now combine the two and examine how they relate to each other – with the analogy of the simple numerical example we provided for cost and profit efficiency in the previous chapter. In Figure 15.1, we compare our average cost and profit scale economies. Recall that the line portrayed in this figure should be downward sloping, if cost and profit scale economies were positively correlated. Remarkably, however, the slope of the

Table 15.1 Average scale economies 1996–2005

	Cost								Profit							
	Y		Y_1		Y_2		Y_3		Y		Y_1		Y_2		Y_3	
Country	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Argentina	1.02	0.03	0.58	0.21	0.41	0.20	0.03	0.02	0.97	0.07	0.66	0.33	0.33	0.31	-0.02	0.07
Austria	1.07	0.04	1.01	0.27	0.06	0.24	0.01	0.04	1.12	0.08	1.31	0.39	-0.14	0.35	-0.05	0.10
Australia	1.03	0.02	0.69	0.22	0.34	0.20	0.00	0.02	1.00	0.05	0.77	0.31	0.28	0.29	-0.05	0.05
Belgium	1.03	0.03	0.46	0.30	0.52	0.27	0.04	0.03	0.98	0.08	0.53	0.44	0.45	0.39	0.00	0.09
Brazil	1.02	0.03	0.48	0.27	0.55	0.24	-0.01	0.03	1.03	0.07	0.60	0.40	0.58	0.36	-0.15	0.07
Bulgaria	1.02	0.02	0.67	0.18	0.34	0.17	0.01	0.02	0.96	0.08	0.72	0.29	0.30	0.26	-0.07	0.08
Canada	1.05	0.03	0.84	0.24	0.20	0.23	0.01	0.04	1.08	0.06	1.07	0.34	0.05	0.33	-0.04	0.09
Chile	1.06	0.01	0.92	0.14	0.10	0.12	0.04	0.05	1.10	0.04	1.20	0.20	-0.12	0.18	0.02	0.12
China People’s Rep.	1.06	0.03	0.73	0.09	0.31	0.08	0.02	0.02	1.01	0.04	0.89	0.17	0.17	0.19	-0.05	0.08
Croatia	1.01	0.02	0.62	0.12	0.38	0.12	0.01	0.02	0.99	0.04	0.70	0.19	0.35	0.17	-0.07	0.04
Cyprus	1.02	0.03	0.64	0.24	0.38	0.22	0.00	0.01	1.03	0.05	0.75	0.33	0.35	0.32	-0.07	0.06
Czech Republic	1.02	0.03	0.52	0.28	0.48	0.26	0.02	0.02	0.98	0.09	0.58	0.43	0.46	0.36	-0.06	0.05
Denmark	1.02	0.02	0.66	0.18	0.34	0.17	0.02	0.02	1.00	0.05	0.76	0.28	0.25	0.27	-0.01	0.06
Estonia	1.02	0.03	0.66	0.20	0.35	0.17	0.01	0.03	0.97	0.07	0.71	0.34	0.30	0.28	-0.05	0.08
Finland	1.07	0.03	0.77	0.18	0.27	0.17	0.02	0.02	1.06	0.06	0.99	0.27	0.10	0.27	-0.03	0.06
France	1.05	0.03	0.72	0.34	0.30	0.33	0.03	0.02	1.03	0.09	0.88	0.50	0.14	0.47	0.01	0.07
Germany	1.03	0.02	0.73	0.18	0.30	0.17	0.00	0.02	1.01	0.05	0.83	0.27	0.23	0.24	-0.04	0.04
Greece	1.05	0.02	0.67	0.19	0.33	0.19	0.05	0.03	1.04	0.04	0.88	0.25	0.12	0.28	0.05	0.08
Hungary	1.02	0.03	0.56	0.23	0.41	0.21	0.04	0.02	0.98	0.06	0.65	0.34	0.34	0.32	-0.01	0.07
Iceland	1.03	0.03	0.69	0.30	0.33	0.27	0.01	0.01	1.03	0.09	0.81	0.46	0.27	0.41	-0.06	0.06
India	1.03	0.02	0.57	0.11	0.44	0.11	0.02	0.03	1.03	0.04	0.70	0.19	0.36	0.18	-0.03	0.06
Indonesia	1.03	0.03	0.74	0.27	0.28	0.26	0.00	0.02	1.08	0.08	0.95	0.40	0.23	0.36	-0.10	0.07
Ireland	1.06	0.04	0.72	0.24	0.35	0.20	-0.02	0.04	1.10	0.07	0.95	0.35	0.30	0.32	-0.16	0.10
Italy	1.02	0.03	0.66	0.19	0.36	0.18	0.01	0.02	1.01	0.06	0.77	0.29	0.30	0.28	-0.06	0.06
Japan	1.04	0.02	0.74	0.11	0.32	0.11	-0.02	0.02	0.88	0.05	0.69	0.18	0.23	0.18	-0.04	0.06
Korea, Rep.of	1.06	0.01	0.78	0.09	0.29	0.07	-0.01	0.02	1.05	0.04	0.96	0.14	0.20	0.10	-0.11	0.04
Latvia	0.99	0.04	0.42	0.36	0.56	0.32	0.01	0.02	0.88	0.11	0.32	0.56	0.63	0.49	-0.07	0.06
Lithuania	1.02	0.02	0.71	0.17	0.29	0.16	0.01	0.02	0.98	0.04	0.78	0.25	0.23	0.25	-0.04	0.06
Luxembourg	1.00	0.03	0.22	0.29	0.77	0.27	0.01	0.03	0.94	0.08	0.17	0.43	0.88	0.39	-0.11	0.07
Malta	1.03	0.03	0.53	0.15	0.48	0.13	0.02	0.01	1.01	0.05	0.63	0.26	0.42	0.23	-0.04	0.02
Mexico	1.04	0.03	0.90	0.42	0.13	0.41	0.02	0.03	1.12	0.10	1.19	0.59	0.00	0.56	-0.07	0.09
Netherlands	1.04	0.04	0.63	0.34	0.40	0.31	0.01	0.02	1.05	0.09	0.80	0.51	0.33	0.46	-0.08	0.07
New Zealand	1.09	0.01	1.16	0.08	-0.05	0.07	-0.01	0.02	1.17	0.03	1.54	0.13	-0.31	0.11	-0.06	0.04
Norway	1.07	0.02	1.13	0.10	-0.07	0.10	0.01	0.02	1.15	0.03	1.47	0.14	-0.32	0.14	-0.01	0.06
Poland	1.03	0.02	0.63	0.26	0.37	0.24	0.03	0.04	1.01	0.07	0.76	0.37	0.28	0.34	-0.02	0.08
Portugal	1.06	0.03	0.73	0.27	0.29	0.25	0.03	0.03	1.06	0.06	0.95	0.37	0.12	0.36	-0.01	0.08
Russian Federation	1.02	0.03	0.71	0.26	0.31	0.24	0.00	0.03	1.01	0.08	0.83	0.38	0.29	0.35	-0.11	0.08
Slovakia	1.02	0.03	0.54	0.25	0.47	0.23	0.01	0.03	0.97	0.07	0.59	0.36	0.48	0.31	-0.09	0.06
Slovenia	1.02	0.02	0.65	0.13	0.34	0.11	0.03	0.01	1.00	0.05	0.76	0.21	0.26	0.15	-0.01	0.04
Spain	1.05	0.04	0.79	0.35	0.27	0.33	0.00	0.02	1.06	0.09	0.98	0.50	0.13	0.47	-0.06	0.07
Sweden	1.04	0.03	0.89	0.22	0.12	0.21	0.02	0.02	1.04	0.06	1.07	0.32	-0.03	0.30	0.00	0.06
Switzerland	1.03	0.02	0.87	0.35	0.16	0.35	0.00	0.02	1.03	0.07	1.00	0.46	0.07	0.45	-0.04	0.09
Turkey	1.03	0.02	0.53	0.16	0.46	0.16	0.04	0.02	1.03	0.05	0.68	0.24	0.37	0.23	-0.02	0.06
United Kingdom	1.04	0.05	0.63	0.43	0.39	0.40	0.02	0.03	1.03	0.12	0.79	0.64	0.29	0.58	-0.06	0.10
U.S.	1.05	0.03	0.81	0.23	0.22	0.22	0.02	0.02	1.05	0.06	1.02	0.35	0.04	0.34	-0.01	0.07

Note: there are no results for Romania, since data on Y_3 are absent.

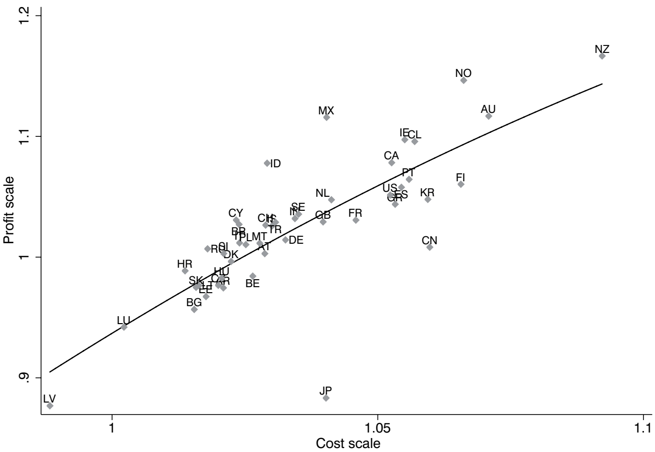

Figure 15.1 Average scale economies per country based on fixed-effects estimations

line is upward: those countries that have the most significant cost scale economies, have the least significant profit scale economies, and vice versa. For example, Luxembourg, with its crowded banking market appears to be relatively close to operating at the minimum (average) cost level, but it has negative profit scale economies. Finland, on the other hand, with its much more concentrated banking market has banks that (on average) benefit from more than proportional increases in profit when total outputs increase – although costs increase even more.

In fact, Figure 15.1 is an illustration of the need for a unifying framework like the one presented in this book: at the very least, the results depicted in this graph suggest that we should verify how competition compares between the countries displayed along the upward sloping line. It very well may be that competition increases as we move from the north-east to the south-west. Again, this comparison will be considered in the next chapter.

For now, let us focus on the development of scale economies over time. After all, the markets included in our analysis have all experienced significant consolidation during the sample period, resulting in increases in average bank size as well as maximum bank size.

In Figure 15.2, we display the development of sample average scale economies over time for the whole sample. In fact, this picture is highly exemplary for what we find for almost all countries in our sample. Clearly, *over time*, cost and profit scale economies are negatively correlated. Importantly, as average bank sizes increase, profit scale economies are eroded by rising costs. Assuming that the basic nature of banks' transformation function, i.e. their production technology, does not change in the near future, these results suggest that consolidation has – from a productivity point of view – almost reached its optimum. If the trends displayed in Figure 15.2 continue, further consolidation may very well result in decreasing profit scale economies.

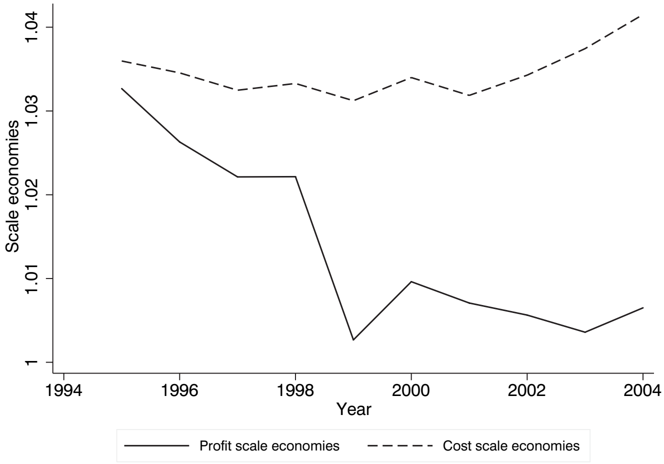

Figure 15.2 Development of scale economies over time

Scope economies

Unfortunately, calculating scope economies is not as straightforward as calculating scale economies.[4] Before we turn to our results, consider the consequences of non-separability in output production for the distinction between scale economies and scope economies. Berger *et al.* (1987) observe that for translog functions complementarities cannot exist at all levels of output. Berger and Mester (1997) noted that an additional problem in the estimating of scope economies is the possible existence of zero outputs. Another potential pitfall in this respect is that extrapolation often creates problems. Given a sample containing both universal banks and other banks, only the former typically offer the full range of financial services. Consequently, the economies of scope derived from the cost function tend to overestimate the true economies of scope among most sample banks. A further problem is that the measurement of *average* economies of scope yields values that are biased due to the inclusion of X-(in)efficiencies. In the search for a better functional form, some researchers have used a Box–Cox transformation for outputs, while others have used a composite function with a separate fixed-costs component of scope economies.

