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ESSAYS ON THE MICROECONOMICS OF BANKING

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Contents

Preface

This dissertation is primarily a contribution to the literature on the microeconomics of banking which can generally be defined as a broad field of applied microeconomics focused on the phenomena specific to the banking industry. Although the banking industry is a very popular object of study among researchers and the topics of interest with applications to the banking industry span practically the whole universe of microeconomic theory, the microeconomics of banking as a separate field is relatively young and has undergone most of its development only since the introduction of the asymmetric information paradigm in the 1980's[1].

The focus of the literature evolved from a simple application of general theoretical insights to the new original modeling approaches reflecting the unique characteristics of banks and their role in the market. Specifically, the banking industry is one of the industries (possibly challenged only by the health care industry) most exposed to the asymmetric information phenomena and thus most of the modern approaches to banking work with the assumption of asymmetric information. The uniqueness of banks is then perceived mainly in their role of transformation of financial assets (the services of divisibility, term and risk transformation) in which banks have a comparative advantage due to scale and scope economies, their role of pools of liquidity in providing the insurance against idiosyn-

[1]Detailed overview of the development of the field can be found in Freixas and Rochet (1997)

cratic shocks to consumers' consumption needs and finally their role of facilitators of effective monitoring of the economic agents' investment projects (thus they also provide the implied mitigation of the adverse selection and moral hazard problems inherent to the asymmetric information environment). These specific characteristics make the banking industry both exceptionally attractive and demanding from the research point of view.

Although many aspects of bank behavior have already been thoroughly studied, there is still room for interesting theoretical developments which can be achieved by extending the existing models by realistic assumptions about the economic instruments that can be used by banks to achieve their ultimate objectives. The binding theme behind the chapters of this dissertation is that banks are very complex economic agents which can react to their market situation through a wide arsenal of different instruments, some of which have not been studied in sufficient detail so far. The dissertation focuses on some of the yet unexplored features of these instruments.

All the three theoretical chapters build on some form of strategic interaction in which one or more banks are involved. It is shown that banks can use different tools (retail fees, loan interest rates or credit information sharing mechanisms) to strengthen their position in these interactions and thus improve their profitability. From the theoretical point of view, all the three theoretical chapters use the tools of applied game theory, two of them with special focus on asymmetric information issues.

The first chapter focuses on the interaction between a bank and its potential borrowers of various quality. Apart from the usual form of asymmetric information between the bank and its borrowers (i.e. the assumption that the bank cannot

observe the borrower's type), there is also an additional informational imperfection in that the borrowers themselves can have false perceptions about their quality (i.e. some of the bad borrowers believe they are good). In such a setting, the choice of the relative size of fees paid by everybody and the interest rates paid only by the successful borrowers is shown to be an effective way of screening loan applicants and thus alleviating the inherent adverse selection problem. It is shown that the higher is the degree of the borrower's misperceptions about their skills the higher fees should be expected. In an alternative setup it is shown that comparable results can be received when banks posses an imperfect testing technology (this assumption replaces the assumption about the borrower's false perceptions). Moreover, both setups also imply that under realistic conditions increasing wealth inequality in a country leads to higher fees because increasing fees disqualify relatively fewer borrowers. These theoretical findings are used as a possible explanation of the observed vast international differences in retail bank fees between countries on different levels of economic development.

The second chapter is centered around the interaction between competing banks facing a heterogenous pool of potential borrowers. The setup is similar to the one from the first chapter but it now includes multiple banks which are allowed to share information about the potential borrowers. Information sharing is shown to be an effective device for facilitating tacit collusion between banks and under some conditions even leads to a natural oligopoly outcome in which there is a maximum number of banks supporting a stable equilibrium in the market. The important contribution to the existing literature is that the results hold even under transactional banking (i.e. without repeated bank-borrower encounters) and also under the realistic assumption that banks also share the information about loan

application history instead of just the information about past defaults.

One of the important outcomes of the first chapter is that banks may use tying of loans to deposits in order to create an effective offering with the desired screening characteristics. The third chapter focuses on the relationship between the loan and deposit side on a more general level. The strategic interaction involved in the chapter is the interaction between a bank and a potential new competitor, i.e. an interaction inherent to any industry attractive for new entry. It is shown that the bank's decisions about loans and deposits are interdependent under very general conditions, even in an environment without asymmetric information. Evaluations of policy measures aimed at one of the two sides of the banks' business should thus take into account also the implied effects on the other side (e.g. deposit rate controls which have recently received renewed interest among both academics and policymakers).

The fourth chapter of the dissertation is empirical and focuses on the analysis of the determinants of retail bank fees in the Central European region with a special focus on explaining the international differences in fees. The analysis is based on the predictions of the existing literature and it uses a unique dataset with interesting cross-developmental variation on one hand and important similarities implied by the traditional ties between the countries on the other hand (the dataset includes Austria as a traditionally strong banking country and the Czech Republic, Hungary, Poland and Slovakia as the countries which are still in the process of gradual development of their banking sectors). Due to the characteristics of the dataset, we are able to use an approach based on a representative client behavior and thus overcome some of the potential biases inherent to studying individual fees. Our results support the Structure Conduct Performance hypothesis and confirm

the hypothesized importance of the degree of reliance on cashless payments and the differences in labor intensity and technological level of the banks' operations.

To summarize, the theoretical part of the dissertation provides new insights about the behavior of banks in important strategic interactions. Specifically, these insights relate to three of the banks' fundamental strategic instruments (retail fees, loan interest rates and credit information sharing) and their use in the interactions. The empirical part of the dissertation then complements the theoretical part by providing an analysis of the determinants of the fee levels using a unique dataset. The results have important policy relevance for the recent debate about the level of retail bank fees in some of the less developed countries or competition policy measures aimed at regulating the degree of competition in the banking industry.

Chapter 1

Alternative explanations of the international differences in retail bank fees

(Joint work with Petr Chovanec)

Abstract

In this chapter we discuss alternative explanations of the vast international differences in bank fees. We are able to show that bank fees are positively related to the level of loan applicants' misperception of their skills ('noise'). We argue that in countries with a higher level of 'noise' banks tend to charge higher fees in order to defend their bottom lines against the lower implied average quality of borrowers. We further show that banks tend to charge higher fees when their creditworthiness testing technology is of a lesser quality. Finally, we also illustrate how the results about fees depend on the wealth level and wealth inequality in a given country.

1.1 Introduction

Retail bank fees have always been a very important source of income of banks around the world[1]. They represent one of the main pricing instruments at the banks' disposal. Traditionally, retail bank fees have been seen in the literature mainly as the banks' tools for covering transaction and administrative costs associated with payment and deposit related services. We argue in this paper that fees may have other important roles which allow banks to improve their operating efficiency under uncertainty and asymmetric information.

It has been noted by several empirical studies that the level of retail bank fees tends to be very different in different countries, despite the continuing process of globalization and integration (more about the past and current trends in the section Observed empirical trends). Interestingly, the pattern of these differences indicates that fees tend to be higher in less developed countries. In this paper, we discuss two alternative theoretical explanations of this phenomenon, one based on the trade-off between creditworthiness testing quality and screening by fees and the other on the role of fees as a tool for coping with the adverse selection effects implied by the loan applicants' misperceptions of their skills.

The research has important policy relevance. A better understanding of the driving forces of the international differences in fees can help us predict how the level of bank fees will evolve with the changing economic environment in the transition and developing countries. Moreover, it can also help the regulatory institu-

[1]For example, on the level of the whole Czech banking industry, the profit from fees and commissions amounted to over 31 billion CZK in 2004 while the interest profit (including securities) amounted to about 60 billion CZK in the same year (based on the data from Czech National Bank (2005)).

tions decide whether the fees are indeed suspiciously high or whether they are in line with the economic environment in a given country.

The paper is organized in the following way. In the next section, we discuss a brief classification of different types of bank fees in order to clarify the main object of our interest in this paper. Next, we discuss the observed empirical trends related to the structure and the level of fees, emphasizing the observed negative relationship between the level of fees and the economic development of a country. We then proceed to the discussion of the traditional explanations of this observed phenomenon and following that we present the intuition behind our proposed alternative explanation. Finally, following a brief literature review we present the model and conclusions.

1.1.1 The classification of fees

Our goal in this section is to specify what exactly is meant by bank fees in the context of this paper. We do not aspire here to list all the possible types of fees used by banks around the world. Neither would it be feasible due to the immense variety of banks' pricing models, nor would it be useful for our research purposes. Instead, we borrow a classification presented in a study by Capgemini, EFMA and ING (2005) and discuss the scope of the paper within this classification.

Generally, the main categories of bank products are core day-to-day services (account management, payments, cash utilization and exceptions handling), savings products (certificates of deposit, mutual funds etc.), credit products (overdrafts, consumer credit, mortgages, loans etc.) and additional products such as insurance, real estate or concierge services. Although fees can be charged for

products falling into basically any of these categories, most attention of both mass media and policymakers has been paid to the fees on the core day-to-day services.

The product categories listed above are by no means independent and banks can use their pricing strategies to leverage the linkages between these product categories. For example, some of the products from the credit products category can be strategically tied to the core day-to-day product category. Banks can also cross-sell products from two or more categories, effectively subsidizing one category and compensating for that by high profits in another category.

The model we present in this paper has general implications for fees associated with all the product categories listed above. However, for the ease of exposition, it is cast in the form of a bank-borrower interaction, thus a natural interpretation seems to be that the fees used in the model are either the loan application and processing fees or the account management fees under tying of loans to accounts (i.e. they represent the fees from the credit products or core day-to-day services category; more about the validity of these settings below). We discuss the applicability of the model to the other types of fees below.

1.1.2 Observed empirical trends

In this section we focus mainly on the fees for the core day-to-day services as they have traditionally received most attention. Two interesting phenomena have been repeatedly addressed by the policymakers and other interested parties - firstly, the apparent vast differences in bank fees between banks from different countries (even within the EU single market area)[2], and secondly, the differences in the structure

[2]For an illustration of the international differences in retail bank fees see Figure 1.7 in the Appendix.

of the fee schemes prevalent within individual countries or regions.

According to a number of industry studies, banks' pricing models are very heterogeneous when fees are concerned. For example, the Capgemini, EFMA and ING (2005) study has identified four distinctive types of approaches to pricing of the products from the core day-to-day services category. These are the account based, packaged based, transaction based and indirect revenue based pricing approaches. Banks using the account based approach set a range of fees including fees for account management and usually tie products from other categories to the account. Banks pricing according to the packaged based approach charge a fixed fee for a whole package of various products. The transaction based approach is characterized by a range of fees for virtually any bank product whereas the indirect revenue approach is based on low or non-existing fees but high interest spreads or high fees for services from other categories of bank products. Interestingly, all the four pricing approaches have been found to coexist in the market.

The described heterogeneity of pricing approaches indicates the significant complexity of the banks' pricing problems. This complexity may arguably be implied by the vast product portfolios of modern retail banks as well as by the desire of banks to use fees strategically to influence the behavior of clients or competitor banks. This point and the complexity of the pricing problem in general can be illustrated on the historical development of pricing behavior used by banks in the Czech Republic since the second half of the 1990's. We choose the Czech example because the rapid evolution of the banking sector in the transition economy gave us the opportunity to observe interesting dynamics over a relatively short period of time.

The Czech banks' approaches to pricing core day-to-day services evolved in

several stages. In the first stage, banks rapidly increased fees for over-the-counter services at the end of the nineties, motivating people to open current accounts and start using ATMs. In the second stage, starting around the year 2001, banks proceeded by significantly increasing the fees for using ATMs in the drive to further decrease the level of their clients' reliance on cash payments and increase profits from their already locked-in clients. The third stage began around 2003 when the fees for core day-to-day services received increased attention of the general public. The topic of the ensuing debate was the banks' prevailing practice of charging fees for closing a current account as well as the continually rising level of other fees. The debate culminated at the end of 2005 when a major consumer defense organization initiated litigation against one of the major banks on the Czech market and later extended the scope of the litigation against yet another bank. One of the main results of the debate was the elimination of the fee for closing of an account and the adoption of a self-regulation mechanism by the major Czech banking institutions with the stated aim of eliminating the switching costs and achieving greater transparency of the banks' offerings. Although the most recent development could possibly be characterized by a surge in the use of the package based approach to pricing, the trend seems to be less profound compared to the past and thus the heterogeneity in pricing styles across banks is becoming increasingly apparent.

The high degree of heterogeneity in pricing approaches makes comparisons of individual levels of fees very difficult if not misleading. Different banks using different pricing approaches may use one specific type of fees in a totally different way as they optimize prices for the whole portfolio of products. However, it is possible to compare the total expenditure a client has to make for a specified

bundle of services over a given period of time. Specifically, it is possible to specify the behavior of a typical client and calculate an index of prices of the services regularly consumed by this client. This approach has been taken by a number of industry studies including the Capgemini, EFMA and ING (2005) study, the results of which we use as the basis for the following discussion.

Specifically, the authors of the study have found a striking result. They have created a fee index based on a localized behavior pattern[3] in a set of both developed and emerging economies, normalized the fee index by the GDP per capita in a given country[4] and found that the resulting variable tends to be relatively lower in the less developed countries. Thus, they have found empirical evidence for a negative relationship between the level of the fees for the core day-to-day services and the economic performance of a given country. We focus in this paper on the alternative theoretical explanations of this puzzling empirical phenomenon.

1.1.3 Traditional explanations of the fee differentials

The goal of this section is to discuss the traditional explanations of the international fee differentials pointed out in the previous section. The list of the explanations discussed here is by no means meant to be exhaustive. We focus on the most common explanations which emerged in the media or during the debates among banks, policymakers and other interested parties.

The simplest explanation of the apparent vast differences in the level of retail bank fees between countries is that the GDP per capita is lower in the less devel-

[3]The authors of the study have defined the typical bank client behavior in a given country based on the data collected from individual banks in the country.

[4]This is by no means the only possible normalization but it can be expected to approximate the real burden that fee-related activities represent in the different countries within a very heterogeneous sample.

oped countries and thus the denominator of the ratio of fees to GDP per capita (a measure often used in international comparisons) is lower for these countries. The implicit assumption behind this argument is that there is what could be called a free movement of retail bank capital between countries and thus the nominal fees must be the same in all countries or else there would exist profitable arbitrage opportunities. However, according to a number of studies[5], the national retail bank markets still seem to be rather separated with little across-the-border activity.

A More reasonable explanation, often put forward by bankers themselves, is based on the assumed international differences in demand characteristics[6]. The argument runs as follows. Apart from the core day-to-day services like bank account management, banks also offer their clients more complex services which are usually tied to the basic ones (e.g. various types of saving, credit or insurance products). Depending on the demand characteristics, the basic services may be used as a loss leader in order to capture more clients who will then generate high profits by paying higher margins on the additional services purchased from the bank. The implicit assumption behind this story is that banks are somehow able to cash in on the higher complexity of the additional services by securing higher margins than they can on the basic ones. We believe one possible reason why this may happen is higher differentiation potential of the additional services. The higher complexity of these services allows banks to differentiate themselves from competition on more dimensions than they can with the basic commodity-like services.

[5]See for example the European Commission Interim Report II: Current Accounts and Related Services.

[6]For an interesting discussion about retail bank fees see for example the interview of the CNB Vice-Governor Luděk Niedermayer for the Czech Radio from the 14-th September 2005 (the transcript of the interview is available on the CNB webpages at http://www.cnb.cz/cs/verejnost/pro_media/clanky_rozhovory/media_2005/cl_05_050914.html).

The other two prominent factors believed to be affecting the level of bank fees are banks' costs and the degree of competition in the banking market. If banks in the less developed countries are less cost effective or face higher costs than their western counterparts then one would expect the fee differentials to reflect this gap. One might hypothesize that one of the major drivers of the high levels of fees in the less developed countries is the relatively higher use of cash payments in these countries. The higher the cash-dependence of a country the higher are the costs of providing the basic services - banks need much many people to handle the cash, count it, etc. Moreover, it is much more difficult to transform this cash into lending; banks are thus less inclined to lend (could be understood as the opportunity cost of cash). The hypothesis that cash-dependence of a country strongly determines the costs of providing basic services seems to conform very well with the observed inverse relationship between the normalized fee levels and the economic development of a country - less developed countries are usually much more cash-dependent than modern developed economies in which widespread use of electronic payments has mostly limited cash payments only to very small transactions or illegal business activities. However, this hypothesis of the effect of cash-dependence has not been tested yet.

The differences in fees are often believed to result from the lower degree of competition in the banking industry in the less developed countries. However, the predictions of the theoretical literature on the effect of competition on pricing behavior in banking are mixed and there are papers suggesting that prices set by banks may be increasing in the number of banks in the industry[7]. Thus, the

[7]As reviewed by Brewer and Jackson (2006) or Shaffer (2004), there are two main competing theories - the traditional Market power theory, usually understood in the form of the Structure-Conduct-Performance hypothesis (SCP hypothesis) due to Mason (1939) and Bain (1951, 1956),

direction of the competition effect is generally unclear.