Cost scope economies

For cost models, Molyneux *et al.* (1997) proposed a comparison of the separate cost functions for individual outputs with the joint costs of production. However, the plant and firm level data required for this type of analysis are not available for our sample banks, so we cannot claim to solve all these problems. Instead, we propose a rather simple way of measuring economies of scope that overcomes some problems and mitigates others.

Our specifications contain three outputs, Y_1, Y_2, and Y_3, which sum to Y. We start by taking the ratios Y_1/Y (= a), Y_2/Y (= b) and Y_3/Y (= c). If a ratio is high, a bank is relatively specialized. We then proceed by calculating $d = a^2+b^2+c^2$, which is bounded between 1/3 (not specialized) and 1 (specialized). We define 'high' [H] as referring to the upper 25th percentile, and 'low' [L] for the remainder of the observations.[5] Next, for the cost model we calculate the ratio $(TC_H - TC_L)/TC_L$ for Y_1, Y_2, Y_3, and Y.[6] Total costs (and total profit) are divided by total revenues to adjust for the possibility that banks in groups indicated by 'high' and 'low' may differ in size. By measuring scope economies for four size classes – resulting from a k-means cluster analysis – we control for some of the X-(in)efficiencies which may vary across size classes. If scope economies exist, the ratio is larger than 1.

As the left-hand side of Table 15.2 shows, cost scope economies are significantly positive across the board. Diversification pays off, as banks are able to spread the costs of their networks across their outputs. Scope economies are positive and significant for loans (Y_1) and investments (Y_2), but negative for off-balance sheet operations. These results may relate to what we found in the previous section: for off-balance sheet operations, size rather than product mix matters – at least on the cost side.

Profit scope economies

For the profit model we calculate the ratio $(PBT_L - PBT_H)/PBT_L$, which can be interpreted in the same way as cost scale economies: values higher than 1 signify positive scope economies. Profit scope economies are only significantly positive for off-balance sheet operations. For loans and investments, increasing specialization *ceteris paribus* will lower profits. Recall, however, from our discussion of scale economies, that increases in size are – when it comes to off-balance sheet operations – a risky business.

Combined cost and profit scope economies

Figure 15.3 combines cost and profit scope economies. Now, a positive slope line signifies a *positive* correlation.

Before we discuss the graph itself, note the following: we used the same four size classes for all countries. In addition, our Herfindahl–Hirschman indices for measuring specialization are of course the same for our profit and cost model. Combined, this explains why all countries are (almost) perfectly aligned in Figure 15.3. What it does not explain, however, is the unexpected negative slope of this line.

Figure 15.3 corroborates our scale economies results: cost and profit scope economies are negatively correlated. Importantly, whereas the bulk of the gains with respect to scale economies were on the profit side, the bulk of the gains that can be reached through scope economies are clearly on the cost side. Countries such as Sweden, that appear to benefit from significant cost scope economies, are not able to translate these cost scope economies into profit scope economies.

Table 15.2 Average scope economies 1996–2005

	Cost								Profit							
	Y		Y_1		Y_2		Y_3		Y		Y_1		Y_2		Y_3	
Country	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Argentina	1.15	0.04	1.13	0.09	1.02	0.15	0.69	0.04	0.82	0.05	0.84	0.12	0.95	0.15	1.23	0.02
Austria	1.13	0.01	1.06	0.02	1.16	0.04	0.72	0.03	0.85	0.01	0.93	0.02	0.81	0.05	1.22	0.02
Australia	1.15	0.04	1.14	0.08	0.99	0.13	0.70	0.04	0.82	0.06	0.83	0.12	0.99	0.13	1.23	0.03
Belgium	1.14	0.03	1.09	0.06	1.08	0.11	0.71	0.04	0.84	0.04	0.89	0.09	0.90	0.12	1.23	0.02
Brazil	1.14	0.03	1.09	0.07	1.09	0.12	0.71	0.04	0.84	0.04	0.89	0.09	0.89	0.13	1.23	0.02
Bulgaria	1.16	0.04	1.16	0.09	0.95	0.13	0.68	0.04	0.81	0.06	0.80	0.13	1.03	0.12	1.24	0.02
Canada	1.14	0.03	1.10	0.07	1.07	0.13	0.71	0.04	0.83	0.04	0.88	0.10	0.90	0.14	1.23	0.02
Chile	1.12	0.01	1.06	0.01	1.13	0.05	0.70	0.04	0.86	0.01	0.93	0.02	0.85	0.06	1.23	0.02
China People's Rep.	1.15	0.03	1.09	0.07	1.12	0.12	0.72	0.03	0.83	0.04	0.90	0.10	0.85	0.13	1.22	0.02
Croatia	1.17	0.04	1.18	0.09	0.93	0.14	0.68	0.04	0.79	0.06	0.76	0.13	1.05	0.14	1.24	0.02
Cyprus	1.16	0.04	1.15	0.09	0.98	0.15	0.70	0.04	0.81	0.06	0.81	0.13	0.99	0.15	1.23	0.02
Czech Republic	1.13	0.02	1.08	0.04	1.10	0.08	0.70	0.04	0.85	0.02	0.92	0.06	0.88	0.09	1.23	0.02
Denmark	1.17	0.04	1.17	0.09	0.94	0.13	0.69	0.04	0.80	0.06	0.78	0.13	1.04	0.13	1.24	0.02
Estonia	1.16	0.04	1.16	0.09	0.97	0.15	0.69	0.04	0.80	0.06	0.80	0.13	1.01	0.15	1.24	0.02
Finland	1.13	0.01	1.06	0.01	1.16	0.03	0.72	0.03	0.85	0.01	0.93	0.01	0.81	0.04	1.22	0.02
France	1.14	0.03	1.09	0.06	1.10	0.12	0.71	0.04	0.84	0.04	0.90	0.09	0.88	0.12	1.22	0.02
Germany	1.14	0.04	1.12	0.08	1.01	0.13	0.70	0.04	0.83	0.05	0.85	0.11	0.97	0.13	1.23	0.03
Greece	1.13	0.01	1.07	0.03	1.14	0.07	0.72	0.03	0.85	0.02	0.93	0.04	0.84	0.08	1.22	0.02
Hungary	1.13	0.03	1.09	0.06	1.07	0.11	0.71	0.04	0.84	0.04	0.89	0.09	0.92	0.12	1.22	0.02
Iceland	1.14	0.03	1.10	0.07	1.05	0.12	0.71	0.04	0.84	0.04	0.88	0.09	0.94	0.12	1.23	0.02
India	1.14	0.03	1.09	0.06	1.09	0.11	0.71	0.04	0.84	0.04	0.90	0.09	0.89	0.12	1.22	0.02
Indonesia	1.16	0.04	1.14	0.09	0.99	0.14	0.70	0.04	0.81	0.06	0.82	0.13	0.99	0.14	1.23	0.03
Ireland	1.13	0.01	1.06	0.00	1.17	0.02	0.73	0.02	0.84	0.01	0.94	0.00	0.80	0.02	1.21	0.01
Italy	1.17	0.04	1.17	0.09	0.96	0.15	0.69	0.04	0.80	0.06	0.79	0.13	1.02	0.14	1.24	0.02
Japan	1.13	0.01	1.07	0.03	1.11	0.07	0.70	0.04	0.86	0.02	0.92	0.04	0.87	0.08	1.23	0.02
Korea, Rep. of	1.14	0.00	1.06	0.00	1.17	0.00	0.74	0.00	0.84	0.00	0.94	0.00	0.79	0.00	1.21	0.00
Latvia	1.18	0.04	1.20	0.08	0.90	0.12	0.68	0.04	0.78	0.06	0.74	0.12	1.08	0.11	1.24	0.02
Lithuania	1.17	0.04	1.17	0.09	0.94	0.13	0.68	0.04	0.80	0.06	0.78	0.13	1.04	0.13	1.24	0.02
Luxembourg	1.14	0.03	1.09	0.06	1.08	0.12	0.71	0.04	0.84	0.04	0.89	0.09	0.90	0.12	1.22	0.02
Malta	1.15	0.03	1.12	0.08	1.04	0.15	0.72	0.04	0.82	0.05	0.85	0.12	0.93	0.16	1.22	0.02
Mexico	1.16	0.04	1.14	0.09	1.00	0.15	0.71	0.04	0.81	0.06	0.83	0.13	0.97	0.15	1.23	0.02
Netherlands	1.13	0.02	1.08	0.05	1.11	0.10	0.71	0.04	0.84	0.03	0.91	0.07	0.87	0.11	1.22	0.02
New Zealand	1.14	0.00	1.06	0.00	1.17	0.00	0.74	0.00	0.84	0.00	0.94	0.00	0.79	0.00	1.21	0.00
Norway	1.13	0.02	1.08	0.05	1.09	0.09	0.71	0.04	0.85	0.03	0.91	0.06	0.89	0.11	1.22	0.02
Poland	1.14	0.03	1.11	0.07	1.03	0.13	0.71	0.04	0.83	0.05	0.86	0.11	0.95	0.13	1.23	0.02
Portugal	1.13	0.02	1.07	0.04	1.14	0.08	0.71	0.03	0.84	0.03	0.92	0.06	0.83	0.08	1.22	0.02
Russian Federation	1.16	0.04	1.17	0.09	0.94	0.13	0.69	0.04	0.80	0.06	0.79	0.13	1.04	0.13	1.24	0.03
Slovakia	1.15	0.04	1.12	0.08	1.03	0.14	0.71	0.04	0.83	0.05	0.86	0.11	0.94	0.14	1.22	0.02
Slovenia	1.15	0.04	1.14	0.08	0.98	0.12	0.70	0.04	0.83	0.06	0.83	0.12	1.01	0.11	1.23	0.03
Spain	1.14	0.02	1.08	0.06	1.11	0.11	0.71	0.04	0.84	0.04	0.90	0.08	0.86	0.12	1.22	0.02
Sweden	1.17	0.04	1.18	0.09	0.93	0.14	0.69	0.04	0.79	0.06	0.76	0.13	1.05	0.14	1.24	0.02
Switzerland	1.17	0.04	1.17	0.09	0.94	0.13	0.69	0.04	0.80	0.06	0.78	0.13	1.04	0.13	1.24	0.02
Turkey	1.14	0.02	1.08	0.06	1.10	0.11	0.71	0.04	0.84	0.04	0.90	0.08	0.88	0.12	1.22	0.02
United Kingdom	1.14	0.03	1.09	0.07	1.09	0.13	0.71	0.04	0.83	0.04	0.89	0.10	0.88	0.13	1.22	0.02
U.S.	1.14	0.03	1.08	0.06	1.10	0.11	0.71	0.04	0.84	0.04	0.90	0.08	0.87	0.12	1.23	0.02

Note: there are no results for Romania, since data on Y_3 are absent.