1.1.4 Our approach

The goal of this paper is not to reject the validity of the traditional explanations listed above. Instead, we add alternative explanations which are based on specific factors influencing the banking industry and which can enrich the debate about the development of fees in different countries.

The results of our models are based on the following simple intuition. Fees can be shown to play the role of a sorting device in the lending relationship between borrowers and banks, just as collateral does (see e.g. Besanko and Thakor (1987)). The idea is that fees are paid upfront, at the beginning of the lending contract and the loan rates are paid ex-post, only after the borrower survives till the end of the contract. This of course assumes that everybody applying for a loan is required to pay a fee, e.g. by having an open account with the bank[8]. Limited liability (either legal or effective) implies that borrowers with lower probability of success prefer to pay higher rates contingent on success rather than uncontingent upfront fees.

The banks' temptation to charge as high fees as possible is limited by the borrowers' wealth constraints. If banks are able to offer a set of different contracts, self selection assures that bad borrowers choose contracts with low fees and high rates. If the bad borrowers are so bad that they are ex-ante unprofitable for banks

and the Efficient Structure hypothesis (ES hypothesis) developed by Demsetz (1973) and Peltzman (1977). Higher concentration leads to higher prices under the SCP hypothesis (e.g. due to scale economies or the X-inefficiencies discussed by Liebenstein (1966)) but may lead to lower prices under the ES hypothesis (the more efficient firms are assumed to gain market share in the dynamics of competition). Thus, the two main strands of literature in this area lead to opposite implications.

[8]Strong empirical evidence for tying of bank accounts to loans or mortgages has been documented by the European Commission's recent Interim Report II: Current Accounts and Related Services.

then banks choose fees and rates to maximize profits from the good borrowers given the condition that the bad borrowers are discouraged from applying for a loan. In such a setting there is not much room for interesting comparative statics as the level of fees is determined only by the relative characteristics of the good and bad borrowers and by the maximum willingness to pay of the good ones. The setup and implications described above are actually similar in many respects to the models used in the literature on collateral and bank loan commitments (see the review below).

However, interesting insights can be inferred once we extend the basic setup. If some borrowers with low success probability are overconfident and believe they are better than they actually are and some borrowers with high success probability are underestimating themselves then fees may depend on the degree of this misperception of borrowers (henceforth we will call it noise). The higher are the fees the fewer borrowers can afford to pay them but the higher are the expected returns from the bad borrowers. Up to a certain level, the more bad borrowers mix up with the good ones thinking they are good, the higher fees will be charged because the lost profits from the good borrowers who cannot afford to pay the higher fees is offset by the higher returns from the bad borrowers in the pool. Thus, according to this intuition, fees should be higher in countries with higher level of noise in the economy. Empirical evidence for the international differences in the level of overconfidence can be found in Koellinger, Minniti and Schade (2007). These authors show that entrepreneurial overconfidence is very different in different countries.

Other interesting insights follow when we introduce testing into the original specification - this can in fact be seen as an application of the Guasch and Weiss (1981) model of testing with application fees on the labor market. Once we allow

banks to use imperfect testing of borrowers we get a tradeoff between testing and screening by fees. Banks sort ex-ante indistinguishable applicants into different groups according to the results of the test. With just two types of borrowers, there is a group which passed and the other which did not. The better is the test the higher is the share of good borrowers in the first group. Thus, better testing in this setup is essentially the same as lower noise in the previous setup. Ceteris paribus, fees should be higher in countries with worse available testing technologies. This conforms well with the observed inverse relationship between the normalized fee levels and the economic development of a country because banks in less developed countries arguably have worse testing capabilities as the parameters in their testing and scoring models are derived from relatively smaller samples due to the lack of credit history.

Before advancing to the literature review and then finally to the model itself, we first comment on the generality of our approach. The fees play two important roles in our model. First, we model the role of fees as a type of collateral which can be used as a screening device to affect the composition (and thus also the average quality) of the pool of clients faced by a bank[9]. Second, we model fees as an upfront uncontingent income which can be used to affect the bank's expected income for a given composition of its pool of clients. The collateral logic motivated us to use the lending-borrowing relationship as a platform for the exposition of our main ideas. Thus the fee in our model can be best interpreted as a fee for processing the loan application and managing the loan account or as the present

[9]As pointed out by one of the referees, Martin Čihák, the similarity with collateral is obviously not perfect as there are important differences between the two instruments (e.g. fees are generally not returned to the borrower). However, the screening role played by fees in our model is similar to that played by collateral in the literature.

value of the fees for the current account management to which the loan application is tied by the client's bank. However, the model's implications are more general and can be applied to other types of fees as well. The idea is that from the bank's point of view there are often some good and bad clients who are affected differently by a given level of fees charged by the bank. For example, the same logic applies to the problem of a bank faced by two types of depositors who both may demand some additional services in the future but differ in their probability of actually demanding them. In this case, an upfront fee for the depositors' current account plays the role of the fee in our model, the fee for the additional services plays the role of the loan interest rate in our model, the probability of demanding the additional services (and thus paying the fee for these services) plays the role of the quality of borrowers in our model and the bank's experience with assessing the type of depositor plays the role of the testing technology in our model.

1.2 Theoretical Literature Review

Although the literature aimed specifically at the determination of retail bank fees is very small, there are other important strands of literature relevant for our topic. The fees can obviously be affected by standard factors such as costs and the degree of barriers to competition. Thus, all the standard Industrial Organization models of price determination are potentially relevant for studying the determination of fees. However, we believe the international differences in bank fees can also be codetermined by more subtle demand driven factors affecting the whole service portfolio of the bank, not only the fee related services. Thus, we believe it is important to consider also the possible linkages between the different types of

bank services. In this section we briefly review the most relevant contributions from the literature on collateral and bank loan commitments as the research areas closest to our approach.

The fees can under some assumptions be interpreted as a type of collateral (under risk neutrality and tying of loans to fee related services, the fee can be understood as the present value of the collateral) and thus the literature on the screening role of collateral is very relevant for us[10]. The seminal papers on the informational role of collateral are Bester (1985) and Besanko and Thakor (1987). The models derived from these contributions imply that collateral is an effective tool for alleviating the adverse selection problems by screening in the environment of asymmetric information between banks and borrowers. Thanks to the availability of collateral, banks are able to distinguish between otherwise indistinguishable borrowers because the riskier borrowers prefer the contracts with lower collateral and higher loan rates, whereas the less risky borrowers choose the contracts with higher collateral requirements but lower rates. This implies a negative relationship between risk and the level of collateral requirements. As this is not in line with the majority of the existing empirical evidence, huge effort has been made to find reasons for the opposite relationship. Boot, Thakor and Udell (1991) show that the relationship can be positive when banks are also faced by moral hazard and Coco (1999) shows that a positive relationship occurs when heterogeneous attitudes to risk are introduced into the model. However, in all these models the level of collateral depends only on the relative riskiness of the borrowers and none of these models involves testing as an alternative to screening by collateral.

[10]This close relationship between fees and collateral implies that the results of our models can actually be reinterpreted in terms of the the effects of entrepreneurial overconfidnce or testing quality on collateral requirements

The combination of collateral and testing is modeled in Manove et al. (2001) who show that creditor protection in the form of low restrictions on collateral requirements can lead to socially inefficient equilibria in which too many bad projects are financed due to insufficient testing of loan applicants by banks. Testing in their model is costly and banks are thus not motivated to test the loan applicants when high quality applicants post enough collateral. The implication of the model is that restrictions on the use of collateral can lead to a socially more efficient equilibria in which banks use more testing. Although Manove et al. combine screening by collateral and testing, they use the assumption of perfect testing technology, don't account for any wealth constraints among loan applicants and also use simpler assumptions about information imperfections. Thus, the model's parameters cannot be easily identified with country specific factors needed for explaining the international differences in bank fees.

Another strand of literature close to our topic is the literature on bank loan commitments. Kanatas (1987) shows that bank loan commitments can be used to signal the firms' quality on the capital market. Similarly to the case of collateral, higher quality firms are willing to pay a higher commitment fee and a lower interest rate because they are more likely to exercise the commitment. Thus, even risk neutral firms can signal to other institutions on the capital market (e.g. investors on the commercial paper market) its quality by purchasing the bank loan commitment. Similarly, Thakor and Udell (1987) show that a combination of a commitment fee and a service fee can be used as an effective tool for identifying the borrowers' probabilities of the loan takedown, i.e. they can serve as a screening device in the loan commitment contract (the borrowers with higher takedown probability choose a combination with higher commitment fee compensated by a

lower service fee because they have higher probability of actually paying the service fee). However, as in the case of the models with collateral, the fee level is again determined by the objective risk characteristics of borrowers and there is no testing as an alternative to screening.

Outside the literature on collateral and commitment fees, another interesting model with bank fees playing the role of a screening device is Loranth (2000). The model uses a specific industry structure with many incumbent banks and one entrant. The incumbents offer only credit services whereas the entrant offers a package of credit and financial services. The financial services are assumed to increase the return from the projects and the fee required for these services is paid upfront (thus is not dependent on the borrower's type). As a result of the screening, the better borrowers (with higher probability of successful completion of their projects) are served by the entrant. The same result is shown to hold also for an alternative industry structure - a vertically differentiated duopoly. However, similarly as in the cases above, screening is based on the relative risk characteristics of borrowers, there is no testing technology in the model and the assumed industry structure is very specific.

Our models are similar to the ones above in the role of screening played by fees. However, in the first part of the paper, we add a new degree of uncertainty to our model in the form of the borrowers' misperception about their abilities and in the second part of the paper, we enrich the standard setup by introducing testing as an alternative to screening by fees. We show that these modifications lead to interesting new explanations of the international differences in the level of bank fees.

1.3 Model

1.3.1 Imperfect knowledge about borrowers' skills

Let's assume there is a mass M of risk neutral borrowers of two types - good and bad, in proportions l and $1-l$, respectively. Both types have an opportunity to engage in a project[11] which requires the investment of 1 unit of money and has the return of X units in the case of success and 0 units otherwise (we assume the project is not ex-ante unprofitable, i.e. $X > 1$). The probabilities of success are p_1 for the good borrowers and p_2 for the bad borrowers, with $p_1 > p_2$.

Information is imperfect and asymmetric - some of the bad borrowers believe they are of the good type. Let the fraction of borrowers who believe they are good be equal to m (i.e. the total number of this group of borrowers is mM) and let q_1 be the fraction of good borrowers among those who believe they are good. We call this specific form of information imperfection noise. For simplicity of exposition, we now normalize the mass of borrowers believing to be good to 1 (i.e. $mM = 1$).

There is some initial wealth distribution which is independent on the type of borrowers but no borrower has sufficient wealth for investing into the project without borrowing additional funds (i.e. no borrower has wealth 1 or more units of money)[12].

[11] For the sake of expositional simplicity, we choose to present the model in terms of borrowers having projects. However, in the context of retail bank fees, we can also think of the borrower types in terms of their job stability (we thank one of the referees, Evan Kraft, for this point). Specifically, the good borrowers could be those who have stable jobs and thus are more likely to honor their loan commitments whereas the bad ones are more likely to lose their jobs and thus are also less likely to honor their loan commitments.

[12] Alternatively, it can be assumed that all borrowers have the same amount of initial endowment of money but there is a distribution of the willingness of borrowers to use these funds for investing into the project.

Banks cannot see the type of the borrower but they know the parameter q_1[13]. They are also not able to verify the initial wealth endowments of borrowers but they can verify the borrower's success in the project. They can offer loan contracts specified by the loan rate and the fee they charge for it. It is assumed that banks always lend the full amount needed for the project, i.e. all loans are of constant size equal to 1. We assume that the borrowers who believe themselves to be bad are ex ante unprofitable for the bank. We also denote $A = q_1 p_1 + (1 - q_1) p_2$. When the level of noise increases, q_1 decreases and so does A.

Generally, the bank's optimization problem is to find the profit maximizing combination of fee and interest rate. Different borrowers react to different combinations of these prices differently according to what type (good or bad) they believe themselves to be. Thus, banks can engage in screening and influence the composition of the pool of borrowers attracted by the offered contract. The two alternative bank's strategies are to offer a contract that attracts only the borrowers who believe themselves to be good or another contract that attracts both types of borrowers (we assume the latter group of borrowers is ex-ante unprofitable for the bank and thus there is no individual profitable contract for this group). The bank should calculate the profit from both these alternatives and then choose the one which leads to higher profit, i.e. the bank should decide whether it is optimal to use screening or not. We focus on the screening alternative here because it leads to interesting results about the influence of noise on the level of fees but we discuss the conditions under which this alternative is actually optimal later in the end of

[13]As banks know the parameter q_1 and the borrowers do not, the banks have informational advantage over the borrowers. However, compared to the informational advantage in Bond, Musto and Yilmaz (2006), the advantage is only partial and banks still cannot see the exact type of the borrower. Bond et al. (2006) assume the bank knows exactly whether a given borrower is good or bad and thus it can engage in predatory lending which is not possible in our model.

this section.

Under the screening alternative, the bank has the following 'per capita' profit function:

$$\pi_{pc} = A(1+r) + C - 1 \tag{1.1}$$

where r and C are the bank's choice variables, r being the loan interest rate and C the fee at the beginning of the loan contract. Fraction A of the population succeeds and repays the loan including the interest and everybody pays the fee C.

The initial wealth distribution and the presence of upfront fees imply that fewer and fewer borrowers are able to participate as the fee increases. We assume the wealth distribution implies a function $D(C)$ satisfying $D(0) = 1$, $D(1) = 0, D' \leq 0$ on $(0, 1)$. This function returns the fraction of borrowers who can afford to pay the given fee (no decision problem of borrowers is thus involved, a given contract C and r may be attractive but not feasible for some borrowers due to their limited wealth)[14].

Therefore, the total profit maximization problem of the bank takes the following form

$$\max \pi = \max_{C,r} [A(1+r) + C - 1)]D(C) \tag{1.2}$$

$$p_2[X - (1+r)] < C \tag{1.3}$$

$$p_1[X - (1+r)] \geq C \tag{1.4}$$

Condition 1.3 is a sufficient condition for making the contract unattractive to the borrowers who believe themselves to be bad and condition 1.4 is the participation constraint of the borrowers who believe themselves to be good.

[14]For an illustration of the derivation of the function $D(C)$ see the Appendix.

Later we argue that under monopoly condition 1.4 is binding. Thus, we can solve this problem in the standard way as a constrained optimization problem with two variables. However, for discussions about alternative setups of the model and for the ease of comparative statics, we choose a different solution approach based on the following important insight (although this approach may first seem to be unnecessarily cumbersome).

Since all applying borrowers believe themselves to be good (we assume banks choose such combinations of fees and rates that only those who believe themselves to be good are interested in applying), they perceive the contract (C, r) as being equivalent to a hypothetical contract $(0, r_r)$ defined by

$$E(C + 1_{success} r) = E1_{success} r_r \tag{1.5}$$

which under risk neutrality of borrowers translates to

$$p_1 r_r = C + p_1 r \tag{1.6}$$

This follows from the fact that borrowers borrow a dollar, pay C upfront and pay r as the interest payment in the event of success; therefore, they believe they will pay $C + p_1 r$ in expectation. But this means that from the viewpoint of the borrowers there exists a unique r_r (henceforth called effective interest rate) such that $C + p_1 r = r_r$. Of course, we must assume that C is above the minimal rate required to discourage bad borrowers (this requirement will be discussed below).

Using the effective interest rate r_r, the bank's optimization problem can be solved in two steps. In the first step the bank chooses the optimal mixture of r

and C for a given effective interest rate r_r. In the second step it maximizes profit by selecting the optimal r_r.

The first step representation of the problem takes the following form

$$\pi(r, C) = \max_{C,r}[A(1+r) + C - 1)]D(C) \tag{1.7}$$

$$p_1 r_r = C + p_1 r \tag{1.8}$$

$$p_2[X - (1+r)] < C \tag{1.9}$$

$$p_1[X - (1+r)] \geq C \tag{1.10}$$

Lemma 1.1 *$\frac{dr}{dA}$ is positive for given r_r if $2(A - p_1)D'(p_1 r_r - p_1 r) - (A(1+r) + p_1 r_r - p_1 r - 1)D''(p_1 r_r - p_1 r)p_1 < 0$, which holds if D is concave or at least not 'too' convex - to be specified.*

Proof 1.1 *See the Appendix.*

The bank maximizes its profit for a given r_r which means that the level of fee C can be calculated from the equation defining the effective interest rate $p_1 r_r = C + p_1 r$. This implies that C must be increasing in the level of noise, i.e. $\frac{dC}{dA} < 0$.

The required characteristics of the function $D(C)$ are realistic because they are implied by reasonable assumptions about the wealth distribution in the population. Formally, $D(C)$ can be derived from the wealth distribution $f(W)$ in the following way

$$D(C) = 1 - \int_0^C f(W)dW = 1 - F(C)$$

If we assume that the population wealth distribution has the form of a Gaussian curve, we can expect the graph of the $D(C)$ function to be concave in the beginning as increasing fees disqualify only small numbers of the poorest borrowers and convex for high levels of fees as only the highest tail of the wealth distribution remains in the game.

If we assume that the population wealth distribution has the form of a Pareto distribution (as is usually assumed), we get a positive relationship between the level of noise and the level of fees for realistic values of parameters, although the implied $D(C)$ function is convex in that case. Moreover, using the Pareto distribution we can also study the impact of changing income inequality on the level of fees. It turns out that for realistic values of parameters increasing inequality leads to increasing fees. This has an intuitive explanation because a given level of fees disqualifies relatively fewer potential borrowers under higher inequality.

We receive analogous results also when we use the Log-normal distribution. In this case, it is also easy to study the relationship between the fee level and the average initial wealth in a given country. It turns out that for realistic values of the parameters increasing average initial wealth leads to increasing fees but decreasing share of fees on the average initial wealth. Thus, our model is in line with the observed empirical trends discussed above.

Detailed illustration of the relationship between the level of fees and the values of the main parameters under both the Pareto distribution and the Log-normal distribution is given in the Appendix.

Now, it remains to solve the second step problem, i.e. the optimization with respect to the effective interest rate r_r. This turns out to be easier than one might

expect because it is easy to show[15] that the bank's profit is increasing in r_r and thus the bank will choose the highest possible r_r. Under monopoly, the highest possible r_r coincides with the maximum willingness to pay of the borrowers who believe they are good. Formally, the effective interest rate chosen by the bank satisfies the good borrowers' participation constraint with equality, i.e.

$$p_1(X - (1 + r)) = C \tag{1.11}$$

which under the assumed risk-neutrality of borrowers translates to

$$r_r = X \tag{1.12}$$

Note that the maximum willingness to pay of the borrowers who believe themselves to be good is independent of A. The important implication for us is that the optimal level of the effective interest rate is also independent on the level of A and thus our conclusion about $\frac{dC}{dA} < 0$ remains valid.

We have discussed the first of the bank's strategies - the screening option. The alternative strategy is to offer such a contract which attracts both types of borrowers (differentiated by their beliefs about their own type). The pooling contract does not have to violate the participation constraint of the borrowers who believe themselves to be bad and thus the level of the fee can be set to a lower level than in the screening contract. A lower fee in turn means potentially more applying good borrowers, who would not otherwise be able to apply due to their low initial wealth.

[15]For the proof of the positive relationship between bank's profit and r_r see the Appendix.

The optimization problem under the pooling strategy looks as follows

$$\pi(r, C) = \max_{C,r}([lp_1 + (1-l)p_2](1+r) + C - 1)D(C)M \tag{1.13}$$

$$p_2[X - (1+r)] \geq C \tag{1.14}$$

The participation constraint of the good borrowers is redundant in this case because it is implied by the participation constraint of the bad borrowers. Under monopoly, the bank fully exercises its market power and thus sets such a combination of C and r that the participation constraint of the bad borrowers is satisfied with equality. Thus, the optimization problem becomes easily solvable allowing the bank to compare the resulting profitability with that of the screening contract in order to choose the best strategy. The level of the fee in the pooling contract obviously does not depend on the level of noise because the proportion q_1 does not even enter the profit function under the pooling strategy.

The relative profitability of the two strategies depends on the level of the following parameters. First, the higher is the fraction of the borrowers believing to be good (the parameter m), the more attractive is the pooling contract. This is because higher m means relatively lower number of the borrowers in the second group which implies relatively less important worsening of the quality of borrowers faced by the bank. Second, the lower is the difference between the objective qualities of the good and bad borrowers p_1 and p_2, the greater restrictions imposes the participation constraint of the bad borrowers on the minimal level of the fee C and thus the less attractive is the screening strategy. Third, the lower is the fraction of the good borrowers among those believing to be bad, the more important is the worsening of the pool of borrowers faced by the bank under the pooling strategy

and thus the more attractive is the screening strategy.

1.3.2 Testing of borrowers

Next, we modify the setup of the model by introducing testing of borrowers. Banks are now assumed to possess a simple technology which allows them to sort the loan candidates into two categories. The first category consists of those candidates who passed the test and are identified as high quality borrowers and the second consists of the test failures identified as unworthy of receiving a bank loan. The testing technology is imperfect with the following commonly known characteristics: t_1 is the probability of a good borrower being identified by the test as a high quality candidate, t_2 is the probability of a bad borrower being identified as a high quality candidate, i.e. $1 - t_1$ is a type 1 error, t_2 is a type 2 error.

For simplicity, we now assume there is no noise in the economy, i.e. all borrowers know their type with certainty. We also assume the fraction of good borrowers in the total population is equal to l, i.e. $1 - l$ are the bad borrowers. The total population is now normalized to 1 (i.e. $M = 1$ and $m = 1$). Otherwise, we keep the setup from the previous section.

We maintain the assumption that the bad borrowers are ex-ante unprofitable for the bank, i.e. $p_2 X < 1$. This implies that the bank is still interested in attracting only the good borrowers and thus it is still targeting the effective interest rate defined as $p_1 r_r = C + p_1 r$. However, in this case, it may be profitable for the bank to offer a contract which is attractive even for the bad borrowers because high quality testing can function as a sufficient barrier against significant deterioration of the bank's profits due to large numbers of bad borrowers.

The bank's (first step) optimization problem thus changes to

$$\pi(r_r) = \max_{C,r}[(lt_1p_1 + (1-l)t_2p_2)(1+r) + C - 1)]D(C) \tag{1.15}$$

$$p_1r_r = C + p_1r \tag{1.16}$$

$$p_2[X - (1+r)] \geq C \tag{1.17}$$

When we denote $B = (lt_1p_1 + (1-l)t_2p_2)$ we can see the maximization problem simplifies to a problem which can be solved in the same way as the problem from the previous section. Following the same logic as above, Lemma 1.1 implies that $\frac{dC}{dB} < 0$. We can thus conclude that better testing leads to lower fees in equilibrium.

1.4 Conclusion

This paper contributes to the debate about the possible explanations of the vast international differences in retail bank fees. Specifically, we discussed two alternative model specifications which imply the observed negative relationship between the level of retail bank fees and the economic development of a country.

In both specifications, fees play the role of a self-selection device used by banks to alleviate the negative effects of asymmetric information in their relationship with potential clients (borrowers). The level of fees is given by balancing the trade-off between the average expected income per borrower and the size of the pool of borrowers faced by the bank. The lower is the average quality of borrowers the higher is the bank's motivation to charge higher fees to increase the per-borrower expected income, even at the cost of decreasing the total size of the pool

of borrowers attracted by the bank.

In the first specification, the average quality of the pool of borrowers is determined by the the degree of the borrowers' misperception of their abilities (noise). The higher is the degree of noise in the economy the higher fees we should expect. In the second specification, the assumption about noise is replaced by the assumption that banks use imperfect testing to assess the borrowers' types. The role of noise is then played by the quality of testing. It has been shown that lower quality testing implies higher fees in equilibrium.

We also provide a numerical illustration of our results using realistic values of the main parameters. The illustration supports the validity of our results about the positive influence of noise and negative influence of the testing quality on the fee level. Moreover, it also shows an interesting relationship between the fee level and both the income level and income inequality in a country. Firstly, under the parameters specified in the Appendix, the fee level is positively related to the inequality in the initial wealth distribution. Intuitively, under higher inequality the bank discourages relatively fewer potential borrowers with the same fee level. Secondly, although the influence of the average initial wealth level on the fee level is positive, the influence on the fee level as a share of the average initial wealth is negative. Thus, our results comply with the observed empirical phenomena.

Our results have important policy implications. According to our model, the level of bank fees in the transition and developing countries will evolve with the changing economic environment in these countries. To the extent that young emerging economies can be characterized by relatively higher degrees of noise, lower quality testing and often also higher income inequality, we can expect the levels of fees to decrease in time. Importantly, our model implies that higher

fees in the less developed countries do not necessarily have to be implied by less competitive banking markets.

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1.5 Appendix

1.5.1 Proof of Lemma 1.1

The bank's profit maximization problem defined in the text takes the form

$$\pi(r, C) = \max_{C,r}[A(1+r) + C - 1)]D(C) \tag{1.18}$$

$$p_1 r_r = C + p_1 r \tag{1.19}$$

$$p_2[X - (1+r)] < C \tag{1.20}$$

$$p_1[X - (1+r)] \geq C \tag{1.21}$$

Substituting $C = p_1 r_r - p_1 r$ leads to

$$\pi(r_r) = \max_{r}(A(1+r) + (p_1 r_r - p_1 r) - 1)D(p_1 r_r - p_1 r) \tag{1.22}$$

$$p_2[X - (1+r)] < C \tag{1.23}$$

$$p_1[X - (1+r)] \geq C \tag{1.24}$$

We receive the following FOC:

$$\frac{d}{dr}\pi(r_r) = \frac{d}{dr}((A(1+r) + (p_1 r_r - p_1 r) - 1)D(p_1 r_r - p_1 r)) = 0, \tag{1.25}$$

with the solution

$$\frac{d}{dr}((A(1+r)+(p_1r_r-p_1r)-1)D(p_1r_r-p_1r))= \tag{1.26}$$
$$(A-p_1)D(p_1r_r-p_1r)+(A(1+r)+(p_1r_r-p_1r)-1)D'(p_1r_r-p_1r)(-p_1)=0$$

Now we need to use the Implicit function theorem to show the sign of $\frac{dA}{dr}$. We first have to check the conditions for the applicability of the theorem. Thus, we have to show that $F = 0$ and $F' <> 0$. First, $F = \frac{d}{dr}\pi(r_r) = 0$ follows from the definition of the FOC, so the first condition is fulfilled. For the second condition, we assume that we work with a function fulfilling this inequality on a given $\varepsilon-$neighborhood of the optimal solution.

$$\frac{d}{dA}(A-p_1)D(p_1r_r-p_1r)+(A(1+r)+(p_1r_r-p_1r)-1)D'(p_1r_r-p_1r)(-p_1) <> 0 \tag{1.27}$$

Applying the Implicit function theorem (assuming D is not dependent on A)

$$\frac{dr}{dA}=-\frac{D(p_1r_r-p_1r)+(1+r)D'(p_1r_r-p_1r)(-p_1)}{2(A-p_1)D'(p_1r_r-p_1r)(-p_1)+(A(1+r)+p_1r_r-p_1r-1)D''(p_1r_r-p_1r)p_1^2} \tag{1.28}$$

Now, we decompose the formula to evaluate the sign of $\frac{dr}{dA}$. We know that $D(p_1r_r-p_1r)>0$ because D takes values between 0 and 1 and $(1+r)D'(p_1r_r-p_1r)(-p_1) \geq 0$ because D is a decreasing function from definition. Thus the nominator is positive.

Concerning the denominator, we know that the following always holds

$$(A-p_1)=q_1p_1+q_2p_2-p_1<0 \tag{1.29}$$

because $p_1 > p_2$ and $q_1, q_2 < 1$. Thus, the first part of the summation in the denominator is always negative. Concerning the second part of the denominator, we know that

$$(A(1+r) + p_1 r_r - p_1 r - 1) \geq 0 \tag{1.30}$$

as this is the per capita profit of the bank. The sign of $D''(C)$ naturally depends on the shape of the $D(C)$ function. We receive the result $\frac{dr}{dA} > 0$ if $D(C)$ is concave, linear or even if it is convex, but not 'too convex', so that the denominator is still negative.

1.5.2 Proof of the positive relationship between bank's profit and r_r

We want to prove that $\pi(r_r)$ defined by the following equation is increasing in r_r.

$$\pi(r_r) = \max_{C,r}[A(1+r) + C - 1)]D(C) \tag{1.31}$$

$$p_1 r_r = C + p_1 r \tag{1.32}$$

$$p_2[X - (1+r)] < C \tag{1.33}$$

We take r_{r1} and r_{r2} where $r_{r2} > r_{r1}$, and compare values of π. Let (C^*, r^*) be the optimal solution for $\pi(r_{r1})$, so optimal value is $[A(1+r^*)+C^*-1)]D(C^*)$. We can also use $(C^*, r^* + (r_{r2} - r_{r1}))$ as a feasible solution for $\pi(r_{r2})$. But the profit in this case is $\pi(r_{r1}) + A(r_{r2} - r_{r1})D(C^*)$ which is clearly greater than $\pi(r_{r1})$. That is what we wanted to show[16].

[16] the condition 1.33 is satisfied for r_{r2} whenever it is satisfied for r_{r1}.

1.5.3 Illustration of the results under specified distributions of the borrowers' initial wealth

In this section of the Appendix, we provide a numerical illustration of the relationship between the fee level implied by our model and the value of the main parameters. Specifically, we focus on the effects of noise (or testing quality), the degree of the borrowers' initial wealth inequality and the average level of the borrowers' initial wealth. We provide illustrations for both the cases with the Pareto distribution and the Log-normal distribution of the borrowers' initial wealth.

In order to receive numerical results, we first need to specify the explicit formula for the fee level as a function of the parameters. We use the following first order condition implied by the optimization problem of the bank.

$$D(C)(A - p_1) - p_1(A(X - \frac{C}{p_1}) + C - 1)D'(C) = 0 \tag{1.34}$$

The solution for C clearly depends on the specific form of the $D(C)$ function.

Pareto distribution

The cumulative distribution function of the Pareto distribution is defined to be

$$F(x) = 1 - (\frac{x_m}{x})^k, \ x_m > 0, \ k > 0, \tag{1.35}$$

where x_m is the minimum value of x and k is a shape parameter. In order to suit our setup, we shift the distribution to the left by 1 and choose $x_m = 0$ (in order to be able to keep the minimum wealth level at 0). The implied form of the $D(C)$ function has the following form (the fee C now replaces x)

$$D(C) = (\frac{1}{C+1})^k,\ k > 0 \tag{1.36}$$

The parameter k is linked to the degree of wealth inequality through the following relationship to the Gini coefficient

$$G = \frac{1}{2k-1}, \tag{1.37}$$

where G stands for the Gini coefficient. Realistic values of the Gini coefficient vary from 0.2 to 0.6 (see Table 1.1 below) implying k's in the range of 3 and $\frac{4}{3}$.

Table 1.1: International comparison of Gini coefficients (Source: Human Development Report 2007/2008, United Nations Development Programme)

Country	Gini	Country	Gini	Country	Gini	Country	Gini
Denmark	0.25	Yemen	0.33	Malawi	0.39	Mexico	0.46
Japan	0.25	Switzerland	0.34	Mauritania	0.39	Rwanda	0.47
Sweden	0.25	Armenia	0.34	Israel	0.39	People's Republic of China	0.47
Czech Republic	0.25	Kazakhstan	0.34	Burkina Faso	0.40	Guinea-Bissau	0.47
Norway	0.26	Greece	0.34	Morocco	0.40	Nepal	0.47
Slovakia	0.26	Indonesia	0.34	Tunisia	0.40	Mozambique	0.47
Bosnia and Herzegovina	0.26	Ireland	0.34	Russia	0.40	Madagascar	0.48
Finland	0.27	Egypt	0.34	Mali	0.40	Venezuela	0.48
Hungary	0.27	Vietnam	0.34	Sri Lanka	0.40	Malaysia	0.49
Ukraine	0.28	Poland	0.35	Georgia	0.40	Costa Rica	0.50
Germany	0.28	Laos	0.35	Ghana	0.41	Zimbabwe	0.50
Slovenia	0.28	Tanzania	0.35	Turkmenistan	0.41	The Gambia	0.50
Croatia	0.29	Spain	0.35	United States	0.41	Swaziland	0.50
Austria	0.29	Australia	0.35	Senegal	0.41	Niger	0.51
Bulgaria	0.29	Algeria	0.35	Cambodia	0.42	Zambia	0.51
Belarus	0.30	Estonia	0.36	Thailand	0.42	Papua New Guinea	0.51
Ethiopia	0.30	Italy	0.36	Burundi	0.42	Argentina	0.51
Kyrgyzstan	0.30	Lithuania	0.36	Kenya	0.43	Dominican Republic	0.52
Pakistan	0.31	United Kingdom	0.36	Singapore	0.43	Peru	0.52
Netherlands	0.31	New Zealand	0.36	Iran	0.43	El Salvador	0.52
Romania	0.31	Azerbaijan	0.37	Nicaragua	0.43	Ecuador	0.54
Albania	0.31	Benin	0.37	Hong Kong	0.43	Honduras	0.54
South Korea	0.32	India	0.37	Turkey	0.44	Chile	0.55
Canada	0.33	Uzbekistan	0.37	Nigeria	0.44	Guatemala	0.55
Tajikistan	0.33	Latvia	0.38	Philippines	0.45	Panama	0.56
France	0.33	Portugal	0.39	Cameroon	0.45	Brazil	0.57
Mongolia	0.33	Guinea	0.39	Côte d'Ivoire	0.45	South Africa	0.58
Belgium	0.33	Jordan	0.39	Uruguay	0.45	Paraguay	0.58
Moldova	0.33	Trinidad and Tobago	0.39	Jamaica	0.46	Colombia	0.59
Bangladesh	0.33	Republic of Macedonia	0.39	Uganda	0.46	Haiti	0.59

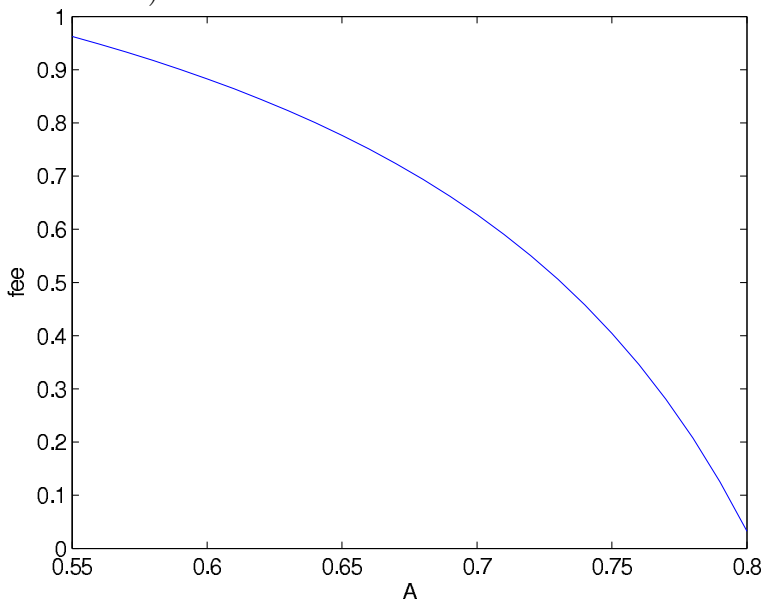
Source: Human Development Report 2007/2008, United Nations Development Programme 2007.