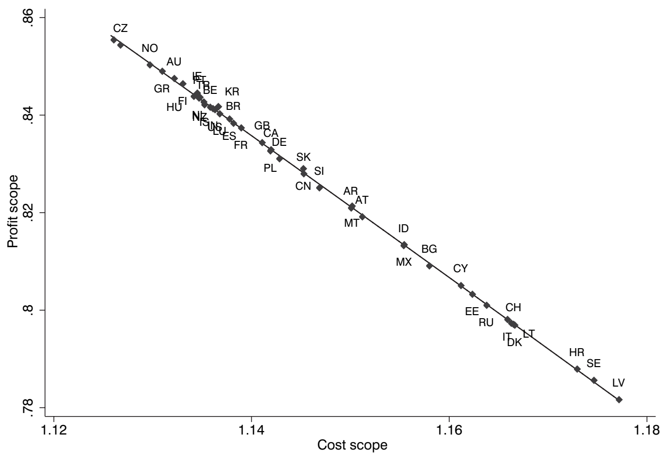

Figure 15.3 Average scope economies per country based on fixed-effects estimations

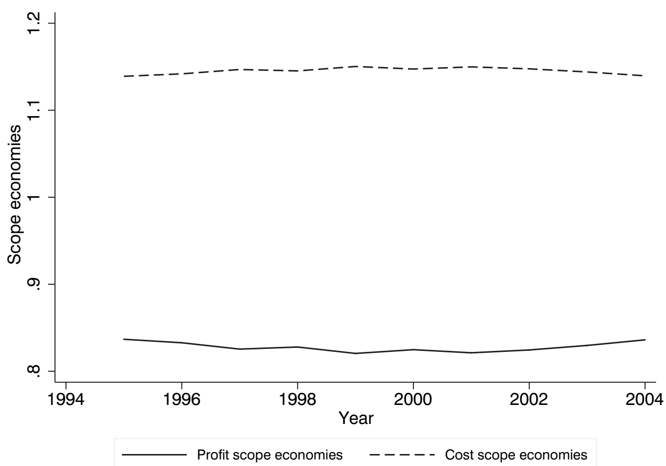

Figure 15.4 Development of scope economies over time

Turning to Figure 15.4, we observe that any development of scope economies over time is absent. Scope economies appear to be relatively constant, despite for example the disintermediation trend that has continued during our sample period. Of course, as we remarked at the beginning of the previous section, in a translog specification, output non-separability characterizes bank production. Put differently, we – in line with the rest of the literature – may not be able to perfectly separate scale and scope economies.

16 Synthesis: the measurement of competition and efficiency

This chapter provides an empirical synthesis on competition and efficiency over all thirty OECD countries during 1996–2006.[1] This synthesis is based on two sets of data: a number of simple but commonly used proxies of competition and efficiency, and the model-based measures of competition and efficiency as estimated in previous chapters.[2] Note that competition and efficiency, although describing different phenomena, are often seen as near synonyms, in the sense that heavy competition forces banks to improve efficiency. These measures are also linked to profitability (be it not unambiguously) in the sense that high competition tends to reduce profitability, whereas high efficiency may improve profitability. We investigate the qualities of the measures and their mutual relationships (or the relationships with competition and efficiency) by calculating mutual correlations.

Data on simple proxies and model-based measures of competition and efficiency

Both in the literature and in daily practice, a number of simple measures or proxies of competition and efficiency are often used. Well-known examples are the ratio of operating (non-interest rate) expenses to gross income (or cost–income ratio; in short C/I), the net interest rate margin ratio (NIM) and indices of concentration, such as the Herfindahl–Hirschman Index (HHI) or market share of the top 3, 5 or 10 banks (C_3, C_5 and C_{10}), based on a measure of banks' size such as total assets, total loans or total deposits. Other market structure variables that are regularly used as measure of competition are average market share or number of banks. Alternative measures for the cost–income ratio we also consider are total cost to total income ratio (TC/TI) and cost margin (CM). Finally, more general bank performance variables, such as return on equity (ROE) and return on assets (ROA), are incidentally also used as proxy for competition and efficiency. Table 16.1 provides an overview of a number of our simple proxies and their precise definitions and Table 16.2 presents the average figures of these proxies for the thirty OECD countries.

Table 16.2 presents two market structure variables: C_5 and MS. The full set of considered concentration indices and other market structure variables have

Table 16.1 Definitions of simple proxies of efficiency and competition

Abbreviation	Description	Full definition
C/I	Cost to income ratio	Operating expenses over net interest and non interest income
NIM	Net interest margin	Net interest income to total assets
TC/TI	Total cost to total income ratio	Interest and operating expenses over interest and non interest income
CM	Cost margin	Operating expenses to total assets
ROE	Return on equity	Net income after tax to average equity
ROA	Return on assets	Net income after tax to average total assets
C_5	Market share top 5 banks	Market share in terms of total assts of the largest five banks
MS	Average market share	Average market share in terms of total assts

been shown in Table 9.3. The interpretation of most measures in this table is quite clear. The net interest rate margin ratio, cost margins and the profit ratios, ROE and ROA, are expected to be smaller, the heavier competition is, so have negative relationships. Traditionally, the market structure variables are often seen as negatively related to competition: competition weakens, the stronger concentration is. Similarly, markets with many banks or low average market shares are expected to show heavier competition. However, recent studies have challenged these formerly established views (Claessens and Laeven, 2004; Bikker *et al.*, 2007).

The meaning of the cost–income ratio, however, is not unambiguous. A common interpretation of the ratio focuses on costs rather than profits and assumes that competition forces banks to push down their costs (reflecting high efficiency), whereas profits may be seen as accidental or determined by external factors.[3] A fall in cost–income ratio then reflects efficiency improvement or heavier competition. An alternative interpretation is to presume that heavy competition reduces the profit rate. Hence, in this view, a fall in cost–income ratio would reflect higher profits due to weakening competition.[4] Our empirical analyses will reveal which interpretation is most valid in practise. The same ambiguity applies to the total cost to total income ratio. Note that all (simple) measures are rough approximations at best. ROE, ROA and the net interest margin ratio, for instance, may be distorted by the composition of assets and liabilities, differences in the yield curve between the countries considered, the relative size of equity capital and book-keeping operations, which lengthen or shorten the balance sheet.

Table 16.3 shows a selection of the estimates of competition and efficiency presented in Chapters 11–14, based on, respectively, the Panzar–Rosse model, the Structure-Conduct-Performance (SCP) model, the Cournot model, and the profit and cost X-efficiency models. Chapter 15 also provides estimates on scale and scope economies, but we do not present these here, as they appear to be less strongly related, if at all, to competition (although a theoretical relationship might be expected as heavy competition is unlikely to leave large unused scale economies).[5] The SCP uses two alternative proxies of market concentration C_3 and HHI. Here, we show only the coefficients of C_3 in the respective SCP variant. All estimates are based on data from 1996–2005. Although in the previous chapters we presented results for 46 countries, in this synthesis on competition and efficiency,

Table 16.2 Simple proxies of efficiency and competition for OECD countries (1996–2005)

	C/I	NIM	TC/TI	CM	ROE	ROA	C_5	MS
Relation with competition	ambiguous	negative	ambiguous	negative	negative	negative	negative	negative
Australia	0.60	0.02	0.80	0.02	0.14	0.01	0.69	0.01
Austria	0.68	0.01	0.85	0.02	0.09	0.00	0.87	0.05
Belgium	0.65	0.01	0.91	0.01	0.13	0.00	0.81	0.02
Canada	0.68	0.02	0.82	0.03	0.14	0.01	0.84	0.03
Czech Republic	0.85	0.02	0.90	0.08	0.04	0.00	0.82	0.06
Denmark	0.57	0.02	0.78	0.02	0.14	0.01	0.87	0.01
Finland	0.64	0.02	0.79	0.02	0.18	0.01	0.98	0.14
France	0.66	0.01	0.89	0.01	0.09	0.00	0.50	0.00
Germany	0.67	0.01	0.87	0.01	0.05	0.00	0.45	0.00
Greece	0.60	0.02	0.79	0.02	0.15	0.01	0.86	0.08
Hungary	0.73	0.04	0.86	0.03	0.09	0.01	0.77	0.06
Iceland	0.59	0.03	0.79	0.03	0.14	0.01	0.97	0.17
Ireland	0.53	0.01	0.82	0.01	0.16	0.01	0.82	0.06
Italy	0.62	0.02	0.78	0.02	0.08	0.01	0.45	0.00
Japan	0.79	0.01	0.86	0.01	-0.06	0.00	0.39	0.00
Korea, South	0.83	0.02	0.86	0.02	-0.10	0.00	0.57	0.06
Luxembourg	0.46	0.01	0.90	0.01	0.14	0.00	0.38	0.01
Mexico	0.66	0.05	0.86	0.05	0.08	0.01	0.80	0.05
Netherlands	0.69	0.01	0.88	0.02	0.13	0.00	0.92	0.04
New Zealand	0.52	0.02	0.79	0.02	0.22	0.01	0.96	0.20
Norway	0.63	0.02	0.83	0.02	0.13	0.01	0.75	0.03
Poland	0.62	0.04	0.80	0.04	0.15	0.01	0.65	0.04
Portugal	0.61	0.02	0.83	0.02	0.08	0.01	0.79	0.05
Spain	0.58	0.02	0.77	0.02	0.11	0.01	0.90	0.12
Sweden	0.66	0.01	0.84	0.02	0.14	0.01	0.62	0.01
Switzerland	0.61	0.01	0.79	0.02	0.12	0.01	0.97	0.03
Slovak Republic	0.81	0.04	0.85	0.05	0.10	0.01	0.88	0.01
Turkey	0.60	0.07	0.86	0.04	0.07	0.00	0.79	0.08
United Kingdom	0.58	0.02	0.78	0.02	0.18	0.01	0.66	0.01
U.S.	0.60	0.03	0.72	0.03	0.14	0.01	0.29	0.00
Averages	0.64	0.02	0.83	0.02	0.11	0.01	0.73	0.05

Sources: First six simple proxies for 1996–2003, OECD (2000, 2002, 2004). Figures for 2004 and 2005 are based on own calculations using BankScope (Fitch-IBCA) figures. Data of the Slovak Republic refer to 1998–2005. Last two simple proxies based on BankScope (Fitch-IBCA).

we restrict ourselves to the thirty OECD countries, as the only reliable data we have on our simple proxies come from OECD sources.

The interpretation of most measures in Table 16.3 is quite clear. While Panzar and Rosse's H-value is a measure of competition itself, the coefficients in the SCP and Cournot models reflect the impact of a market power related markup on prices, so that these coefficients show a negative relationship with competition. As heavy competition forces banks to improve cost efficiency, the latter measure is expected to correlate with competition. Profit efficiency has an ambiguous interpretation that is similar to that of the cost–income ratio: high profit efficiency may reflect high cost efficiency due to heavy competition, but it may also represent the efficient use of market power, which is most successful where competition is weak.

Interdependencies among measures of competition and efficiency

This section investigates the properties of the various simple proxies and model-based measures of efficiency and competition by calculating mutual correlations, using average data from thirty OECD countries over 1996–2005 and

Table 16.3 Model-based estimates of efficiency and competition for OECD countries (1996–2005)

Country	Panzar Rosse	SCP (HHI)	Cournot	*PE*	*CE*	Average ranking
Relation with competition	positive	negative	negative	ambiguous	positive	
Australia	0.27	-1.30	-0.01	0.51	0.84	13.30
Austria	0.26	0.04	0.35	0.53	0.79	18.30
Belgium	0.49	0.04	-0.13	0.48	0.79	12.20
Canada	0.23	-0.21	-0.05	0.50	0.82	16.60
Czech Republic	1.20	-0.49	0.02	0.49	0.79	14.30
Denmark	0.33	0.02	0.11	0.54	0.86	15.70
Finland	-0.49	-0.05	0.01	0.52	0.83	20.90
France	0.73	-0.65	-0.21	0.51	0.83	6.00
Germany	0.86	-0.40	-0.01	0.53	0.86	5.60
Greece	0.58	0.10	0.04	0.44	0.81	20.50
Hungary	0.42	0.12	-0.01	0.47	0.78	19.50
Iceland	1.52	-0.08	0.22	0.49	0.87	18.70
Ireland	0.95	-0.20	0.11	0.52	0.79	16.70
Italy	0.43	3.19	-0.19	0.54	0.85	12.60
Japan	0.53	-2.38	-1.74	0.52	0.85	4.00
Korea, Rep. of	0.96	0.43	0.14	0.35	0.79	13.60
Luxembourg	0.31	2.06	-0.15	0.49	0.80	12.20
Mexico	1.06	0.04	0.14	0.48	0.80	18.00
Netherlands	1.08	0.15	0.04	0.52	0.80	15.40
New Zealand	0.18	0.11	0.04	0.54	0.86	21.70
Norway	0.66	0.03	0.00	0.55	0.84	14.80
Poland	0.09	0.11	0.09	0.49	0.81	21.80
Portugal	-0.16	0.51	0.33	0.51	0.74	19.30
Slovakia	0.24	-0.04	0.06	0.48	0.78	23.60
Spain	0.56	0.12	0.09	0.54	0.84	15.10
Sweden	0.47	-0.28	-0.15	0.54	0.84	13.50
Switzerland	0.81	0.13	-0.05	0.53	0.83	12.10
Turkey	0.69	0.15	0.08	0.48	0.80	18.00
United Kingdom	0.58	-0.18	0.43	0.50	0.79	16.30
U.S.	0.43	-0.33	-0.20	0.55	0.81	14.50
Averages	0.59	-1.30	-0.02	0.50	0.82	

Sources: Chapters 11–14 of this book.

estimates of these countries based on the same sample period. First, this provides an overview of the mutual interdependencies among these measures. The theoretical part of this book explains how different model assumptions lead to divergent model-based measures, all reflecting some of the diverse aspects of competition and efficiency and neglecting others. Similarly, the various simple proxies represent different facets of bank performance and behaviour. The correlations reveal how similar or divergent the various measures are. Second, correlations may help to identify the nature of the measures with ambiguous interpretation. Where an unambiguous theoretical interpretation is lacking, the empirical result may provide some guidance. To make the interpretation more clear, we focus on the relationship of the measures with competition (which may differ from their relationship with efficiency). We will keep this focus in the remainder of this chapter. Third, this approach helps in developing a better measure of competition, which allows the measures to be ranked according to their correlation with competition.