The relationship between the fee level and A under the Pareto distribution of initial wealth

We first focus on the relationship between the fee level and the size of the parameter A (i.e. the inverse of noise). As A represents the expected probability of success of the borrowers who believe themselves to be good, we expect reasonable values of this parameter to be between 0.5 and 0.8.

We set the remaining parameters to be $p_1 = 0.95$, $X = 1.3$ (i.e. we assume 30% return to the project) and $k = 2.5$ (corresponding to the Gini coefficient equal to 0.25). The values of the fee C implied by these parameters and by the values of A within the range of 0.55 and 0.8 are depicted on Figure 1.1 below.

Figure 1.1: The relationship between the fee level and A under the Pareto distribution of initial wealth)

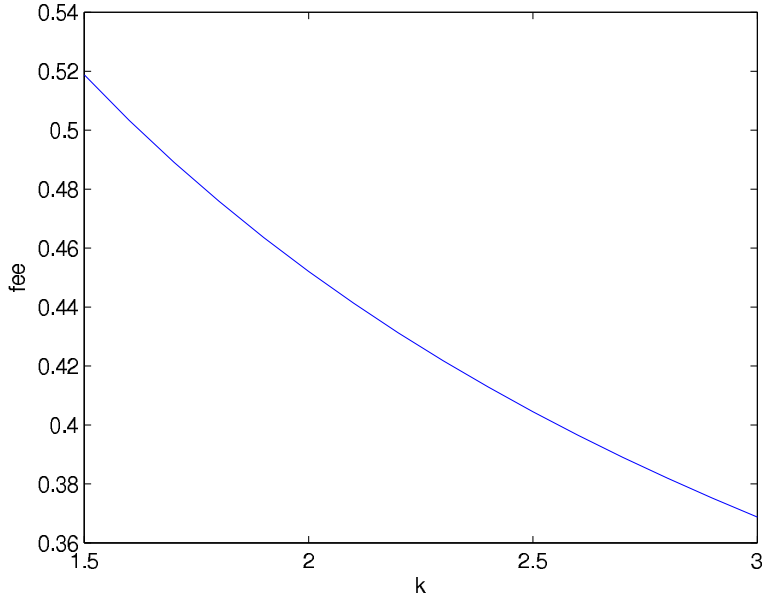


The illustration shows that under reasonable assumptions about the parameter values the fee level is negatively related to the value of the parameter A, implying that it is positively related to the level of noise and negatively related to the quality of testing.

The relationship between the fee level and initial wealth inequality under the Pareto distribution of initial wealth

Next, we focus on the relationship between the fee level and the degree of the borrowers' initial wealth inequality measured by the parameter k. Thus, we calculate the fee levels for k within the range of 1.5 to 3 which corresponds to the Gini coefficients between 0.5 and 0.2. We choose $A = 0.75$ and keep the remaining parameters on the same level as above. The implied values of the fee C are depicted on Figure 1.2 below.

Figure 1.2: The relationship between the fee level and k (under the Pareto distribution of initial wealth)



The illustration shows that under reasonable assumptions about the parameters values the fee level is negatively related to the value of the parameter k and thus also positively related to the degree of the borrowers' initial wealth inequality (the Gini coefficient).

Log-normal distribution

The cumulative distribution function of the Log-normal distribution is defined to be

$$F(x) = \frac{1}{2} + \frac{1}{2} erf(-\frac{(ln(x) - \mu)}{\sigma\sqrt{2}}), \tag{1.38}$$

where μ and σ are parameters which we have to specify.

The Gini coefficient for the Log-normal distribution can be calculated as

$$G = 2\Phi(\sigma/\sqrt{2}) - 1, \tag{1.39}$$

where Φ is the cumulative distribution function of the standard normal distribution.

The relationship between the fee level and A under the Log-normal distribution of initial wealth

As in the case of the Pareto distribution, we first focus on the relationship between the fee level and the size of the parameter A (i.e. the inverse of noise). We again choose the value of the Gini coefficient to be equal to 0.25 and we also choose the mean of the distribution representing the average initial wealth in the population to be equal to 0.4, i.e. slightly less than a half of the size of the project[17] (we focus on the relationship between these parameters and the fee level later in the Appendix). The choice of the Gini coefficient determines the value of the parameter σ which together with the selected value of the mean determines the parameter μ through the following expression for the mean E of the Log-normal distribution

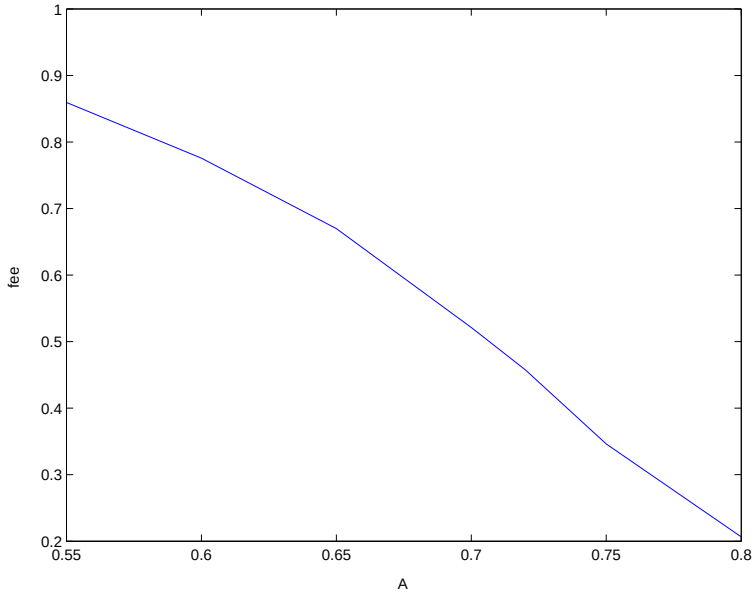
$$E = exp(\mu + \frac{\sigma}{2}) \tag{1.40}$$

We keep the remaining parameters p_1 and X on the same level as in the case of the Pareto distribution (i.e. $p_1 = 0.95$ and $X = 1.3$). The values of the fee C implied by these parameters and by the values of A within the range of 0.55 and 0.8 are depicted on Figure 1.3 below.

The illustration shows that the fee level is again negatively related to the value of the parameter A, implying that it is positively related to the level of noise and

[17]For this value of the distribution mean we receive results very close to the previous illustration with the Pareto distribution; however, the negative relationship between the parameter A and the fee level holds also for other values of the distribution mean, very similar results were received for values 0.3 and 0.5, for example.

Figure 1.3: The relationship between the fee level and A (under the Log-normal distribution of initial wealth)



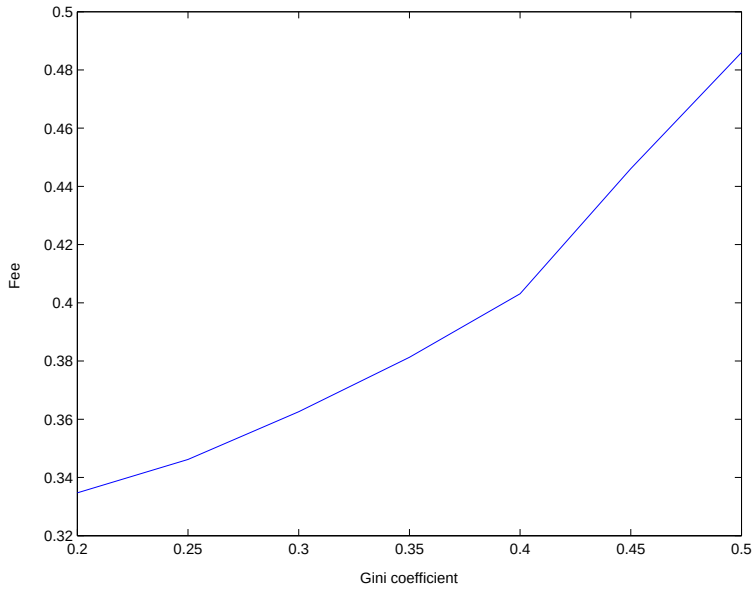
negatively related to the quality of testing.

The relationship between the fee level and initial wealth inequality under the Log-normal distribution of initial wealth

We proceed to the illustration of the relationship between the fee level and the degree of the borrowers' initial wealth inequality measured by the Gini coefficient. We choose $A = 0.75$ and keep the remaining parameters on the same level as above. The mean of the distribution together with σ implied by the Gini coefficient determines the value of μ. The values of the fee C implied by these parameters and by the values of the Gini coefficient within the range of 0.2 and 0.5 are depicted on Figure 1.4 below.

The illustration shows that the fee level is again positively related to the degree of the borrowers' initial wealth inequality (the Gini coefficient).

Figure 1.4: The relationship between the fee level and the Gini index (under the Log-normal distribution of initial wealth)



The relationship between the fee level and average initial wealth under the Log-normal distribution of initial wealth

Finally, we focus on the relationship between the fee level and the average initial wealth. The Gini coefficient is set to be equal to 0.25 and thus the value of σ is determined. We keep the parameters X, p_1 and A on the same levels as in the previous part, i.e. they equal to 1.3, 0.95 and 0.75, respectively. The values of the fee C implied by these parameters and by the values of average initial wealth within the range of 0.3 and 0.7 are depicted on Figure 1.5 below.

The illustration shows that the fee level is positively related to the value of average initial wealth. However, Figure 1.6 shows that our results imply a negative relationship between the average initial wealth and the fee level as a share of the average initial wealth.

Figure 1.5: The relationship between the fee level and the average initial wealth (under the Log-normal distribution of initial wealth)

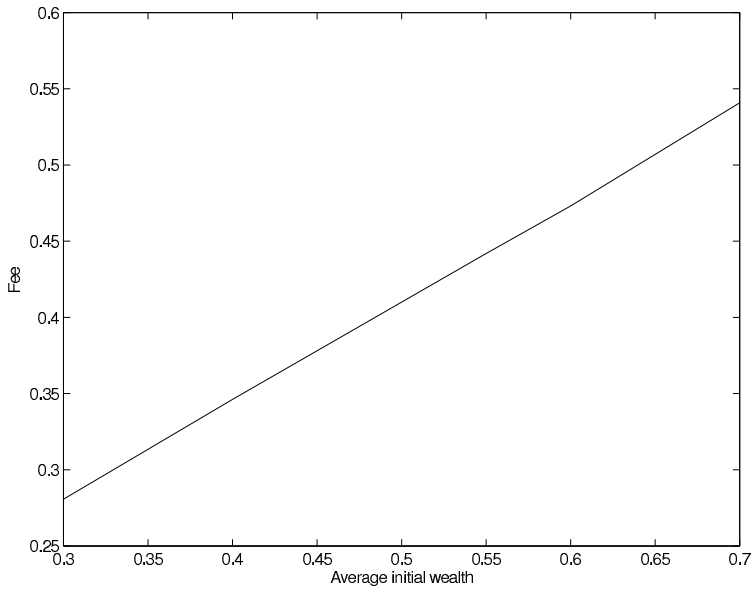
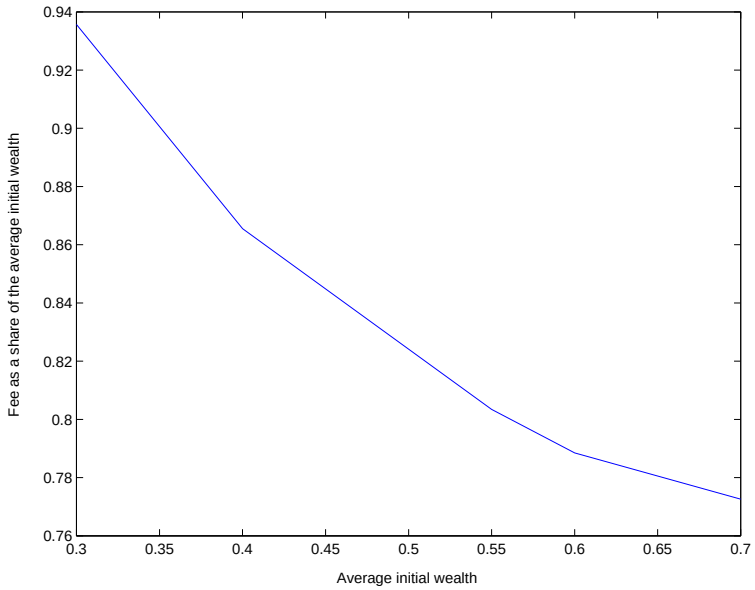


Figure 1.6: The relationship between the fee level as a share of the average initial wealth and the average initial wealth (under the Log-normal distribution of initial wealth)



1.5.4 Empirical evidence on international differences in fees

The following chart illustrates the international differences in retail bank fees scaled by the GDP per capita in the given country. The fees are measured by a fee index calculated by Capgemini, EFMA and ING (2005).

Figure 1.7: Prices of core banking services versus GDP per inhabitant (percent) (Source: World Retail Banking Report, Capgemini, EFMA, ING 2005)

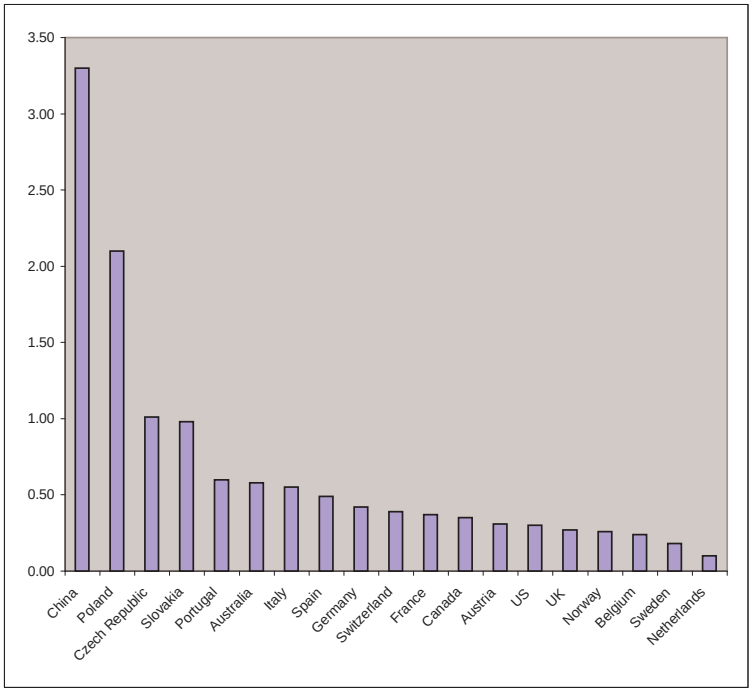
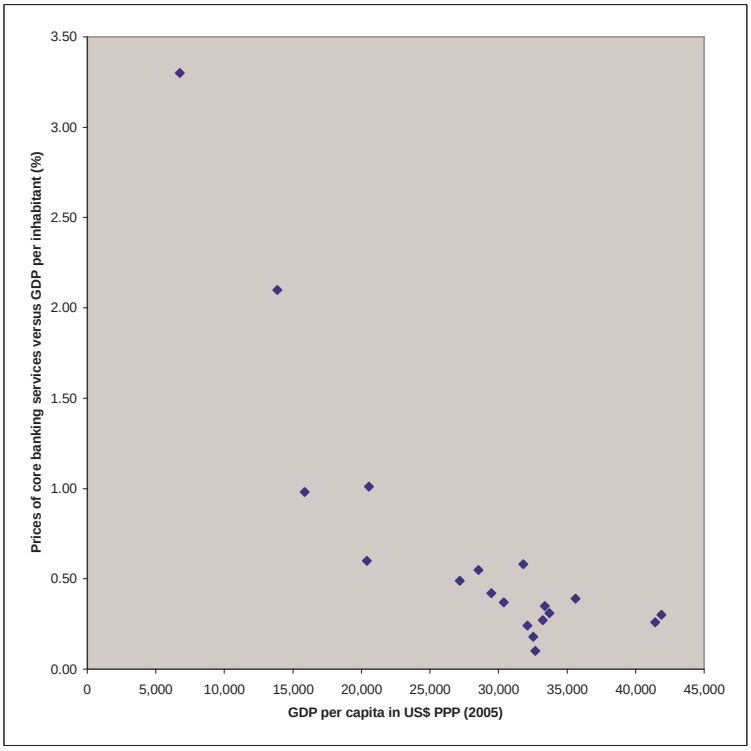


Figure 1.8: Prices of core banking services versus GDP per inhabitant (percent) (Source: World Retail Banking Report, Capgemini, EFMA, ING 2005)



Chapter 2

Credit Bureaus as a Competition Softening Device under Transactional Banking

(Joint work with Petr Chovanec)

Abstract

In this chapter we modify the Broecker (1990) model of interbank competition with costless testing by introducing credit bureau services. Unlike Broecker, we show that there exists a symmetrical pure strategy Nash equilibrium in which all banks fully use the credit bureau services. We show that this pure strategy equilibrium can be interpreted as a competition softening (tacit collusion) outcome because credit bureaus allow banks to coordinate on loan rates independent on marginal costs. Compared to the existing models, our results are not based on the existence of informational rents and thus they hold even under transactional banking. The higher is the number of banks the less likely is the competition softening outcome (the conditions for the competition softening equilibrium are less likely to be satisfied) and thus there exists the optimal number of banks in the market under the conditions of free entry.

2.1 Introduction

Information sharing through bank credit bureaus or public credit registers[1] plays an important role in the interaction between banks and borrowers in the credit market. Some form of information sharing between banks exists in almost all developed and emerging countries around the world, though the specific form of information sharing may differ significantly across countries[2].

Four main reasons for the existence of information sharing between banks have been identified in the literature[3]. Specifically, credit bureaus decrease the degree of asymmetric information between banks and borrowers, decrease borrowers' incentives to moral hazard, act as a barrier against borrowers' over-indebtedness and finally soften competition between banks through the reduction of informational rents obtained by banks in the relationship with their clients[4]. In this paper, we make a contribution related to the competition softening rationale for inter-bank information sharing.

The current explanation of the competition softening effect relies on the assumption of a longer lasting relationship between a bank and its borrowers. The bank can secure valuable informational rents on future lending (repeated lending contracts) only by first getting to know the borrower in the first lending contract. The existence of these informational rents motivates banks to compete today aggressively for tomorrow's rents. Sharing information about the borrowers' quality decreases these rents and thus also makes competition between banks less ag-

[1] For a review of the different types of information sharing instruments see Section 2.2.

[2] For the different forms of information sharing see for example Jappelli and Pagano (2005).

[3] For a comprehensive review of the theoretical reasons for credit bureaus and public credit registers see Japelli and Pagano (2005)

[4] These reasons are discussed in greater detail in the literature review in Section 2.3.

gressive[5]. The crucial assumption of the banks' expectation of a longer lasting relationship with their clients can be identified with the presence of relationship banking.

However, relationship banking is only one of two main forms of banking approaches to the credit market in general. Apart from relationship banking, banks also use transactional banking which can be defined as a bank offering targeted at clients who are not expected to stay with the bank for a longer time period. The bank is obviously not able to benefit from the improved knowledge about the client's characteristics under transactional banking. Which one of the two approaches becomes more prevalent in a specific banking market depends on a number of factors, the degree of competition being one of the crucial ones[6]. Thus, the banking markets in different countries may greatly differ in the relative importance of relationship and transactional banking depending on how competitive are the banking markets in these countries. Some authors even argue that the current trend in general seems to be a move of mainstream banking institutions from relationship banking to the stronger use of credit scoring[7]. Relationship banking is also relatively less relevant in the case of retail banking as repeated borrowing is relatively less likely for households than for firms (for example, a typical household can be expected to take only one mortgage in its lifetime).

We present a model showing that inter-bank information sharing through credit bureaus or public credit registers makes competition less intense (leads to the competition softening effect) even under transactional banking. Thus, we show

[5]See the discussion of Gehrig and Stenbacka (2007) in the Literature Review.

[6]The effect of competition on relationship banking is studied by Petersen and Rajan (1995), Boot and Thakor (2000) or Degryse and Ongena (2007).

[7]See for example Holmes, Isham, Petersen and Sommers (2007).

the competition softening effect of information sharing can be also expected in segments or even countries with a transactional banking environment.

Besides being a contribution to the literature on the alternative rationales for the inter-bank information sharing through credit bureaus or public credit registers, our model also contributes to the literature on competitive equilibria under asymmetric information in banking. We argue that credit bureaus or public credit registers can play an equilibrating role and prevent the inter-bank competition from resorting to mixed strategy zero profit outcomes which we don't see in reality.

The paper is organized in the following way. In the next section, we briefly review the different forms of interbank information sharing mechanisms relevant to our model. Next, we review the relevant literature and move to the exposition of the model. We conclude with a discussion of the implications of our research.

2.2 Alternative forms of interbank information sharing

The purpose of this section is to briefly describe the alternative forms of interbank information sharing relevant to our model. It is not meant to be a comprehensive overview of all the possibilities which can be found in practice. Most of the material in this section is based on Jappelli and Pagano (2005) who provide a thorough discussion of the subject (the historical background overview is based on Miller (2000)).

Generally, the two main types of information sharing mechanisms are credit

bureaus and public credit registers. The distinguishing feature between the two is the nature of their membership. Credit bureaus are characterized by voluntary membership based on reciprocity of its members whereas public credit registers have mandatory membership and usually all loans above some selected threshold size must be reported. Although most countries have some form of information sharing mechanism in place, the specific use of credit bureaus and public credit registers varies significantly between countries. The information sharing system of a given country can be based either on a credit bureau only, public credit register only or both mechanisms simultaneously.

Credit bureaus are the prevailing form of interbank information sharing in the US. Since the nineties the industry has gone through the process of consolidation resulting in the current dominant position of three main credit bureaus, Equifax, Experian and Trans Union in the consumer credit market and Dun and Bradstreet in the small business market. Contrary to the US, public credit registers are used in many European countries, often in combination with private credit bureaus (the first public credit register in Germany was set up in 1934). Generally, public credit registers and credit bureaus boomed in the nineties of the last century as a result of the negative experience with the severe financial crises around the world (e.g. the Mexican credit bureau system established in 1995 was supported by the government after the end of the Tequila crisis).

The information shared through a credit bureau or a public credit register is usually categorized as being either negative or positive (black or white information). Negative information usually consists of information about the borrower's past defaults and other loan repayment delinquencies. Positive information may include information such as the borrower's account balances or balance sheet in-

formation in the case of corporate borrowers. Credit bureaus may also provide some additional services derived from negative and positive information such as credit scoring.

Besides the negative and positive information, credit bureaus and public credit registers usually also provide information which can be used to infer the borrower's application history. Specifically, a borrower's credit report usually includes information about credit inquiries over a given time period (typically several years), i.e. a list of all subjects who have requested the borrower's credit report. The credit report further distinguishes between voluntary (approved by the borrower applying for a loan) and involuntary credit inquiries (usually used by financial institutions for targeted offerings for their clients). The information about the voluntary inquiries together with the information about the borrower's existing loans can be used to infer her application history. This can be understood as a specific type of information falling between the traditional categories of negative and positive information.

The model presented in this paper relates to both credit bureaus and public credit registers. Information sharing is beneficial for banks in our model and thus the existence of information sharing does not depend on the mandatory membership of the public credit registers because banks are naturally motivated to support the creation of a credit bureau. We use the assumption that the information shared is the borrower's application history. The results of the model are robust to the alternative assumptions about what information is being shared. Specifically, analogous results can be obtained even if banks share the information about the borrower's past defaults. We assume sharing the information about application history because we want to show that sharing this type of informa-

tion can be valuable for banks (to our best knowledge, we are the first to point this out) and also because this assumption is more relevant to the transactional banking environment we are interested in modeling.

2.3 Literature Review

The seminal paper in the literature on credit bureaus and public credit registers is Jappelli and Pagano (1993) who show that credit bureaus can be beneficial for banks by decreasing the adverse selection effects implied by the asymmetric information between banks and borrowers. Banks in their model are assumed to be monopolies in local markets whereas borrowers are mobile and a fraction of them randomly moves between the markets. Banks know the borrowers' characteristics in their local market but don't know the type of the borrowers coming from other markets. The exchange of information with the banks from other markets improves the bank's knowledge about the incoming borrowers. Jappelli and Pagano show that information sharing is more likely to be adopted by banks the higher is the mobility of borrowers, the more heterogeneous they are and the higher is the number of banks. On the other hand, information sharing is less likely when markets are contestable. Volume of lending is higher under information sharing when adverse selection is sufficiently severe.

Pagano and Padilla (2000) use a two-period model of bank competition to show the disciplining effect of credit bureaus. Banks have perfect information about their clients but don't know anything about the other banks' clients. Perfect information means banks can extract all surplus from their clients, thus, entrepreneurs don't have incentives to invest into improving their business. Under information sharing,

there is a symmetric competition in the second stage - the competition is thus more intense implying that surplus is shared between banks and entrepreneurs (second period informational rents are decreased). The borrowers' incentives are thus increased. From the banks' viewpoint, the first period profit is increased due to higher borrowers' effort (effort for both periods is chosen prior to any borrowing) and the second period profit is decreased due to more intense competition. In an alternative setup, Pagano and Padilla show that sharing information about borrowers' past defaults can be used as a tool against the negative effects of the borrowers' over-indebtedness.

Gehrig and Stenbacka (2007) show that information sharing through credit bureaus or public credit registers might also be anti-competitive. They illustrate their point on a simple two period model of banking competition. Without information sharing, banks engage in aggressive first period competition for the second period informational rents. Information sharing makes the second period competition symmetric, informational rents are eliminated and the first period competition is thus less intensive and profits are increased.

Bouckaert and Degryse (2002) present a similar idea. They build a two-period model of endogenous incumbency, in which in the first period firms fight for the second period incumbency. Information sharing lowers the second period entry barriers and thus it also softens the first period competition.

The presence of a bank-borrower relationship is the crucial assumption behind the two last models mentioned above. We show that similar effect occurs even without this restrictive assumption. Also, none of the models reviewed above focuses on the potential effects of sharing the information about the borrowers' loan application history (the existing literature deals with the sharing of the information

about borrowers' performance in the repayment of loans that have already been awarded to them or the information about the borrowers' quality). Furthermore, none of the models focuses on the interaction of information sharing and screening (testing) of borrowers. In our paper, we argue that sharing the information about the borrowers' loan application history might have important implications for the efficiency of the bank's testing procedures.

Our paper also contributes to the literature on credit market equilibrium under asymmetric information. Specifically, it shows that information sharing may lead to pure strategy equilibrium in a model conceptually based on the seminal work of Broecker (1990). Broecker models bank competition with costless screening and finds that there are no pure strategy equilibria, only mixed strategy equilibria exist with banks earning zero profits. This result follows from a negative externality of testing - the more banks are active in the market, the worse distribution of borrowers is faced by each of the banks (borrowers can apply to more than one bank). Interest rates are shown to be rising in the degree of competition (number of banks) as the higher number of banks increases the probability of a bad project passing the screening test of at least one bank in the market. There are no pure strategy equilibria because undercutting other banks is profitable even if the current rates equal marginal costs - the lower rate attracts the best borrowers and thus improves the pool of borrowers faced by the undercutting bank. Thus, the model leads to the unrealistic result of erratic movements of interest rates and zero profits of banks.

A number of authors have tried to find reasonable explanations why we don't see such outcomes in reality. Gehrig (1998) builds on the approach of Broecker (1990) and models competition between banks which can choose the level of their

screening intensity. He shows that increased competition may lead to lower incentives to screen. There are two opposing effects of increased competition on the level of interest rates - traditional competition effect leading in the direction of decreasing the rates and an information effect leading in the direction of increasing rates due to the worse pool of borrowers. Gehrig studies two industry cases: 1) the game of incumbent and an entrant case in which the entrant might choose not to screen at all and charge higher rates while the incumbent screens intensively in a pure strategy equilibrium and 2) simultaneous oligopolistic competition in which no pure strategy equilibria exist with screening and a no screening pure strategy equilibrium exists.

Freixas et al. (2004) extends the Broecker (1990) model by introducing small application costs and convex screening costs. The introduction of small application fees leads to sequential application process - borrowers who do not pass the test at the first bank go to the second bank, if again they fail to pass the test, they go to yet another bank etc. The pool of borrowers faced by each individual bank is again worse the more banks there are. The introduction of the convex screening costs is then shown to lead to the existence of pure strategy equilibria. The increase in the screening costs might offset the improvement in the borrowers' pool rendering the undercutting strategy unprofitable. However, the model rests on the questionable assumption of convex screening costs.

In this paper, we show that information sharing through credit bureaus can be used as an effective equilibrating device in a setup derived from Broecker (1990).

2.4 Model

2.4.1 Setup

The setup of our model is conceptually based on the Broecker (1990) setup. Our model contains an additional element – the information sharing mechanism in the form of a credit bureau (or a public credit register). Credit bureau is modeled as additional information available to banks participating in the credit bureau system – each of these banks can see how many times a given borrower has already been denied credit before applying to this bank. We also assume that due to the credit bureau system, borrowers apply sequentially and not simultaneously (i.e. they are allowed to file one loan application at a time)[8].

Let's assume there is a unit mass of potential borrowers of two types - good (subscript a) and bad (subscript b), in proportions l and $1-l$ respectively (the proportions are common knowledge). The borrowers have the opportunity to invest in a project which requires initial investment of 1 unit of money and returns either 0 or X_i units of money, where i stands for a or b. Although it is reasonable to expect $X_a \geq X_b$ due to the difference in quality between the two types of borrowers, we assume $X_a = X_b$ without loss of generality. The probability of successfully completing the project is p_i, with $p_a > p_b$. Borrowers have no initial wealth endowment and thus they have to borrow 1 unit of money from a bank if they desire to invest in the project.

There are N banks which can screen the borrowers by imperfect tests and charge interest rate r_n. The costless screening technology is exogenously given. In

[8]For example, simultaneous applications are reported by the credit bureau and only one loan application (randomly chosen) continues.

every period, banks first announce their rates and then borrowers choose a bank and apply for a loan from the chosen bank. We assume that due to the credit bureau system, in every period a borrower can apply only to one bank[9]. In this sequential application process, borrowers first go to the cheapest bank. If they pass the screening test then they get the loan from this bank and leave the pool of applicants. If however they are rejected then they go to the second cheapest bank in the next period and so on[10]. The tests of different banks are independent and thus the sequential application works even if two or more banks charge exactly the same rates (it is chosen randomly to which bank the borrowers go first in that case). The screening test assigns either 1 (accept) or 0 (reject) to each borrower. The technology is defined by the following a priori probabilities: $q(0|a) = q_a$, $q(1|a) = 1 - q_a$, $q(0|b) = q_b$, $q(1|b) = 1 - q_b$. We also assume that $0 < q_a < q_b < 1$.

2.4.2 Solution of the Model

Let us look for a symmetrical equilibrium with information sharing facilitated by the credit bureau. From the banks' viewpoint, each of the banks is approached by N different types of borrowers - these borrowers are differentiated by the number of tests they have already failed before approaching the current bank. Banks are thus able to charge different rates to these different types of borrowers (this could be seen as a type of price discrimination based on risk-adjusted pricing).

We base our solution of the model on the following simple insight. The rates for the N-th type of borrowers (i.e. those who have failed $N-1$ times already before

[9]This assumption guarantees that a bank cannot do unlimited screening and thus cannot get information of the same quality as the information received through the information sharing mechanism from the other banks, even though the screening technology is assumed to be costless.