Tables 16.4 and 16.5 give the mutual correlations of the measures. Bold numbers indicate that a negative correlation is expected, given the interpretation (or definition) of the measures, that is, a correlation between a measure that is positively related with competition and a measure that is negatively related with competition. Elsewhere we expect positive correlations: either correlations between two measures that are both positively related to competition, or correlations between two measures that are both negatively connected to competition. Asterisks reflect the level of significance, based on asymptotical standard deviations. Generally, high and significant correlations between these measures confirm that the respective measures provide rather similar results over the countries considered. Table 16.4 presents correlations among measures with a clear interpretation, whereas Table 16.5 shows correlation with and among measures with an ambiguous interpretation. In order to be able to show the results conveniently arranged, we present the measures with ambiguous interpretation as (predominantly) negative, if they correlate more often negatively with competition-related measures, and as (mainly) positive elsewhere. Further, we reduce the (original) tables, also to enhance surveyability, by deleting measures that strongly resemble other measures: we drop the SCP results based on C_3 and keep the SCP results based on *HHI* (these two approaches provide highly correlated results); we omit the concentration indices C_3, C_{10} and *HHI* (which are all highly correlated with C_5) and keep C_5; and we leave out the estimates of scope economies, because we consider them less suitable as measures of competition (as is confirmed by the – not shown – correlation outcomes).

The tables make clear that the correlations among the measures are not always high (in absolute terms) nor always significantly different from zero.[6] This indicates that the measures indeed reflect divergent (only partial overlapping) aspects of competition. This holds a warning against applying one single approach only in measuring competition, as such measure would neglect the plentiful facets of competition. On the other hand, Table 16.4 reveals that the signs of the significant correlations are always in line with our expectations, whereas signs of the non-significant correlations are in most cases also in accordance with theory. This confirms the interpretation of the variables, expressed in the first row of the table ('relationship with competition'): almost all measures appear at least to reflect a certain aspect of competition. Table 16.5 shows that the signs of the significant correlations among or with the ambiguous measures are often in line with our expectations too, but we also find three serious exceptions, underlining their ambiguity. Whereas profit efficiency tends to be negatively correlated with competition (as it represents the ability to exploit market power), it is, by contrast, positively correlated with cost efficiency, as low costs help to increase profits.[7] Another example of ambiguity is the C/I ratio which is generally positively correlated with competition, but also with cost margin, which is negatively related to competition.

A balanced score-card approach to measuring competition

This section develops a score-card approach that aims at a better measurement of competition than is possible with single proxies or measures. For each measure in Tables 16.4 and 16.5 we calculate countries' rankings such that highest

Table 16.4 Correlation among model-based measures and simple proxies of efficiency and competition (OECD countries; 1996-2005), part 1

P-R	SCP	Cournot	CE	NIM	CM	ROE	ROA	N	MS	C_5	
pos	neg	neg	pos	neg	neg	neg	neg	pos	neg	neg	Relationship with competition
1.00	**-0.11**	**0.02**	0.14	**0.05**	**0.22**	**-0.31**	**-0.36** *	0.11	**-0.03**	**-0.01**	Panzar Rosse (H)
	1.00	0.34 *	**-0.06**	0.06	-0.06	0.21	0.14	**-0.06**	0.01	-0.09	SCP (HHI)
		1.00	**0.08**	0.18	0.18	0.42 **	0.38 **	**-0.30**	0.24	0.42 ***	Cournot
			1.00	**-0.20**	**-0.26**	**0.14**	**0.09**	0.35 *	**0.08**	**-0.03**	Cost efficiency
				1.00	0.63 ***	-0.06	0.32 *	**-0.18**	0.32 *	0.12	NIM
					1.00	-0.11	0.18	**-0.20**	0.26	0.21	CM
						1.00	0.81 ***	**-0.27**	0.27	0.43 **	ROE
							1.00	**-0.29**	0.40 **	0.40 **	ROA
								1.00	**-0.41** **	**-0.60** ***	N
									1.00	0.61 ***	MS

Note: Panzar–Rosse (P-R) H value; SCP based on HHI; N= Number of banks, *, ** and *** indicate an (asymptotic) level of confidence of 90 percent, 95 percent and 99 percent, respectively. Bold numbers indicate where we expect a negative correlation, that is, a correlation between a measure that is positively related with competition and a measures that is negatively related with competition. Elsewhere we expect positive correlations.

Table 16.5 Correlation among model-based measures and simple proxies of efficiency and competition (OECD countries; 1996–2005), part 2

PE	Scale profit	Scale cost	C/I	TC/TI	Average ranking	
amb/neg	amb/neg	amb/neg	amb/pos	amb/pos	pos	Relationship with competition
-0.22	**-0.02**	**-0.20**	0.20	0.25	0.30 *	Panzar Rosse (H)
-0.07	0.02	-0.30	**-0.39** **	**-0.12**	**-0.23**	SCP (HHI)
-0.14	0.55 ***	0.12	**-0.28**	**-0.17**	**-0.57** ***	Cournot
0.45 **	**0.03**	**0.10**	-0.24	*-0.38* **	0.29 *	Cost efficiency
-0.23	0.08	-0.14	**0.12**	**-0.10**	**-0.53** ***	NIM
-0.20	-0.07	-0.27	***0.46*** **	**0.10**	**-0.39** **	CM
0.49 ***	0.38 **	0.12	**-0.71** ***	**-0.44** **	**-0.49** ***	ROE
0.35 *	0.33 *	0.09	**-0.48** ***	**-0.61** ***	**-0.73** ***	ROA
0.30	**-0.21**	**-0.10**	0.06	-0.01	0.63 ***	N
-0.20	0.30	0.30	**-0.04**	**-0.13**	**-0.65** ***	MS
-0.03	0.33 *	0.14	**0.00**	**-0.04**	**-0.62** ***	C_5
1.00	0.19	0.14	**-0.41** **	**-0.35** *	***0.18***	Profit efficiency
	1.00	0.78 ***	**-0.31**	**-0.31**	**-0.34** *	Scale profit
		1.00	**-0.11**	**-0.32** *	**-0.11**	Scale cost
			1.00	0.43 **	0.18	C/I
				1.00	0.37 **	TC/TI

Note: For explanation, see Table 16.4; numbers in italics refer to significant correlations (or to a correlation with the average rank) with an unexpected sign.

rankings (numbers 1, 2 and 3) refer to the most competitive countries. The last column of Table 16.3 gives an average over ten unambiguous measures, selected so as to minimize overlap, that is, one of each pair of similar measures has been deleted. This average aims to represent the information with respect to competition contained in the respective measures. The last column of Table 16.5 shows the correlations between the measures considered and this average ranking. Remarkably, almost all unambiguous measures correlate significantly with the average ranking, while eight of the eleven variables do so even at the 99 percent level of confidence (be it in most cases negatively, that is, the relationship is inversed): Cournot model, NIM, CM, ROE, ROA, number of banks, MS and C_5. Apparently, a common notion of competition exists that can be found in many measures. Many ambiguous measures, however, appear to be uncorrelated with the average ranking.

One approach to interpreting the 'average ranking' results is to compare them to the *communis opinio*, or the so-called expert view, on the ranking of countries in terms of performance and efficiency. Generally, banks in France, Germany, and, especially, Mediterranean countries, such as Italy and Spain, are expected to be less efficient, on average, than banks in the other Western European countries. Underlying causes might be stricter regulation by the supervisory authorities, interference by local government in the German Länder reducing competition, financial conservatism, a low level of consolidation, and an extended network of branches (all referring to Germany), strong direct government interference (France and Italy) and lagging economic development (Greece, Spain, and Portugal). Similarly, less banking competition and efficiency is expected in Central and Eastern European countries, also given their limited experience with market economics. Banks in Anglo-Saxon countries are often believed to be exposed to stronger competition.

For some countries, this expert view is fully or partly in line with the average ranking results of Table 16.3. Indeed many Central and Eastern European countries rank low in terms of competition, and this also holds for a number of Southern European countries. On the other hand, France, Germany and Italy rank high, whereas Anglo-Saxon countries take an intermediate position, except Australia, contrary to the expert view. Japan ranks on top owing to relatively low profit margins, a weak relationship, if any, between profitability and market share or concentration, the existence of many banks and (hence) low concentration. However, many of these characteristics stem from the Japanese financial crisis during the sample period and do not reflect competitive pressure (see also Van Leuvensteijn *et al.*, 2007). Number two on the list is Germany, where the situation is somewhat comparable to Japan: many banks, (hence) low concentration, and low profits, the latter due also to the weak performance of many German banks during part of the sample period. These countries and France (number 3), also have very low cost levels and (hence) high efficiency levels. For some countries, particularly Luxembourg and Switzerland, the results reflect the special position of the banking industry and its added advantages of bank secrecy and tax benefits. Further, Luxembourg has many subsidiaries of foreign banks where cost levels seem to be low, as the costs are (partly) borne by the mother company. For these countries low cost levels and low concentration contribute to their high ranking, whereas they score less well on cost X-efficiency and competition (Panzar–Rosse's H-statistic), except Switzerland. Banks in Anglo-Saxon countries have high profits and net interest margins in common – generally not indicators of strong competition. Nor do their H-statistics point to competitive markets. On the other hand, banks in these countries have low cost levels, with an intermediate position as the net result. For some countries, for example Finland, Iceland and New Zealand, the small number of banks makes outcomes less reliable.

Although many results are plausible, not all of them tally with commonly held expert views on country ranking with respect to competition – which, by the way, may not be accurate. It is also clear that special circumstances may affect the use of our measures. Interpretations should therefore be made with great caution and with due respect to exceptional conditions.