[10]They cannot go to the same bank twice because this bank already knows the result of the test.

applying to the current bank - let us call these borrowers the N-th level) will be set equal to X because the borrowers of the N-th type have no other chance than to accept the offer of the last bank[11]. The bank can thus charge these borrowers their maximum willingness to pay.

Let's denote the profit each of the banks in the equilibrium gets from the N-th level as P. Then in the equilibrium, the rates for the $(N-1)$-st level have to be set to a level that leads to the same per-level profit P as in the case of the N-th level. This is always possible for two reasons: 1) there are more applicants on the $(N-1)$-st level than on the N-th level (some of the applicants on the $(N-1)$-st level pass the tests, become clients and leave the pool of applicants), 2) the average quality of the borrowers on the N-th level is lower than that of the borrowers on the $(N-1)$-st level. Thus the room for profit is always greater on the $(N-1)$-st level than on the N-th level.

This leads us to the following lemma:

Lemma 2.1 *If X is greater than the break-even rate for the N-th level r_0 implicitly defined by $(1-q_a)q_a^{N-1}l(p_a r_0 - 1) + (1-q_b)q_b^{N-1}(1-l)(p_b r_0 - 1) = 0$, then there exists an equilibrium[12] with the loan rates given by the backward induction process*

[11] This is true if X is larger than the break-even rate for this level - we discuss what happens otherwise later.

[12] Moreover, there are other equilibria which have the same rates, but some banks decide not to provide credit in some levels. These equilibria are comparable in the sense that they have the same profit and rates. Their existence does not affect the presented implications of the model but they are mathematically challenging. Therefore, we do not take them into account here.

described above, i.e. they are implicitly defined by

$$
\begin{aligned}
&(1-q_a)q_a^{N-1}l(p_aX-1)+(1-q_b)q_b^{N-1}(1-l)(p_bX-1)= \\
&=(1-q_a)q_a^{N-2}l(p_ar_{N-1}-1)+(1-q_b)q_b^{N-2}(1-l)(p_br_{N-1}-1)= \\
&=(1-q_a)q_a^{N-3}l(p_ar_{N-2}-1)+(1-q_b)q_b^{N-3}(1-l)(p_br_{N-2}-1)= \\
&... \\
&=(1-q_a)l(p_ar_1-1)+(1-q_b)(1-l)(p_br_1-1), \qquad (2.1)
\end{aligned}
$$

where r_{N-1} stands for the rate for the $(N-1)$-st level of borrowers, r_{N-2} for the rate for the $(N-2)$-nd level etc ($r_N = X$).

Proof 2.1 *See the Appendix.*

Lemma 2.1 implies that the specified pure strategy equilibrium exists whenever the N-th level of borrowers is ex-ante profitable for a bank, i.e. whenever

$$(1-q_a)q_a^{N-1}l(p_aX-1)+(1-q_b)q_b^{N-1}(1-l)(p_bX-1)\geq 0, \qquad (2.2)$$

which is more likely to be satisfied the higher are the parameters X, p_a, p_b, l and the lower is the number of banks N. The relationship to q_a and q_b is more complicated as the left-hand side of the above inequality is generally not monotonic in these two parameters.

What happens when X is lower than the break-even rate for the last level? In that case, there is a Bertrand-type competition between banks for each of the levels of borrowers with the result of zero profit for all banks. For each level of borrowers, each of the banks is tempted to undercut the other banks in order to

increase its pool of borrowers. Banks compete only for the levels of borrowers who are ex-ante profitable for them. This means the number of the levels for which banks compete is strictly smaller than the number of banks and thus all borrowers always have a choice which bank to apply to. Thus, banks cannot apply monopoly power with respect to any of the borrowers.

Importantly, the higher is the number of banks, the less likely is the existence of the competition softening pure strategy equilibrium. The more banks there are, the higher is the probability that X is lower than the break-even rate for the last level in which case there is only the zero-profit pure strategy equilibrium. This is because the average quality of each additional level of borrowers is worse compared to the previous level.

The crucial result of interest for us is that the loan rates determined by the backward induction process described above are clearly independent on marginal costs and thus allow space for positive economic profit for banks. Information sharing facilitated by the credit bureau system effectively gives banks greater market power with respect to borrowers. Importantly, this effect is not dependent on any dynamics implied by the continuation of the bank-borrower contract and thus it is relevant even for one-shot encounters between banks and borrowers in the environment of transactional banking.

2.4.3 Extension of the Model

In the model described above, we assumed that the borrowers' application process is sequential due to the existence of the interbank information sharing mechanism, i.e. the credit bureaus or public credit registers. However, it could be argued

that in the model described above, banks can achieve the same sequentiality by announcing that they will test loan applicants only at certain specified time points, i.e. they will carry out only one stage of the described application and testing process at a time (e.g. on a specified day once in a week). Although unrealistic, such a setting would allow banks to distinguish the different levels of borrowers even without the information sharing mechanism because only one level of borrowers will appear at the banks' doors every period and banks would always know with certainty which level they are facing in a given period.

In order to show that our results do not depend on the specific setup described above, we now discuss an alternative setup which is derived from the original one but is robust to the objection expressed in the previous paragraph. Specifically, every period a unit mass of borrowers of the two types is born and the game has infinitely many stages. Furthermore, we assume banks discount future streams of payoffs by a discount factor δ. Otherwise, the setup is the same as in the original game.

The main distinguishing feature of the new setup is that banks are always (with the exception of the very first period) faced by a mixture of different levels of borrowers so that there is always uncertainty about what level a specific borrower belongs to. Specifically, in the first stage there are only level-one borrowers. In the second stage there is a number of level-two borrowers (those rejected in the first period) and a unit mass of level-one borrowers (the newborn ones). The mixture of borrower types in the other stages can be derived analogously.

The solution of this infinitely repeated game depends on the size of the discount factor δ. Intuitively, for high enough δ any feasible outcome at least as good as the zero profit solution can be supported by suitable strategies as a Nash equilibrium

of the repeated game, no matter whether the interbank information sharing mechanism is in place (this follows from the folk theorem[13]). Thus, even the solution that all banks charge rates equal to X in every stage can be supported as a Nash equilibrium of the game (e.g. when all banks use trigger strategies). On the other hand, for extremely small δ the zero profit solution is the only solution, no matter whether the interbank information sharing mechanism is in place (banks do not care about the future).

The interesting case for us is when the discount factor δ takes on intermediate values such that neither of the two extremes described above applies. In such a case, each bank has a motivation to undercut the others and seize the whole market in the first period. Thus, the collusion equilibrium is not attainable and banks (if an interbank information sharing system is in place) revert to the non-cooperative equilibrium described in the previous section for each of the generations of borrowers (we define the generation of borrowers as all the borrowers who were born to the model in a given period).

It should be obvious that the attractiveness of the collusion equilibrium also depends on the number of banks in the market. For a higher number of banks the difference between the per-period collusion profit (the profit obtained from charging X to the N-th of the market) and the one-time per-period profit from deviation (the profit obtained from undercutting the other banks and seizing the whole market) is obviously higher and thus the attractiveness of sticking to the collusion equilibrium is smaller. This means that under free entry, the viability of collusion depends not only on the size of the discount factor δ but also on whether the non-cooperative equilibrium leads to the zero-profit Bertrand outcome or the

[13]For the discussion of the folk theorem see for example Kreps (1990).

competition softening outcome as defined in the previous section (i.e. whether X is smaller or greater than the break-even interest rate for the N-th level of borrowers).

2.5 Conclusions

In this paper, we have shown that interbank information sharing through credit bureaus or public credit registers may lead to softer competition (prices set independently of marginal costs) even under transactional banking (one-shot bank-borrower encounters, borrowers have to borrow funds only once). This result complements the findings of the existing literature in which the same result has been shown to hold for the case of relationship banking (repeated bank-borrower encounters, borrowers need to borrow funds more than once).

Our results can be seen as an addition to the list of alternative rationales for interbank information sharing because it can be concluded from our results that the assumed form of interbank information sharing is beneficial from the banks' point of view. Our results follow from the fact that banks do not have to compete for the borrowers who were previously rejected by all the other banks and thus they can exercise monopoly market power in relation to this type of borrowers. When an equilibrium exists in our model, the interest rates for the other types of borrowers are then derived by a type of backward induction process assuring no bank has a motivation to deviate from the resulting equilibrium.

We used the assumption that banks share the information about the borrowers' application history instead of the information about the borrowers' past defaults as in the existing literature. We have shown that this type of information can

prove to be very valuable for banks as a tool for increasing their profits (to our best knowledge, this has not been pointed out yet in the theoretical literature). However, we argue that the same results hold even with the traditional assumption that banks share the information about the borrowers' past defaults instead of the information about the application history.

Our paper also has important policy relevance. Firstly, the sequentiality of the borrowers' application process facilitated through a credit bureau or a public credit register serves as a stabilizing factor preventing the erratic movements of interest rates implied by a repeated mixed strategy equilibrium. Secondly, the existence of the competition softening pure strategy equilibrium in our model is more likely the lower is the number of banks in the market. As the competition softening pure strategy equilibrium can be interpreted as a more stable equilibrium compared to the zero-profit one (higher capital buffers due to higher banks' profits), we can conclude that our model implies that the increase in the number of banks active in the market with interbank information sharing may have a destabilizing effect on the local banking industry (local in the sense of the scope of the information sharing mechanism)[14]. Thirdly, if we allow for free entry, there is a maximum number of banks that choose to be active in the market. Thus, our model leads to a type of natural oligopoly industry structure in banking.

[14]Specifically, the banks' economic profit drops to zero when the addition of the last marginal bank to the banking industry leads to X being smaller than the break-even rate r_0 defined above. Of course, the implications for banking stability would have to be supported by a richer model than the present one because in our model banking industry is stable even with zero economic profit.

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2.6 Appendix

2.6.1 Proof of Lemma 2.1

Consider the case with $N = 2$. In order to prove the existence of an equilibrium, we have to show that no bank is tempted to deviate from the candidate for an equilibrium. In this candidate, in each level, every bank gains P. Let us first look at the motivation to undercut by ε on the first level (i.e., charging a lower rate for the yet untested borrowers). The undercutting bank would attract all the borrowers on the first level (i.e. all the borrowers in the market would first go to the undercutting bank). This would lead to the profit of $2(P - \varepsilon^*)$ for the undercutting bank which is clearly smaller than $2P$ under the equilibrium strategy (the undercutting bank would obviously not have any profit from the second level because all borrowers would have already applied to this bank on the first level).

Let us now consider the motivation to charge a higher rate to the yet untested borrowers - i.e. the overcharging strategy. The overcharging bank would deliberately forgo any profit from the first level (all the borrowers would first go to the other bank) but it would get a potentially positive profit from the second level. This profit would be equal to $2P$ as the overcharging bank would be approached by all the second level borrowers. If we assume that banks stick to the equilibrium strategy if indifferent between the equilibrium and some alternative strategy (there might be some small menu costs which favor the status quo) then the equilibrium in the case of $N = 2$ is proved.

Let us now generalize to the case of $N > 2$. Let us look for a symmetrical information-sharing equilibrium again (we will subsequently show that this equilibrium is unique). The rates charged by banks to the last level of borrowers must

again be equal to X. We claim that the rates charged to the lower levels of borrowers must again be set to such levels that the expected profit from each of the levels of borrowers is equal to P. Let us consider the case of $N = 3$ – the same argument applies to all the cases of $N > 2$. We can use the same argumentation as above to show that no bank is tempted to undercut or overcharge the rate set by other banks for the second level without changing the rate for the first level too; thus, we have to test only the optimality of the deviations from the first level and the of the combined deviations from the first and second level. When one of the banks undercuts on the first level then it gets $3(P - \varepsilon) < 3P$ which means it will decrease its profit relative to the equilibrium strategy. When the bank instead overcharges on the first level then it forgoes all profit from the first level as all the yet untested borrowers go to the other two banks. That means that on the second level half of the borrowers can go either to the first bank or the third (the deviating one) and the other half of the borrowers can go either to the second bank or the third. Thus, on average one half of the borrowers will go to the third bank on the second level. This in turn means that the profit of the third bank from the second level will be $\frac{3}{2}$ (in equilibrium, P is obtained from one third of borrowers). On the third level, the borrowers who went to the first bank on the second level (of mass equal to $\frac{1}{4}$) and the borrowers who went to the second bank on the second level (of mass equal to $\frac{1}{4}$) will go to the deviating bank. That means that the profit of the deviating bank from the third level is also $\frac{3}{2}$. The total profit from overcharging on the first level is thus $3P$ as in the equilibrium.

Chapter 3

New Insights about the Separability of Loans and Deposits Decisions in the Monti-Klein Model of Banking Industry

Abstract

It is shown that it is enough to introduce small changes to the industry structure of the original Monti-Klein model for the independence between the banks' loans and deposits decisions to break down. Thus, the interdependence result arises even under less drastic changes to the original Monti-Klein model than in the existing literature. The results about the relationship between the loans and deposits decisions have important policy implications - especially for the optimality of the popular deposit interest rate regulation which has recently received renewed interest in the literature on banking regulation.

3.1 Introduction

Although there are many alternative models, the oligopoly version of the Monti-Klein model[1] still ranks among the most popular Industrial Organization models of the banking industry. The model has been frequently used in empirical work. Some of the more recent papers include de Bondt, Mojon and Valla (2003), Bruggeman and Donnay (2003) or de Guevara and Maudos (2004). The popularity of the Monti-Klein model can arguably be attributed to its simplicity but also to its relative power in modeling the effects of the most frequently discussed issues about the conduct and performance of the banking industry.

However, even the well accepted Monti-Klein model is not free of controversies. One of the most debated ones is the question of the separability of the decisions about loans and deposits in the banks' optimization problem. The question of separability has strong links to banking regulation. If the decisions about loans and deposits are interdependent then severe competition in deposits might lead to excessively high interest rates on loans (high deposit rates driven up by competition inflate the costs of resources and banks are tempted to compensate for these higher costs by increasing rates charged to borrowers). This has led many governments to impose ceilings on deposit rates - a regulatory instrument which has become very popular in many countries around the world including the United States where it was known as Regulation Q[2]. However, if the decisions about loans and

[1]The Monti-Klein model is based on the work of Klein (1971) and Monti (1972); the oligopoly version of the model is due to Freixas and Rochet (1997).

[2]In the USA, Regulation Q was enacted in 1933 and was removed in 1986 (it was phased-out by the Monetary Control Act from 1980). Other countries with experience in deposit interest rate control include France, Japan, China or Republic of Korea. The deposit rate controls have recently received renewed interest in both theoretical and empirical literature (see e.g. Hellman et. al [2000], Matutes and Vives [2000] or Kraft and Galac [2005]).

deposits are independent then such a regulation has much weaker appeal. The standard result of the basic Monti-Klein model is that (under the assumptions to be discussed below) the two decision problems are indeed independent. Thus, the Monti-Klein model in its original form implies that Regulation Q is a misguided policy instrument which cannot achieve the intended objectives.

In reaction to the separability result of the Monti-Klein model, many authors have tried to show that under some changed assumptions the loans and deposits decisions can be interdependent. One approach has been to introduce risk of default into the model. Most notably, Dermine (1986) shows that loans and deposits decisions are interdependent if the bank faces a positive probability of default (the link between the two decisions is facilitated through the limited liability of the bank). Another case of interdependence is discussed by Pringle (1973) who relaxes the assumption of a single decision period; Prisman et al. (1986) introduce liquidity risk in a two-stage setting, Van Loo (1980) builds a model with liquidity and solvency constraints and Broll, Pausch and Welzel (2002) achieve interdependence through hedging with basis risk. Interdependence is also the result of some models not directly based on the Monti-Klein model. For example, Pyle (1971) presents a different model in which the bank chooses between three securities - one risk-less security and two securities with uncertain returns - loans with interest rate r_1 and deposits with interest rate r_2. Pyle shows that in his model the loans and deposits decisions are indeed interdependent if r_1 and r_2 are not independent[3]. Finally Chiappori, Perez-Castrillo and Verdier (1995) use a spatial competition model to show that interdependence arises through tied sales which

[3]For a more detailed disscussion of Pyle's model as well as of other similar models see for example Baltensperger (1995) or Santomero (1994).

become the optimal bank's strategy after the deposit rates regulation is imposed.

All the reviewed models with interdependence between loans and deposits are very complex when compared to the original Monti-Klein model. Their setups depart unnecessarily far from the original model and thus significantly reduce the generality of their implications. The complexity of these models also limits their use in empirical work. In this chapter we show that even a relatively simple variation of the original model can give rise to the interdependence result. Specifically, we show that it is enough to slightly modify the assumptions about the industry structure by introducing positive fixed costs and a threat of entry. The issue of entry has already been introduced into the Monti-Klein framework by Toolsema and Schoonbeek (1999) who have studied the Stackelberg version of the Monti-Klein model. However, Toolsema and Schoonbeek (1999) have focused on the influence of the changed assumptions about industry structure on the relationship between the money market rate and the banks' decisions about loans and deposits. Moreover, they haven't introduced barriers to entry. Thus, although their model is similar to our approach in the assumed form of industry structure, it does not answer the question of separability which is the goal of this chapter.