Part V
Conclusions

17 Summing up

This book derives nine approaches to measuring competition and efficiency from a single theoretical profit-maximizing framework, assuming that these models share the same features as our baseline model. The major conclusion is that all models focus on a single variable instead of a set of variables as theory prescribes. For this reason, all models may suffer from identification problems in the sense that they pick up market power when estimating efficiency and vice versa. Also contributing to this problem is the measurement of input and output prices in banking. These problems may explain why the various approaches result in such diverging outcomes. The banking landscape has changed considerably over the last decade. First, demand is affected by foreign competition and competition from non-bank financial firms. This calls into question the underlying assumption that the price elasticity of demand faced by all firms is the same and constant over time. Second, banks have reacted to changes in regulation and production technology. They have branched out into new products and behave less like the traditional intermediaries we model them after. Reaction curves may have shifted considerably, both on the market level and for individual banks. Although competition has intensified internationally, some banks may occupy dominant positions within national borders that allow them to react differently than their smaller competitors. Some of the models we reviewed are theoretically unable to cope with these changes, as they have traditionally assumed that all banks react similarly to each other. Third, the markets banks operate in have also changed as, for example, concentration has gone up, which may weaken competition. But foreign competition has intensified, so that it is uncertain what, on balance, the effect on individual banks has been. Most approaches ignore the fact that banks produce various products and operate in various markets, where competitive positions may differ per product or market. An exception is the Bresnahan model, which considers competition in one submarket (e.g. loans, deposits). Approaches based on bank observations (Iwata, Panzar–Rosse) can circumvent this problem distinguishing various bank-size classes linked to different markets, e.g. small banks on local or retail markets and large banks on international or wholesale markets (Bikker and Haaf, 2002a). Where ample observations are available, gradual effects on competition of the trends over time should be incorporated by using time (or trend) dependent coefficients (Bikker and Haaf, 2002a). Structural changes in banking markets and the lack of reliability of the data (particularly interest rates for credit loans and deposits) reduce the reliability of the estimates of the Bresnahan approach. One notable problem for the efficiency models discussed here is the fact that their outcomes are very difficult to validate. There is no sound theory providing the correct distribution of the efficiency term, and we know little about the economic validity of the efficiency scores. Particularly with increasing internationalization, contestability and foreign competition, it is hazardous to transpose best practices in one country or market to another. All in all, we expect that the observed trends have similar consequences for most banks: increases in competition result in lower profit margins, higher cost efficiency and lower profit efficiency. In absolute levels, we also expect cost reductions. The dynamics of the consolidation process, however, may have increased the volatility of earnings.

Although we have emphasized the many different ways of looking at competition and profitability, most empirical performance measures reviewed here tell a fairly similar story, with two important exceptions. First, the cost–income ratio is not correlated with other measures: competitive conditions affect revenues more strongly. In addition, relative performance as measured by cost X-efficiency does correlate with most other performance measures, and has shown a marked decrease over time. Savings and co-operative banks are relatively efficient. These plain banks tend to perform the traditional intermediary role that is assumed in most of the models reviewed here. With increasing disintermediation, the question arises as to how to interpret this result. Second, X-efficiency estimates indicate that competition has increased over the last decade (Bikker, 2002). Other evidence based on both the Boone indicator and the Panzar–Rosse model points to weakened competition over time (Van Leuvensteijn *et al.*, 2007; Bikker and Spierdijk, 2008). Further, returns (ROA and ROE) have increased, and concentration has gone up. Apparently, increased efficiency has not been forced by increased competition.

Country comparisons reveal marked differences between countries. Therefore, controlling for country-specific circumstances remains crucial in comparative studies, such as the metafrontier technique, applied to European countries. Although markets may have become more contestable and foreign competition may have intensified, performance – both absolutely and relatively – is not easily exported across borders, due to these differences in national competitive conditions. Relative performance, as measured by X-efficiency, can shed some light on these differences. The comparison of cost and profit X-efficiency reveals that there is no clear correlation between the two measures. Hence, estimating both types of efficiency may be useful as an indirect measure of market power.

18 Research agenda

At this point, we may draw up a future research agenda. Our first recommendation concerns the use of data. Although we are aware of the difficulty of finding good (proxies for) output prices, this book has once again emphasized the need for output prices in an analysis of bank competition and profitability. Without output prices, we are unable to calculate banks' mark up on costs or to derive the reaction functions to their competitors. As a result we know very little about the differences between banks in a single market. The increase in concentration in all markets reviewed here makes this an important concern. A change in the definition of the production process of banks would also be welcome. We need to rethink the traditional intermediation approach and focus more on other types of income. Our choice of variables in all models described here is mostly determined by banks' balance sheets. An increasing part of the action in today's banking markets, however, takes place off the balance sheet. Including off-balance sheet items in the intermediation approach therefore is a first step towards a more balanced view of bank production. Our second recommendation regards the theoretical foundation of the models employed to measure market power and efficiency. As we have shown, models focusing on a single variable may suffer from identification problems. In particular, we emphasize the distinction between market power and efficiency, for example using the efficiency hypothesis test in Chapter 6 or through a comparison of cost and profit efficiency. In addition, the fact that we observe such strong trends in banking calls for time-dependent models. In particular, we stress the need for making both the price-elasticity of demand η_D and conjectural variation λ time-dependent. Our third recommendation concerns the market under examination. For reduced-form market structure models such as the SCP model, we advocate their application to a wider range of specific submarkets. (Sub)markets that are not very contestable and have experienced less internationalization (e.g. deposits or mortgages) lend themselves particularly well to this type of analysis. For non-structural models such as Iwata, Panzar–Rosse and Bresnahan we suggest estimating a different H or λ for different size classes and submarkets.

As a final remark, we observe that all models introduced here are highly complementary. For example, whereas some lend themselves better to assess the impact of distintermediation, others are more suitable for analyzing the consequences of internationalization. By using several complementary models we can overcome the identification problems that arise when we limit ourselves to applying a single model to analyze bank competition and profitability.

Appendix 1

Guide for instructors

In this appendix, we give an example of how this book can be integrated in a (third year) undergraduate or graduate banking course. The example we give is based on the course entitled 'Regulatory Policy in Financial Markets and Banking', taught at Utrecht School of Economics, the Netherlands, since 2005.

Although the course is part of a graduate program on Economics and Law, we have also used elements in undergraduate teaching and in (guest) lectures in other courses and at other schools. The course is a mixture of theory and empirics, as is this book. Students are required to use Stata. Part of the student population was familiar with this software package, another part attended a short introduction.

A crucial part of the course is an applied paper that students write individually. In terms of style and length, students have to meet the requirements set by Economics Letters (www.elsevier.com/locate/ecolet). All students receive the same data set and have to estimate the same basic specification. In addition, each student studies a different subsample (= local market) and is expected to extend the basic specification.

In this appendix, we first introduce the course. Then we discuss the general format of the course. Next, we give an example course itinerary, followed by an example exam and exam key. Finally, we show the paper assignment that is a crucial part of the course.

Introduction

In the course, we develop a theory of financial intermediation that allows us to explain the role of banks in the economy, highlight structural weaknesses of the financial sector and justify and interpret regulatory policy. We will study reasons for the existence of financial intermediaries, including transaction costs, liquidity insurance and search costs. Building on this knowledge we will study theoretical models of competition in the banking sector and risk management. From there, we will go on to study the choice of a regulatory framework, the role of a central bank and moral hazard in deposit insurance. We will finish the theoretical part of the course with an overview of recent developments in banking regulation (Basel II) and other financial regulation (e.g. Solvency II and the Dutch Financial Regulatory Framework for, respectively, insurance firms and pension funds).

In the second half of the course, we will use a sample data set to empirically test competitive behavior in banking. We start with simple concentration measures, and measure transaction costs (economies of scale). Then we compare price and non-price competition models. We build several reduced-form competition models and estimate them with our sample data. In addition, we review existing empirical evidence, such as spatial competition models.

Position in the curriculum

This is the first course in an Economics and Law program. It aims to bridge the gap between a theoretical and an empirical approach to regulatory policy in financial markets and banking. It approaches regulatory policy as a reaction to market failure. Good knowledge of microeconomics is assumed as well as basic knowledge of finance. The course requires a basic level of calculus and statistics (regression analysis). In the course, we will use a combination of competition theory (first half) and empirics (second half).

Learning goals

At the end of the course the student is able to:

- apply the concepts of the role of transaction costs, liquidity insurance, moral hazard and adverse selection to financial markets and banking;
- formally establish the link between (competition) theory and empirical tests;
- explain the justification for, impact of and limitations of financial regulation;
- measure and interpret the relationship between the production of the banking firm, the level and type of competition on banking markets, and the stability and regulation of the financial system;
- explain policy implications of firm behavior on the basis of theoretical and empirical evidence;
- interpret firm behavior by selecting the appropriate tools from a coherent analytical framework;
- understand and critically evaluate current advancements in the literature;
- carry out independent empirical research with a solid theoretical foundation;
- solve problems.

General format

The course consists of twice-weekly meetings for the discussion of papers, capita selecta and exercises.

Lectures

Weekly lectures serve several goals. First, they aim to create a synthesis between the book chapters, the articles, and the empirical exercises. Second, they serve to deepen the analyses presented in the mandatory literature. Students are expected to have read and studied the relevant literature in advance. Lecture slides will be made available through the the intranet and – if possible – before the lectures. Lecture notes are thus also part of the compulsory material for the written exam. Attendance at the lectures is voluntary. Three hours per lecture have been scheduled.

Tutorials

In the weekly tutorial groups, we cover parts of the mandatory literature. Students are required to participate actively and should take turns in introducing a subject. The coordinator will lead these meetings, but students are expected to prepare for them with the help of the information in the course manual and additional information given during the lectures.

Paper assignment

The paper assignment focuses on the academic skill of the 'Ability to carry out independent empirical research with a solid theoretical foundation'. The objective of the paper is to analyze the degree and type of competition in a banking market. For this purpose, students are expected to use a data set provided by the course coordinator to: (i) measure market concentration; (ii) estimate the level of competition in a market; (iii) interpret the results; and (iv) give a policy advice. Each student is assigned to one of the models studied at this point in the course, and is expected to write an empirical paper using this particular model.

Students are expected to (a) define an interesting problem statement; (b) go beyond the standard theory; and (c) relate their empirical results to a set of policy recommendations. In week 3 of the course, a tutorial will be given by the course coordinator on the data set to be used, the Stata programs distributed in the course and the general outline of the paper.

Assessment method

- Student performance is tested by means of an open book final exam (60 percent of the final grade) as well as by his/her performance on a paper assignment (40 percent of the final grade).
- Performance with respect to the paper depends on the choice of problem statement, the information collection, level of the empirical analysis, independence of working method; general level of the discussion and the policy recommendations.
- The final, written exam consists of a number of essay questions. It is an open book exam, based on the mandatory literature and the lecture notes. All written material can be brought to the exam.

Course itinerary

The course spans nine weeks. Here is an example of what the course itinerary looks like:

Week 1: Introduction

Lecture 1: General introduction / What is a bank?

Literature:

- Course manual (i.e. this appendix).
- Chapter 1 of Freixas and Rochet (1997).

Tutorial 1: Why do financial intermediaries exist?

Literature:

- Chapter 2 of Freixas and Rochet (1997).

Week 2: Asymmetric information

Lecture 2: Transformation

Literature:

- Boot and Thakor (1997).

Tutorial 2: Costly monitoring and credit rationing

Literature:

- Yan (1996).

Week 3: Competition theory and practice

Lecture 3: Competition models

Literature:

- This book.
- Bos (2004).

Tutorial 3: Stata, data and market structure

Literature:

- This book.
- Bikker and Haaf (2002a).
- Bikker and Haaf (2002b).

- Handout (Introduction to Stata).

Week 4: Regulatory incentives

Lecture 4: Investors' incentive schemes

Why regulate banks?

Literature:

- Chapter 6 of Dewatripoint and Tirole (1994).
- Bhattacharya *et al.* (1998).

Tutorial 4: Investors' incentive schemes

Literature:

- Chapters 7 and 8 of Dewatripoint and Tirole (1994).

Week 5: Regulatory theory

Lecture 5: Economics of banking regulation

Literature:

- Bhattacharya and Thakor (1993).

Tutorial 5: Market information

Literature:

- Gai and Shin (2003).
- Gropp *et al.* (2006).
- Basel Committee on Banking Supervision (BCBS, 2006).

Week 6: Regulatory practice

Lecture 6: Deposit insurance

Literature:

- Flood (1992).
- Gilbert (1990).
- Santomero (1997).

Tutorial 6: Relationships and lending

Literature:

- Cetorelli and Strahan (2004).
- Cole *et al.* (2004).

Week 7: Paper assignment

Lecture 7: Progress meeting

Tutorial 7: Mergers

Literature:

- Berger *et al.* (1999).
- Jones and Critchfield (2004).

Week 8: Capital selecta

Lecture 8: Alternative ways to study competition

Literature:

- Chapter 8 of Allen and Gale (2003).

Tutorial 8: Monti Klein and Salop

Literature:

- Chapter 3 of Freixas and Rochet (1997).
- Chiappori *et al.* (1995).
- Dvořák (2005).

Week 9

Examination

Literature:

All of the course literature.

Remarks:

Open book exam with essay questions.

Specimen exam

The exam consists of four essay questions, and takes three hours to complete. It is an open book exam, where students are allowed to use all course materials, as well as a calculator.

Question 1: Regulation and accounting

Reading a bank balance sheet is a complex task. Constructing a bank balance sheet is probably even more complex. On the asset side, consider a bank with a large commercial loan portfolio with loans that differ with respect to maturity, origination, probability of default, loss given default and exposure at default.

Dewatripoint and Tirole (1994, part of the course literature) discuss the relative merits of market value accounting and book value accounting (in Chapter 6).

Suppose that you are a bank supervisor, and all banks in your banking system switch from book value accounting to market value accounting.

[a] In your own words explain your concerns regarding this move.

Bikker and Bos (2005, part of the course literature) describe a general model of a profit maximizing bank and on the basis of this model discuss various ways to explain bank performance. They also discuss empirical applications of the various (market power) models introduced.

Suppose you wanted to estimate the Structure–Conduct–Performance model and the Panzar–Rosse model for the banking system described above.

[b] Would you change your empirical specification after the shift from book value accounting to market value accounting, and why (or why not)? And if so, how?

Dewatripoint and Tirole (1994, part of the course literature) discuss the cases in which $r \geq r^{\min}$ and $r < r^{\min}$, respectively (where r is the solvency ratio). Typically, we have some uncertainty regarding the exact value of $r^{\min}$.

[c] In your own words explain why it matters if we can lower the uncertainty regarding $r^{\min}$.

Suppose we replace all (regular) debt in the model of Dewatripoint and Tirole with subordinated debt.

[d] Show and explain how Figures 8.1 and 8.2 in Dewatripont and Tirole (1994) will change (note: if you do not have those graphs with you, please notify the exam supervisor who will give you a copy).

Question 2: Basel II

The Basel II framework is supposed to leave average capital ratios unaffected. But some fear it may make these capital ratios more cyclical.

[a] In your own words explain why capital ratios may become more cyclical.

An article in a recent issue of *Banking Review* argued that new credit risk models now allow banks to estimate expected losses on their mortgage loans far more accurately than before. Bhattacharya and Thakor (1993, part of the course literature) review the contemporary theory of financial intermediation. As part of their review, they compare an economy without intermediaries with an economy with diversified intermediaries.

[b] How does this comparison change if banks improve their expected loss estimations as in the above example?

Bhattacharya and Thakor also discuss credit rationing. Suppose you are a supervisor, solely interested in financial stability.

[c] In the interest of enhancing financial stability, why are you concerned about credit rationing?

Various articles discussed in the course mention capital requirements. Under the current Basel I regime, capital requirements have both positive and negative effects on credit allocation.

[d] In your own words give two examples for and against the use of regulatory capital requirements.

Question 3: Deposit insurance

One of the things that sets the regulation of banks apart from the regulation of other industries is the existence of deposit insurance. Bhatthacharya *et al.* (1998, part of the course literature) argue that the ability of supervisors to assess a bank's risk-taking is crucial when deciding about optimal deposit insurance and – perhaps – complementing deposit insurance with additional policies.

[a] In your own words explain what the consequences for optimal deposit insurance are in the case a supervisor would be perfectly able to accurately observe a bank's true risk-taking.

In the basic model of Dewatripoint and Tirole (1994, part of the course literature) there is no capital requirement. What if there were? Let us say that the capital requirement results in an r^{cap}.

[b] Discuss the cases in which $r^{cap} > r^{\min}$ and $r^{cap} < r^{\min}$, respectively. In your discussion focus on the position of shareholders. How are they affected by the capital requirement?

Deposit insurance and capital requirements are both tools regulators used by regulators to maximize welfare and ensure the stability of the financial system. An alternative is the issuance of uninsured subordinated debt. This alternative is discusse by Gilbert (1990, part of the course literature). Using a fairly simple model, Gilbert finds when comparing the case of basic deposit co-insurance (case C) with the case of uninsured subordinated debt (case D) that in the former case (i) expected profits are higher, (ii) the expected loss to the FDIC is higher, and (iii) the market interest rate on bank liabilities is lower.

[c] In your own words explain these findings.

Berger *et al.* (1999, part of the course literature) mention dozens of reasons why banks merge.

[d] Discuss two reasons mentioned by Berger *et al.* that increase expected losses to the FDIC, explaining why this is the case.

Question 4: Essay question

In this course, you estimated the level of competition in the Texas banking market. A crucial issue when you were putting together your empirical specification is the fact that you had an important omitted variable, named λ_i in this book and in Bos (2004), both part of the course literature.

Suppose you were given an exact measure of λ_i.

Write a short essay on how you would change your paper. In particular, pay attention to the following aspects:

- The empirical specification that you would estimate.
- The hypothesis/hypotheses that you would test.
- What type(s) of competition you could now distinguish and test for.
- The advantages for a supervisor of receiving the new version of your paper (compared to the version you handed in during the course).

In your answer, you have to show that you understand the importance of conjectural variation, and can explain clearly what type of bias its absence causes in standard competition models. You can earn extra points for coming up with a creative way of including λ_i in your empirical specification.

Note: be specific and precise. Write out specifications, tests, etc.

Short answer key to specimen exam

Question 1: Regulation and accounting

[a] In your own words explain your concerns regarding this move.

With market value accounting, capital ratios become more cyclical and shocks affect the system much more directly. Control can shift from debtholders to equity holders without a proper alignment of incentives.

[b] Would you change your empirical specification after the shift from book value accounting to market value accounting, and why (or why not)? And if so, how?

The crucial question here is what happens to Y, the outputs. Under market value accounting, loans are affected in particular. For the SCP model, things may change if banks gain a large market share by taking more risk. In that case, ceteris paribus Y is lower under market value accounting, since banks will have higher expected losses. Thus, C_3 ratios for example will drop, and you will find that you have underestimated the degree of market power. On the other hand, if banks enjoy the quiet life (cf. the Quiet Life Hypothesis), then large banks will face lower risk, and the opposite will happen. Under the P–R model, the same basic argument holds.

[c] In your own words explain why it matters if we can lower the uncertainty regarding $r^{\min}$.

The Dewatripoint and Tirole model is attractive, but difficult to interpret around $r^{\min}$. More precisely, when $r = r^{\min}$, it is not clear who should have control. Thus the more uncertainty we have regarding $r^{\min}$, the more likely it is that control erroneously shifts from shareholders to debtholders, or vice versa. Think of the case in which we think $r > r^{\min}$, and we give shareholders control. If in truth $r < r^{\min}$, then shareholders may gamble for ressurection.

[d] Show and explain how Figures 8.1 and 8.2 in Dewatripoint and Tirole (1994) will change.

Subordinated debtholders' incentives are aligned between those of shareholders and regular debtholders. Thus, compared to regular debtholders, they are more inclined to favor C (= continue) for a given r. However, the return stream of subordinated debtholders is similar to that of regular debtholders. Hence, gambling for resurrection is less of an issue. For a given η, subordinated debtholders will favor C more than regular debtholders. Hence, we expect the distribution of $h_c\ (\eta|u)$ to shift to the right in Figure 8.1. In that case $\eta_0(u)$ in Figure 8.2 shifts to the right, and the curve to the left of $\eta_0(u)$ drops even more below 0. Hence, the value of η for which stopping is optimal has increased.

Question 2: Basel II

[a] In your own words explain why capital ratios may become more cyclical.

Under Basel II, capital ratios more accurately reflect expect losses. And expected losses are higher in a bust than in a boom.

[b] How does this comparison change if banks improve their expected loss estimates as in the above example?

Ceteris paribus, more accuracy regarding expected losses means that the ex ante costs in Bhattacharya and Thakor drop. Hence this means that diversified intermediaries enhance welfare even more, compared to an economy without intermediaries.

[c] In the interest of enhancing financial stability, why are you concerned about credit rationing?

Banks ration credit as a second best solution to the lemon's problem. They are unable to properly screen potential borrowers, and fear that the percentage of bad quality borrowers will increase prohibitively at high(er) interest rates. Hence, in times of credit rationing, your worry as a supervisor is about the quality of banks' loan portfolios. Unexpected losses may very well turn out higher. In times of credit rationing, some very good quality investments do not get executed. Hence the average quality of investment – *ceteris paribus* – drops.

[d] In your own words give two examples for and against the application of regulatory capital requirements.

+ Enhance financial stability if banks are risk prone.

+ A good complement to deposit insurance.

- Increase the likelihood of moral hazard.

- Inefficient, if expected loss < than capital required.

Question 3: Deposit insurance

[a] In your own words explain what the consequences for optimal deposit insurance are, assuming that a supervisor would be perfectly able to observe a bank's true risk-taking.

In that case, you would not need a conventional deposit insurance scheme. Instead, risk-sensitive deposit insurance would be incentive compatible and optimal. Banks would contribute to the deposit insurance in proportion to their true risk. Moral hazard problems related to deposit insurance would disappear, and the overall costs of deposit insurance would (most likely) drop.

[b] Discuss the cases in which $r^{cap} > r^{\min}$ and $r^{cap} < r^{\min}$, respectively. In your discussion, focus on the position of shareholders. How are they affected by the capital requirement?

Remember that shareholders know that they will keep control if $r > r^{\min}$. Hence, they have a strong incentive to keep the solvency ratio above the minimum. This limits their risk-taking. If $r^{cap} > r^{\min}$, then shareholders know that they will lose control before their reach $r^{\min}$. So, they will limit their risk-taking even more. If on the other hand, $r^{cap} < r^{\min}$ then r^{cap} does not have much effect on shareholders incentives.

[c] In your own words explain these findings.

See the article. Subordinated debt limits risk-taking of banks, and as a result expected profits are higher in case C. Subordinated debtholders will also discipline banks much more, and as a result the expected loss to the FDIC is lower in case D. The deposit insurance acts as a negative subsidy on deposit rates, and as a result the market interest rate on bank liabilities is lower in case C. Berger *et al.* (1999, included in the course literature) mention numerous reasons why banks merge.

[d] Discuss two reasons mentioned by Berger *et al.* that increase expected losses to the FDIC, and explain why this is the case.

Any merger motive that is not value-maximizing should have this result.

Question 4: Essay question

We cannot give an exact answer to this question, as there is more than one way to incorporate λ_i. Instead we will give some suggestions. The main differences with existing empirical analysis, including the Cournot model, are (i) the fact that in our case, not all banks are assumed to react the same way to an increase in market share, and (ii) the fact that market power does not have to come from a (high) market share. Thus:

– we can test for price and non-price competition (Cournot quantity competition).

– we can include market share times λ_i, but we can also include λ_i separately and do a joint hypothesis test on the coefficients for λ_i and market share.

– we can even do a time series analysis per bank.

– we can group banks with a similar λ_i and create dummies for these banks.

– we can now accurately interpret the coefficient for market share. So far, we have only been able to clearly interpret extreme outcomes: perfect competition and monopoly. Now we can not only rank other outcomes (which we could before) but also compare them quantitatively. So we could for example tell supervisors how much competion has increased.

– also, we can now tell supervisors who the dominant banks are, so we can enhance competition even if there is no perfect collusion.

Paper assignment

This document gives a description of what is expected of the mandatory paper written for the course. It contains a description of the paper objectives, style requirements, a description of the data and sample Stata code.

Introduction

For this course you have to write a paper that hypothetically could be targeted at the journal *Economics Letters*. Your paper should fit the journal's writing style, length, content and style requirements. It should be concise and to the point, and introduce some type of innovation. In the next section, you will find a list of items to be included in your paper. Your grade for the paper will depend on three points:

1. Overall form and content of the paper: everything required should be in the paper, and the paper itself should have an excellent style (no typo's, etc.).
2. Your choice of how to measure market power and your arguments supporting this choice.
3. Your conclusion, which should be fair but firm.