In this paper we show that under some very plausible assumptions about the industry structure, the well known separability of (the independence of) the decisions about the optimal levels of loans and deposits in the Monti-Klein model breaks down. Compared to the other models with interdependence between loans and deposits decisions, our approach is relatively closer to the original Monti-Klein setup and thus it retains much of its simplicity and generality.

We present a simple model inspired by the standard incumbent/entrant game in the spirit of the Bain-Sylos-Labini-Modigliani framework (BSM framework). We

thus introduce barriers to mobility into the standard Monti-Klein model. Specifically, we first present a two-stage game with quantity as the strategic variable in the second (duopoly) stage of the two-stage game. Later we present a similar model in which prices instead of quantities play the role of the strategic variable and there is partial product differentiation so that it is possible to avoid the Bertrand paradox. We are able to show that the banks' decisions about loans and deposits are interdependent - thus we reverse the basic result of the standard Monti-Klein model of the banking industry.

3.2 Barriers to mobility in the Monti-Klein model with Stackelberg competition

The simplest version of my model is based on a Stackleberg version of the standard Monti-Klein model (for a review of the standard Monti-Klein model please refer to the Appendix). By introducing sequential competition and barriers to entry, new optimal strategy emerges - entry deterrence by the incumbent bank. This strategy introduces a new optimization condition for the incumbent bank (it chooses loans and deposits so as to drive entrant's profits to zero). This condition involves both deposits and loans and thus introduces the interdependence between the decisions about loans and deposits.

The modification we propose is inspired by the standard incumbent-entrant game in the traditional BSM framework[4]. The model is set up as a two-stage

[4]Tirole (2003) discusses the BSM framework in its general form. The novelty of our model is in the incorporation of the simultaneous competition in inputs (deposits) and outputs (loans) and also in the inclusion of the Monti-Klein type of perfectly elastic outside clearing (represented by the interbank-lending rate r).

game (rather than the one-stage game in the traditional Monti-Klein framework) and the position of the competing banks is asymmetric - in the duopoly case, one bank plays the role of the incumbent and the other assumes the role of the entrant. Another crucial assumption is that there are fixed setup costs which have to be incurred by any bank which plans to enter the banking industry[5]. Otherwise the setup of the new model follows the setup of the standard Monti-Klein framework. Specifically, we assume a downward sloping demand for loans $L(r_L)$, an upward sloping supply of deposits $D(r_D)$ and the respective inverse functions $r_L(L)$ and $r_D(D)$. The demand for loans and the supply of deposits are assumed to be independent (otherwise the interdependence occurs trivially). Furthermore, there is a perfectly elastic interbank market with exogenously given rate r. Bank i takes the amount of loans and deposits chosen by the other banks as given and maximizes its profit by the choice of the amount of loans L_i it offers and the amount of deposits D_i it demands (i is 1 or 2 in duopoly). We assume the cost function takes the additively separable form

$$C(L_i, D_i) = \gamma_L L_i + \gamma_D D_i \tag{3.1}$$

because we concentrate only on the fundamental reasons for independence of the loans and deposits decision problems.

In the first stage of the game, the incumbent chooses its amounts of deposits and loans it wants to offer on the market. The entrant can observe these choices

[5]Fixed setup costs in banking are huge - especially in retail banking a successful bank needs to have an extensive system of offices in order to attract customers; banks have to invest in promotion of services in order to get the attention of customers, make investments into brand building; moreover, even without physical fixed costs or legislative barriers, there would be huge barriers to entry due to asymmetric information - see Dell'Ariccia, Friedman and Marquez (1999).

of the incumbent and, depending on this information, decides whether or not to enter the industry. In the second stage of the game, the entrant (if in the industry) reacts optimally to the choices of the incumbent. Due to the presence of fixed setup costs, the incumbent can potentially deter entry.

It is instructive to begin with the standard Stackelberg model without fixed costs. In such a model, the entrant (let's call it 2) maximizes the profit function

$$\pi_2 = ((r_L(L_1 + L_2) - r)L_2 + (r(1-\alpha) - r_D(D_1 + D_2))D_2 - \gamma_L L_2 - \gamma_D D_2) \quad (3.2)$$

which leads to (analogously to the standard case reviewed in the Appendix) the optimal choices (reaction functions)

$$L_2^* = L_2^*(r, \gamma_L, L_1) \quad (3.3)$$

$$D_2^* = D_2^*(r, \alpha, \gamma_D, D_1) \quad (3.4)$$

The incumbent's optimization problem is then to maximize the following profit function

$$\pi_1 = ((r_L(L_1 + L_2^*(L_1)) - r)L_1 + (r(1-\alpha) - r_D(D_1 + D_2^*(D_1)))D_1 - \gamma_L L_1 - \gamma_D D_1) \quad (3.5)$$

where $L_2^*(L_1)$ and $D_2^*(D_1)$ stand for the reaction functions from the entrant's problem. The first order conditions imply

$$r_L(L_1 + L_2^*(L_1)) - r + r_L'(L_1 + L_2^*(L_1))(1 + L^{*\prime}{}_2(L_1))L_1 - \gamma_L = 0 \quad (3.6)$$

$$r(1-\alpha) - r_D(D_1 + D_2^*(D_1)) - D_1'(r_D'(D_1 + D_2^*(D_1))(1 + D^{*\prime}{}_2(D_1)) - \gamma_D = 0 \quad (3.7)$$

Now it is clear that the incumbent's optimal choices of loans and deposits are still independent. Precisely, we obtain the following general results

$$L_1^* = L_1^*(r, \gamma_L), \quad D_1^* = D_1^*(r, \alpha, \gamma_D) \quad (3.8)$$

Thus, the sole market leadership is not enough to break the independence of the loans and deposits decision problems in the Monti-Klein model.

Now, let's move to the more interesting case with the presence of the fixed setup costs. The entrant's profit function now changes to

$$\pi_2 = (r_L(L_1 + L_2) - r)L_2 + (r(1-\alpha) - r_D(D_1 + D_2))D_2 - \gamma_L L_2 - \gamma_D D_2 - F, \quad (3.9)$$

where F stands for the fixed setup costs which have to be incurred on entry. If the entrant has to face positive fixed setup costs then the incumbent has to compare the profitability of accommodation and entry deterrence. In other words, it has to compute whether it is more profitable to let the entrant enter and make positive profit or whether it is more profitable to choose such levels of loans and deposits that the entrant would make non-positive profit and thus would not enter.

Let's look at the incumbent's problem in a slightly more formal way. The profit from accommodation is computed in the same way as in the standard case of Stackelberg competition discussed above. Precisely, the profit is given by

$$\begin{aligned} \pi_1^A =& (r_L(L_1^A + L_2^*(L_1^A)) - r)L_1^A + (r(1-\alpha) - r_D(D_1^A + D_2^*(D_1^A)))D_1^A \\ & - \gamma_L L_1^A - \gamma_D D_1^A, \end{aligned} \quad (3.10)$$

where the index A stands for accommodation and L_1^A and D_1^A are the optimal choices of the Stackelberg leader from above.

The profit from entry deterrence is computed in a slightly more complex way. As the first step, the incumbent has to compute its own amounts of loans and deposits which induce the entrant's profit to be non-positive. Precisely, the incumbent chooses such amounts of loans L_1 and deposits D_1 that the following equation holds

$$\begin{aligned}\pi_2 =&((r_L(L_1 + L_2^*(L_1)) - r)L_2^*(L_1) + (r(1-\alpha) - r_D(D_1 + D_2^*(D_1)))D_2^*(D_1) \\ &- \gamma_L L_2^*(L_1) - \gamma_D D_2^*(D_1) - F) \leq 0, \end{aligned} \tag{3.11}$$

Note that we have obtained this equation by plugging the entrant's reaction functions into the entrant's profit function and by comparing the resulting term to 0. Thus, the entry-deterrence equation implicitly defines the combinations of the incumbent's loans and deposits for which the entrant's profit is non-positive. Precisely, these combinations can be expressed as $L_1^{**} = L_1^{**}(D_1^{**})$ or $D_1^{**} = D_1^{**}(L_1^{**})$, where the index ** means that the respective variable belongs to the solutions of the implicit equation given above[6]. In the second step, the incumbent maximizes its monopoly profit function (entry is deterred) subject to the entry-deterrence equation given above. Thus, the problem is to maximize

$$\pi_1 = (r_L(L_1^{**}) - r)L_1^{**} + (r(1-\alpha) - r_D(D^{**}))D_1^{**} - \gamma_L L_1^{**} - \gamma_D D_1^{**} \tag{3.12}$$

subject to the entry deterrence condition $L_1^{**} = L_1^{**}(D_1^{**})$.

[6] $L_1^{**}(D_1^{**})$ and $D_1^{**}(L_1^{**})$ can be shown to be functions if demand and supply are linear.

It is obvious that the optimal loans and deposits decisions are interdependent now - the interdependence naturally comes from the entry-deterrence condition. The incumbent's optimization problem is then completed by the comparison of the accommodation profit π_1^A with the implied entry deterrence profit $\pi_1^D = \pi_1^D(L_1^{***}, D_1^{***})$, where the index *** means that the respective variable is the solution of the incumbent's profit maximization problem in the case of entry deterrence. However, the main result of interest for us is the presence of the interdependence between the deposits and loans decisions in the entry deterrence part of the whole problem.

The loans and deposits decision problems might obviously become interdependent even in the standard Monti-Klein model once we relax our assumptions about the separability of the cost function. However, the administrative costs are arguably not very important relative to other aspects of the banking business and thus, the issue of the independence of the decision problems should not hinge only on the form of the cost function[7].

3.3 Barriers to mobility in the Monti-Klein model with differentiated price competition

The present modification of the Monti-Klein model is very similar to the first model discussed in this chapter. The main difference is that now the two banks are assumed to be choosing prices (the interest on loans and deposits) instead of quantities (the amounts of loans and deposits) - in the jargon of game theory, we

[7]For a discussion of the basic determinants of the commercial banking business see for example Sinkey (2002).

have different strategic variables here. If we had homogenous product in a model with prices as strategic variables, we would get the standard undercutting problem which is known as the Bertrand paradox. Thus, in order to avoid undercutting and the implied absolute price competition, we assume here that the bank's product (loans and deposits) is not perfectly homogenous. In other words, we assume that the loans and deposits are partially differentiated. For the sake of simplicity of notation, we neglect the reserve requirements represented by the parameter α (without loss of generality, we set it equal to zero arbitrarily). Otherwise, the setup of the model is the same as in the case with quantity competition.

The logic of the solution of the model is very similar to the logic of the model from the previous section and thus we proceed at a slightly faster pace this time. The incumbent bank is again comparing its profit in the accommodation with the entry deterrence cases. For both these cases, it first needs to know the entrant's reaction function which can be computed by maximizing the entrant's profit with respect to the entrant's interest on loans r_{L2} and the entrant's interest on deposits r_{D2}. The entrant's profit function looks as follows

$$\pi_2 = (r_{L2}-r)L_2(r_{L1}, r_{L2})+(r-r_{D2})D_2(r_{D1}, r_{D2})-C(L_2(r_{L1}, r_{L2}), D_2(r_{D1}, r_{D2}))-F, \tag{3.13}$$

where it is assumed that $\frac{\partial L_2}{\partial r_{L2}}, \frac{\partial D_2}{\partial r_{D1}} \leq 0$, $\frac{\partial L_2}{\partial r_{L1}}, \frac{\partial D_2}{\partial r_{D2}} \geq 0$ due to the assumption of partial differentiation of the loans and deposits. The first order conditions imply

$$L_2(r_{L1}, r_{L2})+(r_{L2}-r)\frac{\partial L_2(r_{L1}, r_{L2})}{\partial r_{L2}}-\frac{\partial C(L_2(r_{L1}, r_{L2}), D_2(r_{D1}, r_{D2}))}{\partial L_2}\frac{\partial L_2(r_{L1}, r_{L2})}{\partial r_{L2}} = 0 \tag{3.14}$$

$$-D_2(r_{D1},r_{D2})+(r-r_{D2})\frac{\partial D_2(r_{D1},r_{D2})}{\partial r_{D2}}-\frac{\partial C(L_2(r_{L1},r_{L2}),D_2(r_{D1},r_{D2}))}{\partial D_2}\frac{\partial D_2(r_{D1},r_{D2})}{\partial r_{D2}}=0 \tag{3.15}$$

We can immediately see that the cost function term is the first potential source of the interdependence between the decisions about loans and deposits. However, as in the previous model, we are interested in a more fundamental source of the interdependence and thus, from now on, we neglect the cost term completely. It is then obvious that the entrant's reaction functions take the form $r^*_{L2}=r^*_{L2}(r,r_{L1})$ and $r^*_{D2}=r^*_{D2}(r,r_{D1})$.

The incumbent's optimization problem in the case of accommodation is to maximize the following profit function

$$\begin{aligned}\pi_1^A =&(r_{L1}-r)L_1(r_{L1},r^*_{L2}(r_{L1}))+(r-r_{D1})D_1(r_{D1},r^*_{D2}(r_{D1}))\\ &-C(L_1(r_{L1},r^*_{L2}(r_{L1})),D_1(r_{D1},r^*_{D2}(r_{D1}))),\end{aligned} \tag{3.16}$$

where $r^*_{L2}(r_{L1})$ and $r^*_{D2}(r_{D1})$ stand for the reaction functions from the entrant's problem. The first order conditions imply (neglecting the cost term)

$$(r_{L1}-r)(\frac{\partial L_1(r_{L1},r^*_{L2}(r_{L1}))}{\partial r_{L1}}+\frac{\partial L_1(r_{L1},r^*_{L2}(r_{L1}))}{\partial r_{L2}}\frac{r_{L2}(r_{L1})}{\partial r_{L1}})+L_1(r_{L1},r^*_{L2}(r_{L1}))=0 \tag{3.17}$$

$$(r-r_{D1})(\frac{\partial D_1(r_{D1},r^*_{D2}(r_{D1}))}{\partial r_{D1}}+\frac{\partial D_1(r_{D1},r^*_{D2}(r_{D1}))}{\partial r_{D2}}\frac{r_{D2}(r_{D1})}{\partial r_{D1}})-D_1(r_{D1},r^*_{D2}(r_{D1}))=0 \tag{3.18}$$

It is again clear that the incumbent's optimal choices of loans and deposits are still independent in the case of accommodation.

The profit from entry deterrence is computed in the following way. Firstly, the incumbent has to compute its own interest on loans and deposits which induce the

entrant's profit to be non-positive. Thus, the incumbent chooses such levels of r_{L1} and r_{D1} that the following equation holds

$$\pi_2 = (r^*_{L2}(r_{L1}) - r)L_2(r_{L1}, r^*_{L2}(r_{L1})) + (r - r^*_{D2}(r_{D1}))D_2(r_{D2}, r^*_{D2}(r_{D1})) - F \leq 0 \tag{3.19}$$

This entry-deterrence condition implicitly defines the combinations of the incumbent's interest on loans and deposits for which the entrant's profit is non-positive. These combinations can be expressed as $r^{**}_{L1} = r^{**}_{L1}(r, r_{L2})$ or $r^{**}_{D1} = r^{**}_{D1}(r, r_{D2})$, where the index ** means that the respective variable belongs to the solutions of the implicit equation given above. In the second step, the incumbent maximizes its monopoly profit function (entry is deterred) subject to the entry-deterrence equation given above. Thus, the problem is to maximize

$$\pi_1 = (r^{**}_{L1} - r)L(r^{**}_{L1}) + (r - r^{**}_{D1})D(r^{**}_{D1}) \tag{3.20}$$

subject to the entry deterrence condition $r^{**}_{L1} = r^{**}_{L1}(r, r_{L2})$.

It is obvious that the optimal decisions about the interests on loans and deposits are now interdependent - the interdependence again comes from the entry-deterrence equation.

3.4 Conclusions

In this chapter we have focused on the issue of the separability of banks' decisions about loans and deposits in the family of industrial organization models derived from the Monti-Klein model. In the standard oligopoly version of the Monti-

Klein model, under appropriate assumptions about the banks' cost functions, the decisions about loans and deposits are independent. In this chapter, we were able to show that this independence is rather an exception to the rule because it depends on the very simple industry structure of the banking industry assumed in the standard Monti-Klein model.

The previous efforts to break the independence of the loans and deposits decisions in the Monti-Klein model have achieved their goal by considering relatively strong modifications of the original setup. These models are interesting but, due to their complexity, not very easy to work with in empirical work. In this chapter, we have shown that it is enough to adopt more realistic assumptions about the industry structure and the independence breaks down. Thus, we have shown that it is possible to build a model which is able to explain the interdependence of the two major bank's decision problems and yet keeps relative simplicity.