In writing your paper, please pay attention to the following:

- Since you have limited space, you will have to choose carefully what to present from among the output you have generated.
- Good papers have focus. These papers should be entirely about market power.
- Choose your niche within that context.
- Your paper should look exactly like an *Economics Letter*s article.

Also, in writing the paper you face the following restrictions:

1. All the empirical work should be carried out in Stata. With your Stata do file and the data file you receive, anyone should all be able to replicate everything that is in your paper.
2. Start a folder (electronic or hardcopy) that contains all the material that you use for the paper. On request from the coordinator you will have to be able to produce this folder during the course (i.e. until the end of the exam week).
3. Plagiarism is a fellony and will be punished. Cite sources properly, be clear about where your own arguments end and those of others begin.
4. On the day of the deadline, you hand in a hardcopy version of the paper and

the do file. In addition you send an electronic copies of both the paper and the do file to the coordinator.

Paper objectives

Your objective is to measure competition. In particular, each student is assigned a subsample of a large data set. In analyzing competition in this subsample, you must:

- Describe and discuss (changes in) the market structure.
- At the minimum use the SCP model. All the other models discussed in this book may be used as well.

Since space is at a premium, do not provide an elaborate literature overview. Instead give a brief overview, like the one in Altunbas *et al.* (1999).

You are strongly advised to start working on the data as soon as possible. In week 4, we will reserve time to briefly discuss market structure measurement problems. In week 5, we will do the same for questions regarding regression issues.

Style requirements

Please visit the *Economics Letters* website at:
http://www.sciencedirect.com/science/journal/01651765

Sample code

The Stata code used in the tutorial group in week 3 (see also www.jwbbos.com):

```
/**********************************
First we set some standard settings
**********************************/
clear
set memory 200m
cd "C:\Paper" /* Fill in your own file path */
set more off
set scheme sj, permanently
cap log close
log using banks log, replace
/**********************************
Now we load the data and create some descriptive statistics
**********************************/
use banks.data, clear
codebook year /* [codebook *] for all variables */
summarize * /* for more info, type [help summarize] */
sort year
by year: egen number = count(entityid)
graph twoway line number year, ///
```

```
ytitle("number of banks") xtitle("year") ///
graphregion(color(white))
graph export numberofbanks.wmf, replace
/*********************************
And we create some market structure variables
*********************************/
cap drop marketsize
cap drop marketshare
sort year msa
by year msa: egen marketsize = sum(totassets)
gen marketshare = totassets/marketsize
sum marketshare
/* N.B.: to select your MSA, use the following code:
[drop if msa!=x], where x is the number of your MSA] */
sort year
by year: egen msrank = rank(-1*marketshare), unique
replace msrank =. if msrank>3
by year: gen temp = sum(marketshare) if msrank<=3
by year: egen c3 = max(temp)
drop temp
graph twoway line c3 year, ///
ytitle("C3 Concentration Ratio in MSA 1920") xtitle("year") ///
graphregion(color(white))
graph export c3.wmf, replace
by year: egen hhi = sum(marketshare*marketshare)
twoway (line c3 year) (line hhi year), ///
ytitle("C3 and Hirschman-Herfindahl") xtitle("year") ///
graphregion(color(white))
graph export c3hhi.wmf, replace
/*********************************
Finally, we estimate a simple scp model
*********************************/
regress netatinc hhi independentbank loanlossprov
cap log close
```

Appendix 2

Programming code

We estimated everything in this book using Stata 9.2, except for the stochastic frontiers, which were estimated using Limdep 8.0. On the website (www.jwbbos.com), we give the Stata and Limdep codes used, respectively. Note that these codes are based on BankScope data, and that they automatically generate most of the graphs and tables in the book. For more information on the code and some examples, visit www.jwbbos.com.

Occasionally, we shall use country numbers for graphs, or to exclude some countries. The key for that part of the code is given in Table A2.1

Table A2.1 Countries, country codes and country numbers

country name	code	number	obs	excl.	country name	code	number	obs	excl.
Argentina	AR	1	247		Italy	IT	27	4658	
Australia	AU	3	176	*	Japan	JP	28	2419	
Austria	AT	2	975		Korea, Rep. of	KR	29	26	*
Belgium	BE	4	406		Latvia	LV	32	87	*
Brazil	BR	6	429		Lithuania	LT	30	40	*
Bulgaria	BG	5	34	*	Luxembourg	LU	31	810	
Canada	CA	7	308		Malta	MT	33	40	*
Chile	CL	9	31	*	Mexico	MX	34	58	*
China-People's Rep.	CN	10	37	*	Netherlands	NL	35	220	
Croatia	HR	21	225		New Zealand	NZ	37	35	*
Cyprus	CY	11	94	*	Norway	NO	36	277	
Czech Republic	CZ	12	141	*	Poland	PL	38	203	
Denmark	DK	14	781		Portugal	PT	39	167	*
Estonia	EE	15	31	*	Russian Federation	RU	41	341	
Finland	FI	17	67	*	Slovakia	SK	44	52	*
France	FR	18	2229		Slovenia	SI	43	81	*
Germany	DE	13	15042		Spain	ES	16	941	
Greece	GR	20	113	*	Sweden	SE	42	276	
Hungary	HU	22	91	*	Switzerland	CH	8	1864	
Iceland	IS	26	36	*	Turkey	TR	45	119	*
India	IN	25	459		United Kingdom	GB	19	656	
Indonesia	ID	23	368		U.S.	US	46	3916	
Ireland	IE	24	115	*					

Notes: obs is the number of observations in the fixed-effects frontier estimations; excl. = excluded for single frontier estimations, due to data/estimation problems; results for Romania are absent as no data on the output category off-balance sheet items are available.

Notes

2 Production of the banking firm

1. This chapter is based on Chapter 3 of Bos (2002).
2. Here profits are net earnings minus any retained earnings.
3. See also Tirole (1993), p. 35. The same reasoning, but to a far lesser extent of course holds for risk-neutral shareholders.
4. This section borrows from Tirole (1993), Chapters 0, 1, 6, 7 and 9, from Dewatripoint and Tirole (1994), Chapters 2, 5–8 and 12; and from Freixas and Rochet (1997), Chapters 2 and 3.
5. For an excellent introduction into principal–agent theory, we refer to Arrow (1985). Seminal references for banking are Edwards (1973) and Edwards (1977).
6. See Tirole (1993), pp. 35–55. In addition, regulators have considered creating deposit insurance schemes conditional on the banks' performance (Dewatripoint and Tirole (1994), p. 129).
7. See again Tirole (1993), pp. 35–55, as well as Chapters 6 and 8 of Dewatripoint and Tirole (1994).
8. For examples, see Chapter 3 of Freixas and Rochet (1997).
9. See Molyneux *et al.* (1997), pp. 82–83 for a short overview.
10. Cf. Chapter 3 of Molyneux *et al.* (1997), especially Table 3.20 where standard deviations for the EU area are small for all banks, and mean ownership (capital/assets) of private and cooperative banks is remarkably similar.
11. Cf. Hanweck (1984).
12. Zardkoohi, Kolari and Dahm (1995) do the same for US commercial banks, without the explicit focus on mergers.
13. This section relies on and refers to Beattie (1985), Coelli *et al.* (1998) and Molyneux *et al.* (1997).
14. We note that the assumption that banks are rational agents does not mean there is no longer an agency problem, nor does it mean that banks only have pecuniary objectives.
15. As a sidestep from the argument raised here, it is important to notice that this assumption is highly valid in the long run even in the presence of the incentive problems raised in the previous section. As an example, consider that even the bank manager who pursues ulterior motives such as an increase in his pay check or work force can only continue doing so without being fired as long as his bank makes sufficient profits. In short, profit maximization and cost minimization will no doubt appear in a bank's objective function.
16. Note that there is of course a feasible production set. A bank can – in principle – be allocated anywhere in this production set.
17. See Lovell (1993), p. 4 and also Coelli *et al.* (1998).
18. Note that in this example, the efficiency ranking is invariant to whether we choose output maximization or input minimization. This is coincidental and normally only the case with a constant returns to scale frontier.
19. In the remainder of this chapter and in the chapters that follow, we will use the terms 'economies of scale' and 'scale efficiency' interchangeably, in line with Molyneux *et al.* (1997).
20. For a comparison of radial and non-radial measures, see Ferrier *et al.* (1994).

21. Cf. Altunbas *et al.* (1999).
22. For an elaborate overview and deeper discussion see Freixas and Rochet (1997).
23. This is the case for instance in the original Diamond model, cf. Diamond (1984), Diamond and Dybvig (1983) and Freixas and Rochet (1997).
24. Seminal references are Tirole (1993) and Bain (1956), and for banking markets Milgrom and Roberts (1982a, 1982b), and Freixas and Rochet (1997). Product differentiation in banking has been studied in for instance Berg and Kim (1994, 1998). The opposite effect (channel discrimination) has been studied in Barefoot (2000).
25. See e.g. Ali and Greenbaum (1977), Caprio and Wilson (1997) and Chiappori *et al.* (1995).
26. This subsection relies on Coelli *et al.* (1998) and Beattie and Taylor (1985).
27. Likewise, for every output level, there is a cost-minimizing and/or profit-maximizing input level.
28. Again, likewise by taking the first derivative with respect to y for the output supply equation. In a multiple-input, multiple-output setting, the principle stays the same, but we solve simultaneously for all inputs and outputs, respectively.
29. We refer to Freixas and Rochet (1997), Ferriet and Lovell (1990) and Berger and Humphrey (1997) for an overview of the debate.
30. See Molyneux *et al.* (1997) for a discussion.
31. See Hughes and Mester (1993) and Mester (1991, 1992).

3 Regulation of the banking firm

1. Llewellyn (1999) distinguishes between regulation (setting specific rules), monitoring (observing compliance), and supervision (general observations of bank behavior).
2. The fiercest opponents to government regulation can be found in the Free Banking School. See, for instance, Dowd (1994), Rolnick and Weber (1984), and White (1984). More recent criticism can be found in Benston and Kaufman (1996) and Benston (2000).
3. See Allen and Herring (2001), Table I, for a discussion of additional motives, including measures employed.
4. This section draws on Bikker and Van Lelyveld (2003).
5. For that reason, the new Basel capital accord introduces a set of disclosure requirements to encourage greater transparency and reduce uncertainty.
6. Seminal contributions in this area are Bryant (1980) and Diamond and Dybvig (1983).
7. For an overview, see Garcia (2000). Deposits held by households in the Netherlands amount to Euro 190 billion, i.e. 54 percent of all deposits held by the private and government sector. Note that this insurance scheme only covers deposits held by bank offices in the Netherlands.
8. For instance, in the Netherlands, all deposits are covered, not only the deposits which are directly demandable and hence contribute to the bank-run risk, but also non-demandable liabilities such as fixed long-term time deposits. Moreover, securities in trust are also covered to some extent.
9. Unless the deposit insurance is based on risk sensitive premiums, as is the objective in a growing number of countries (Garcia, 2000).
10. Some argue that financial firms do not directly target a certain probability of default (PD) level but try to avoid a downgrade during a severe downturn. Hence, one can not draw the conclusion that an AA rating reflects the management's target of, at the worst, only one default in thousand years.
11. This section draws on Bikker and Metzemakers (2007).
12. Tier 2 also includes, up to certain limits, provisions for general loan loss reserves. This might be a more favourable purpose for retained earnings than equity as, in many countries, such provisions are tax deductible. Bikker and Metzemakers (2005), who investigate bank provisioning behaviour and procyclicality, indeed found a negative relationship between equity and provisions on the profit and loss account, both taken as shares of total assets.
13. Hall (1993), Haubrich and Wachtel (1993), Thakor (1996) and Calem and Rob (1999).
14. Other studies investigated whether, within asset categories with equal regulatory risk weights, banks have substituted safer, lower-yielding assets for riskier, higher-yielding investment (Shrieves and Dahl, 1992; Haubrich and Wachtel, 1993; Jacques and Nigro, 1997). From a theoretical point of view, such substitution can be proven to be sensitive to assumptions about banks' objective functions (Rochet, 1992).

15. For instance, the risk weight for all enterprises was 100 percent under Basel I, whereas its value ranges from 20 percent to 150 percent under Basel II.
16. Under IRB, risk weights for enterprises range from as little as 3 percent to as much as 600 percent and more.
17. So far, most banks do not yet estimate through-the-cycle ratings as it is more intricate.
18. The revised standardized approach of Basel II with pseudo risk weighting produces capital requirements that are lower and less cycle sensitive than those under the IRB approach.
19. The necessary buffers follow from simultaneous modelling of Basel II capital requirements, based on rating transitions, and actual bank capital, driven by bank income and default losses.
20. If banks were to shift systematically from commercial loans to government bond during a certain phase of the business cycle, this would effect their capital requirements. Generally, capital requirement for market risk do depend on the business cycle.

4 Basic model of bank performance

1. Here profits are net earnings minus any retained earnings.
2. Homothetic functions are characterized by the linear expansion paths that we require to be able to compare the competition proxies and efficiency measures that we shall introduce later in this chapter.
3. See also Tirole (1993), p. 35. The same reasoning, but to a far lesser extent of course holds for risk-neutral shareholders.
4. This section borrows from Tirole (1993), Chapters 0, 1, 6, 7 and 9; from Dewatripoint and Tirole (1994), Chapters 2, 5–8 and 12, and from Freixas and Rochet (1997), Chapters 2 and 3. We simplify the discussion in these references, for example by not discussing monitoring costs.
5. For an excellent introduction into principal–agent theory, see Arrow (1985). Seminal references for banking are Edwards and Heggestad (1973) and Edwards (1977).
6. See Tirole (1993), pp. 35–55. In addition, regulators have considered creating deposit insurance schemes conditional on the banks' performance (Dewatripoint and Tirole (1994), p. 129). Barnett *et al.* (1994) and Barnett and Hansen (1996) study the same incentive problem.
7. See again Tirole (1993), pp. 35–55, as well as Chapters 6 and 8 of Dewatripoint and Tirole (1994).
8. For examples, see Chapter 3 of Freixas and Rochet (1997).
9. See Molyneux *et al.* (1997), pp. 82–83 for a brief summary.
10. Cf. Chapter 3 of Molyneux *et al.* (1997), especially Table 3.20 where standard deviations for the EU area are small for all banks, and mean ownership (capital/assets) of private and cooperative banks is remarkably similar.
11. Cf. Hanweck and Rhoades (1984).
12. The model described here is derived from Cowling (1976), Cowling and Waterson (1976), and Stigler (1964). The model by Cowling describes a relationship between *industry* performance and market concentration, both over time (intra-industry) and between industries (inter-industry).
13. See Hughes and Mester (1993) and Mester (1996).
14. See Coelli *et al.* (Chapter 3, 1998).
15. Here $f^{'}$ denotes the first derivative of f.
16. Note that on the markets for inputs, banks are assumed to be price takers. Therefore, they face exogenously determined market input prices (cf. Berger and Mester, 2003). These authors state that input prices are essentially misspecified in many studies, since they are calculated for each individual bank instead of at the market level.
17. A high λ_i means a firm has a high awareness of its interdependence with other firms. True myopia in a firm is represented by $\lambda_i = 0$.

5 Market power models

1. The assumptions underlying the Cournot oligopoly theory according to Hause (1977) are: homogeneous products, n firms with strictly increasing marginal cost functions (which need not be identical), independent (non-cooperative) behaviour of firms to maximize their own profits, no new entries, and strictly decreasing industry demand.
2. On a more theoretical level, our basic framework can lead to the same two-player competitiveness that we find in many (simple) Bertrand models.
3. Note that from an economic point of view, a price elasticity of demand smaller than (or equal to) unity would make no sense, as the return of an additional unit of production would then be negative (or zero), see Equation (4.A.2) in Bikker (2004).
4. See Panzar and Rosse (1987) or Vesala (1995) for details of the formal derivation of the H–statistic.
5. Not surprisingly, this is also a necessary condition for the myopic Cournot oligopolist, who is ignorant of the impact of his actions on his competitors and therefore not prone to collusive behaviour.
6. As explained, for the collusive oligopoly we assume a λ_i that is not constant but unmeasurable – except through MS_i. In the collusive Cournot oligopoly an increase in output Y_i by a bank i has the consequence that all banks in the market increase their output proportionally. This is consistent with a dynamic Cournot equilibrium.
7. As argued by Cowling (1976), firms could need time to adjust to the new competitive situation and the impact of an increase in market share on performance may therefore involve a lag. In empirical applications, a one-year lag is therefore applied to MS_i.
8. This section is taken from Bos (2004).
9. On a market level, the notion that concentration 'facilitates collusion between firms and increases industry-wide profits' (Tirole (1993), p. 222) is widely accepted.
10. Where $\sum_{i=1}^{N} Y_i = Y = f(N_0)$.
11. Where $MS_i = Y_i / \sum_{i=1}^{N} Y_i$.
12. A bank expects a consumer to either become a customer (with expectations dependent on its current market share) or not. Thus, for the binomial mean $\mu = n * p$, variance is $n * \pi(1 - \pi)$.

6 Efficiency of banks

1. In our use of wording, we shall be relatively lighthearted about the precise distinction between productivity and efficiency. For a more formal treatment of the topic, see Coelli *et al.* (1998).
2. Economic efficiency is the sum of technical and allocative efficiency. Technical efficiency is a measure of a bank's distance from the frontier, minimizing inputs given outputs or vice versa. Allocative efficiency measures the extent to which a bank is able to use inputs and outputs in optimal proportions given prices and the production technology.
3. See also Berger and Humphrey (1997) and Molyneux *et al.* (1997).
4. Cf. in this respect deterministic models with, for example, Data Envelopment Analysis.
5. For a theoretical framework underpinning the Stochastic Frontier models used here, see Coelli *et al.* (1998) and Bos (2002).
6. For a description of the functional form and empirical specification used to estimate this model see Chapter 14.
7. Note that the hypothesis we present in Chapter 7, $(1 - \frac{\Pi_i^*(Y_i, w_i)\exp(\nu_i)}{\Pi_i^*(Y_i, w_i)}) > 0$, should be tested if $\lambda > 0$.
8. We shall refrain from discussing the relationship of both types of efficiency with X-efficiency.
9. This is reflected by a significantly positive value for μ/σ_u.
10. See also Bos (2004), on which this section is based.
11. This modification is explained for the Cournot model and therefore in loglinear form. However, it can be applied just as well (without taking logarithms) to the traditional SCP model.
12. Profit X-efficiency would not really solve this problem, since – to the extent that a bank with

market power can maximize profits without minimizing costs – it basically captures the same effect as *MS*.

13. The same can of course be done with Equation 5.9.

7 Synthesis

1. The null hypothesis is based on the premise that profits increase: i.e. market power exists or efficiency goes up.
2. The same holds for a monopoly (cf. Chapter 5).

8 Trends and basic framework

1. For all trends described here, empirical evidence in the form of figures over the last decade is provided by Bikker and Wesseling (2003). See also Danthine *et al.* (1999) and European Central Bank (2002).
2. This directive boosted the deregulation and liberalization of international capital flows. Other policy initiatives were lifting of restrictions on interest payments on deposits and the development of a harmonized framework for supervision of the European banks. In the beginning of 1993, all formal restrictions regarding the provision of financial services across the European Union were removed. Banks which are licensed anywhere in the Union are given a 'single banking licence', which allows them to service the entire European market, either by setting up branches in other countries or by offering products across national borders. For a detailed description of the economic integration in the EU, see Vanthoor (2002).
3. European Commission (1997) gives a detailed evaluation of the impact of the single market programme on the performance and strategic reaction of the banking sector in European countries. See also Molyneux and Gardner (1997), Vander Vennet (1997), Danthine *et al.* (1999) and Bos (2002).
4. European Commission (1997) discusses the increase of competition. Improved efficiency has been observed by Groeneveld (1999), Altunbas *et al.* (2001), Maudos *et al.* (1999, 2001, 2002). This is also confirmed in later chapters. However, Bikker and Spierdijk (2008) observed a decrease in competition over time.

9 Data

1. An extended set with 12 000 additional small U.S. banks is also available, containing 25 000 banks in total. This extended database has been used in Bikker *et al.* (2006a).
2. In 2000, Slovakia joined the OECD as the thirtieth Member State. Member States that joined later have not been taken into account.
3. To deal with possible inaccuracies in the measurement of fixed assets, we make an adjustment to this variable, following Resti (1997) and Bikker and Haaf (2002a), we regress the natural logarithm of fixed assets on the logarithm of total assets and loans, including quadratic and cross terms of these variables. Subsequently, we use the regression forecast of fixed assets to calculate PCE_{it}.

10 The Bresnahan model

1. As suggested above, an alternative would be to define the price as the difference between the risk-free (or money market) rate and the deposit rate. In our empirical application, the alternative model would be equivalent to the current model, because alternative rates (such as the money market rate) are also included as explanatory variables.
2. The equilibrium version of the demand equation for deposits, that is, Equation (10.6 after substitution of the equilibrium price r_{dep} from Equation (10.11).

3. This is obvious from Equation (10.11): if $\alpha_3 = 0$, λ and β_1^* are indistinguishable from each other.
4. The intercept estimates the Dutch deposit level, after taking the other variables into account.
5. The Cournot model assumes that a firm does not expect retaliation from other firms in response to changes in its own output.
6. We note that the relevant number of banks, *n*, is not always known exactly. For instance, there is a substantial difference between the number of banks with a banking licence and the number of actually active banks.
7. Bresnahan's model has also been applied to other industries, for example, Alexander (1988), Graddy (1994), Genesove and Mullin (1998) and Steen and Salvanes (1999).

11 The Panzar–Rosse model

1. Values greater than 1 indicate that banks cooperate and apply strategic pricing methods, taking into account the manner in which they expect competitors to respond to their prices.

14 X-Efficiency

1. When we consider the lower end of the efficiency distribution for the fixed effect specification, we observe that all countries share the same minimum efficiency point (10.3 percent).

15 Scale and scope economies

1. Country-specific results, not reported here, are mostly similar.
2. In addition, the full Fourier specification often suffers from multicollinearity problems, and estimating a partial Fourier leads to biased scale economy estimates (see Brambor *et al.* (2006) on the inclusion of all interaction terms).
3. Equation (14.1) nicely demonstrates the consequences of non-separability. Clearly, the scale economies that we find for output Y_1 depend on the level of the other outputs, input prices, and the equity ratio. In addition, the level of scale economies changes with our time trend, t. Another interesting issue is the scaling of outputs and total cost. In particular, results may be affected if some banks produce outputs that (e.g. expressed in millions) are between 0 and 1, before taking logs. We do not discuss this issue here.
4. Part of the text in this section is based on Bos and Kolari (2005).
5. We tested for the robustness of our results by taking other cutoff points. Our results stay qualitatively the same for a range of approximately -10 percent to +10 percent.
6. Note that these ratios can only be constructed using averages; as such, the scope measure itself therefore does not have a standard deviation. This is a common problem, as recognized in Berger and Humphrey (1994). Instead, we can report a t-value for an independent samples test for TC_H-TC_L (cf. Bos and Kolari, 2005). Note also that by varying the cutoff point to more or less than the 25th percentile, we can check for extrapolation problems.

16 Synthesis: the measurement of competition and efficiency

1. In 2000, Slovakia joined the OECD as the thirtieth Member State. Member States which joined later have not been taken into account as such.
2. Note that correlations between the simple proxies are much weaker and less often significant when averaged over the entire sample period, compared to correlations based on one year (see Bikker and Bos (2005)).
3. This would, for instance, be the case if bank service tariffs were determined by a markup on costs.
4. This interpretation supposes that bank service tariffs, such as lending rates, commissions and fees, are dictated by competition and hence that, given the output level, revenues are a residual item.

5. Note that these variables do correlate with efficiency.
6. Bikker and Bos (2005) show that higher levels of confidence are obtained when data of simple proxies of one year are considered, instead of averages over a decade. Those ten-year averages, however, are better comparable to the model-based measures, estimated over 1996–2005.
7. This reveals that the assumption of constant revenues in the hypothetical example in the section on profit efficiency in Chapter 14 should be rejected.

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