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3.5 Appendix

Review of the standard Monti-Klein model

We review here the standard oligopoly version of the Monti-Klein model which serves as a benchmark model for our analysis in this paper. More precisely, we concentrate on the duopoly version due to Freixas and Rochet (1997) for the sake of simplicity and clarity of exposition (the generalization to the n-banks case is trivial).

The model assumes a downward sloping demand for loans $L(r_L)$, an upward sloping supply of deposits $D(r_D)$ and the respective inverse functions $r_L(L)$ and $r_D(D)$. The demand for loans and the supply of deposits are assumed to be independent (otherwise the interdependence occurs trivially). Furthermore, there is a perfectly elastic money market with exogenously given rate r. Bank i takes the amount of loans and deposits chosen by the other banks as given and maximizes its profit by the choice of the amount of loans L_i it offers and the amount of deposits D_i it demands (i is 1 or 2 in duopoly). The profit function of bank i takes the form

$$\pi_i = (r_L(L_1 + L_2) - r)L_i + (r(1-\alpha) - r_D(D_1 + D_2))D_i - C(L_i, D_i), \qquad (3.21)$$

where α reflects the exogenous reserve requirements and $C(L_i, D_i)$ is the bank's cost function which is assumed to be the same for all banks and which is usually interpreted as the administrative cost associated with the provision and management of loans L_i and deposits D_i. After combining the first order conditions we obtain the pricing rule $L = \frac{1}{2\epsilon}$, where L stands for Lerner index and ϵ stands for

demand elasticity. In our case, this rule takes the form

$$\frac{r_L^* - (r + \frac{\partial C(L_i, D_i)}{\partial L_i})}{r_L^*} = \frac{1}{2\epsilon_L(r_L^*)} \tag{3.22}$$

$$\frac{r(1-\alpha) - \frac{\partial C(L_i, D_i)}{\partial D_i}}{r_D^*} = \frac{1}{2\epsilon_D(r_D^*)} \tag{3.23}$$

It is clear from these optimality conditions that the interdependence of the loans and deposits decisions depends only on the form of the terms $\frac{\partial C(L_i, D_i)}{\partial L_i}$ and $\frac{\partial C(L_i, D_i)}{\partial D_i}$. It is commonly assumed that $C(L_i, D_i)$ takes an additively separable form $C(L_i, D_i) = \gamma_L L_i + \gamma_D D_i$. In such a case, we obtain full independence of the loans and deposits decisions and the optimal amounts of loans and deposits are determined as

$$L_i^* = L_i^*(r, \gamma_L, L_{-i}) \tag{3.24}$$

$$D_i^* = D_i^*(r, \alpha, \gamma_D, D_{-i}), \tag{3.25}$$

where the index $-i$ stands for "other than i".

Chapter 4

The determinants of retail bank fees in Central Europe

Abstract

We analyze a unique dataset on fees from five Central European countries and test an empirical model of the determinants of the retail bank fee levels in these countries. We build the model on the predictions of the existing literature about the most likely determinants of the fee levels. We find support for the Structure Conduct Performance hypothesis about the effect of industry concentration, importance of the differences in the degree of reliance on cashless payments and the differences in labor intensity and technology level of the banks' operations. Our analysis thus shows that the international differences in retail bank fees can be explained by fundamental economic factors and thus it is a contribution to the continuing debate about retail bank fees.

4.1 Introduction

The level of retail bank fees has always been an issue of great interest in the debates among bankers, policymakers and even the general public worldwide. The interest in the bank's approaches to pricing of the basic retail bank services has been especially evident in the Central European region where the debate culminated to an open conflict between some of the main interested parties. Specifically, the Czech Republic has even seen a number of cases of litigation against major banking houses initiated by an influential domestic consumer defense organization.

The surge in the intensity of the public interest in the level of fees can arguably be at least partially attributed to the recent international comparisons which have shown that fees scaled by proxies for purchasing power parity tend to be higher in the less developed countries. Specifically, in the previous chapters we have already discussed the Capgemini, ING and EFMA (2005, 2006) studies which report a negative relationship between the economic level of a country and the fee levels scaled by GDP per capita. It is not surprising that such results could help to create fears that the relatively high level of retail bank fees in the emerging economies is due to inter-bank collusion and cartelization of the market.

In the first chapter we have shown that there exist a number of fundamental theoretical reasons for the prevailing international differences in fees. The goal of this chapter is to complement our theoretical work from the previous chapters by providing an empirical analysis of the retail bank fee levels in Austria, the Czech Republic, Hungary, Poland and Slovakia with the aim of identifying whether there is empirical support for the fundamental economic reasons for the international differences in the level of retail bank fees.

The analysis is made possible thanks to the availability of a unique dataset on the fee levels in the five Central European countries. It is generally almost impossible to obtain quality data about retail bank fees in the detail and size necessary for a rigorous empirical analysis (as Hannan (2006) reports, it is extremely difficult to obtain such data even for the US). This unavailability of the data on fees also causes the fact, that although a large number of empirical studies have focused on the determinants of bank interest rates, there is only small evidence concerning the determinants of the retail bank fees so far.

The uniqueness of the dataset is even more evident when we consider the socio-geographical region it covers. Specifically, analyzing the fee level differences within Central Europe has two important advantages for our research purposes. Firstly, the region can be characterized by significant differences in the maturity of the banking sector, as shown by Hanousek, Kocenda and Ondko (2007) who document differences in privatization of the banking sector in the Central and Eastern European countries as well as ensuing significant changes in financial flows between the banking sector and other sectors of the economy. Within the set of the countries in our dataset, the differences are also evident from the comparison of Austria as a traditionally strong banking country and the other four countries which are still in the process of gradual development of their banking sectors (see also the description of the data in the Appendix)[1]. Secondly, the countries in the Central European region form a very compact group of countries with strong cultural and historical links (most of the countries in our dataset even share common history as parts of the Austro-Hungarian monarchy). Due to these links, there are important

[1]Importantly, Austria has also been a market economy for the whole post World War II period, in contrast to the other countries in the sample.

similarities in consumption habits and needs, views about the role of money and ultimately also about the behavior of bank clients in relation to banks.

This developmental variation on one hand and the relative compactness on the other hand make the region a natural laboratory from the point of view of our research goals. The variation helps to identify the effects of the variables in our model and the similarities make easier the comparison of the fee levels between the different countries. Specifically, it is possible to use indexing of the prices of bank services based on a specified behavior of a typical bank client (experts from Scott & Rose, s.r.o., the provider of our data on fees, were able to set up a typical client behavior model robust for the different countries in the dataset).

As we have already discussed in the first chapter (and as we elaborate on in greater detail in the later sections), the existing literature implies that among the most likely supply side factors affecting the apparent vast international differences in bank fees are the banks' costs, degree of competition in the market and regulation of the banking industry. Among the demand side factors, it is expected that there may be a cross-subsidization between the different types of bank products as banks are trying to maximize the benefits from facing a pool of clients with given demand characteristics.

Due to the specific characteristics of our dataset (specifically the developmental variation in our data), we believe that a crucial role among the cost factors is played by the degree of reliance on cashless payments in the country of a given bank. Cash-related operations represent a significant cost burden for any bank due to high labor requirements of cash-handling processes and the opportunity costs of necessary cash reserves. As cashless payment technologies represent a characteristic of a more advanced banking industry, we can expect the share of

cashless payments to vary significantly across the countries in our dataset (this is indeed confirmed in a more detailed data description in the Appendix). Similar arguments can be given in support of the expected importance of the differences in the labor intensity and general technological level of the banking industries in the countries in our dataset.

Our analysis can also be understood as a contribution to the literature on testing the contradicting empirical predictions of the Structure Conduct Performance and the Efficient Structure hypotheses regarding the influence of concentration on prices in the banking industry. As the connection between the degree of competition in the banking sector and the level of retail bank fees has been at the center of the continuing debates about fees, discriminating among the two hypotheses also has relevance for future policy approaches to the banking industry.

In this chapter, we primarily focus on testing an empirical model based on the cost, competition, regulation and cross-subsidization factors, i.e. the factors implied by the existing literature as the most likely determinants of the fee levels. Our dataset does not allow us to directly test the implications of the effect of asymmetric information and income inequality on the fee level (however, we provide a partial test using an imperfect proxy for asymmetric information as part of the sensitivity analysis).

The paper is organized around the following simple structure. In the next section, we review the relevant literature on which we build the setup of our empirical model. Further, we describe the model specification and the unique dataset we use in our analysis. We proceed to the description and interpretation of the results of our analysis, a sensitivity analysis for checking the robustness of the results and finally we present the conclusions of our research. We provide further data

description in the Appendix.

4.2 Literature review

As discussed above, the degree of competition is one of the common suspects among the factors believed to be affecting bank fees. The literature on the relationship between industry concentration and pricing is very large. As reviewed by Brewer and Jackson (2006) or Shaffer (2004), there are two main competing theories - the traditional Market power theory, usually understood in the form of the Structure-Conduct-Performance hypothesis (SCP hypothesis) due to Mason (1939) and Bain (1951, 1956), and the Efficient Structure hypothesis (ES hypothesis) developed by Demsetz (1973) and Peltzman (1977). Higher concentration leads to higher prices under the SCP hypothesis (e.g. due to scale economies or the X-inefficiencies discussed by Liebenstein (1966)) but may lead to lower prices under the ES hypothesis (the more efficient firms are assumed to gain market share in the dynamics of competition). Thus, the two main strands of literature in this area lead to opposite implications[2].

Within the context of the banking industry, the SCP and the ES hypotheses were tested by a number of studies. Berger and Hannan (1989), Calem and Carlino (1991), Hannan and Berger (1991) and Jackson (1992) focus on the deposit interest rates and they generally find negative relationship between concentration and the level of deposit interest rates, thus they support the SCP hypothesis (lower deposit

[2]It should however be noted that a distinctive strand of literature implies doubts about systematic link between concentration and competitive behavior. This is the contestability literature based on Baumol (1982) and Baumol et al. (1982) which implies that even an industry with only one firm but with low enough barriers to mobility can be characterized by prices close to the perfect competition level.

rates can be viewed as higher or less favorable "prices" for bank clients).

The common specification in this type of papers is

$$r_{ijt} = \alpha + \beta CONC_{jt} + \gamma^N X_{ijt} + \epsilon_{ijt}, \tag{4.1}$$

where CONC is a measure of concentration (typically the Herfindahl-Hirschman index of industry concentration or the top-three firm concentration ratio) and X is a vector of control variables. Specifically, Jackson (1992) uses market growth, market share, T-bill rate, total assets and time as the control variables. Brewer and Jackson (2006) are first to show that it is important to control also for bank specific riskiness; otherwise there might be spurious regression as banks in more concentrated markets might be less risky and thus charge lower rates (the existence of the positive link between individual bank riskiness and deposit rates is shown by Brewer and Mondschean (1994) and the negative link between concentration and riskiness by Rhoades and Rutz (1982)). Brewer and Jackson (2006) thus include measures of capital adequacy (total capital to total assets) and asset quality (non-performing loans to total assets and the gap between rate sensitive assets and liabilities to total assets). They also use an equally weighted index of three types of deposit rates instead of individual rates (they argue that banks may use deposit rates strategically, thus an index is better than the individual rates) and they find that the magnitude of the effects of concentration on deposit rates decreases by about fifty percent after controlling for the individual bank riskiness.

Other authors have found evidence in favor of the ES hypothesis. For example, Kahn, Pennacchi and Sopranzetti (2000) have found that although the data on personal loans support the SCP hypothesis, data on automobile loans support the

ES hypothesis - they have shown that higher concentration reduces the rates on these loans.

There are also some theoretical papers implying the possibility of the negative link between concentration and prices for different reasons than gains in efficiency. Broecker (1990) shows that competition between banks in the provision of loans under asymmetric information can lead to adverse selection in the banks' credit-worthiness testing processes (the more banks there are in the market the higher is the probability that a given bad borrower is accepted by at least one bank) and higher number of banks (lower concentration) then may force banks to charge a higher loan rate. Marquez (2002) receives similar results in a model in which banks' knowledge about the market is worsening with the number of banks in the market (under the assumption of limited capacity).

Another strand of literature important for our analysis focuses on the determination of net interest margins (defined as the difference between interest income and interest expense as a percentage of assets) - many contributions within this category imply that the banks' decisions about interest rates and fees are interconnected. Authors of these contributions thus include fee-relevant variables among the explanatory variables in their models. Many explanatory variables from these models can be expected to be associated with the bank's pricing process in general (thus influencing both margins and fees).

Two main approaches have been used to study the determination of interest margins - the dealership approach (Ho and Saunders [1981], Allen [1988]) and the industrial organization approach to the banking firm (building on the Monti-Klein model, e.g. Zarruck [1989], Wong [1997], Goyeau et al. [1999]). The dealership approach perceives margins to be a form of bank's compensation for the risks asso-

ciated with the maturity discrepancies between the loans it sells and the deposits it buys. The industrial organization approach as presented by Wong (1997) perceives the bank as a standard firm which maximizes expected profit. Compared to the original Monti-Klein framework, the bank is risk-averse and faces credit and interest rate risks.

Nys (2003) builds an empirical model which combines the variables implied by the two approaches mentioned above and most importantly she also includes bank fees revenue as an explanatory variable. She concludes that there is an inverse relationship between the bank fee revenue and the interest margin - thus, she finds evidence for a cross-subsidization between the interest and non-interest bearing activities (fee-related services). Other explanatory variables in her model include measures of interest rate risk, liquidity risk, credit risk, administrative costs, opportunity costs and equity capital.

Gischer and Juttner (2003) use the dealership approach and also find a strong inverse relationship between the fee income and the margins. The other explanatory variables include the country's exposure to foreign competition, domestic market power, cost factors and several risk measures.

Demirg-Kunt, Laeven and Levine (2004) also study the determination of the margins. They use measures of regulations, concentration, inflation and national institutions as explanatory variables (together with several controls for risk factors) and conclude that margins increase in tighter regulation of entry and in higher inflation. Importantly, they also control for the fee income and they report an inverse relationship between the fee income and the level of the margins - thus, their results also support the hypothesis of the cross-subsidization between the interest and non-interest bearing activities.

Although the authors mentioned above find an inverse relationship between margins and fee income, it does not automatically follow that there is an inverse relationship between margins and fees. A bank's fee income obviously equals the level of fees multiplied by the amount of fee-related services purchased by the bank's clients and thus it might have happened that the banks with low interest margins sold more fee-related services than the banks with high interest margins. This is actually supported by Carb and Rodrguez (2007) who find that the spread between loan and deposit rates is not significantly related to a measure of the value of fee-based acivities (measured by the Boyd and Gertler (1994) estimator[3]). Nevertheless, the significant relationship between the interest and non-interest bearing activities suggests that the link between the fee levels and the margins should be controlled for in our analysis.

In contrast to the large literature on deposit and loan interest rates, the literature on the determination of retail bank fees has been surprisingly small. To our best knowledge, the only relevant empirical paper is Hannan (2006). Hannan uses a unique cross-section of US banks and tests the systematic differences in pricing between single-market and multi-market banks implied by the spatial models of Barros (1999) and Park and Pennacchi (2005). He focuses on the determination of six selected retail bank fees and for each of them runs the following cross-sectional regression (one for each of the years in the sample)

$$fee_i = \beta_0 + \beta_1 HHI + \beta_2 ln(BKASSETS_i) + \beta_3 ln(MKTPOP) + \beta_4 MMSHARE_i + \beta_5 MMSHARE_i * HHI + \beta_6 BRSHARE_i, \quad (4.2)$$

[3]The estimator is defined as (fee income / total revenue - fee income) x total bank assets.

where HHI stands for the Herfindahl-Hirschman concentration index, $BKASSETS$ for the total bank assets, $MKTPOP$ for the size of the bank's local market, $BRSHARE$ for the bank's market share in terms of the number of branches and finally $MMSHARE$ stands for the market share of the bank's multimarket competitors, again defined in terms of the number of branches.

Concerning the relationship between concentration and fees, Hannan has found a significant positive relationship supporting the SCP hypothesis. However, Hannan's approach has several drawbacks from the viewpoint of the goals of our analysis. Firstly, the study is focused entirely on the US market and thus it doesn't allow for the degree of heterogeneity implied by our data from Central European (mostly emerging) countries. Secondly, Hannan's analysis focuses on the determination of individual types of fees instead of some representative type of fee index and thus it doesn't allow for the possible interaction and cross-subsidizations between the different types of fees. Although this approach may work well for the relatively homogenous environment of highly competitive US banking industry, it would be much more questionable when applied to the international data we intend to use.

4.3 Model

Conceptually, we derive our model mainly from the setups of Hannan (2006) and Brewer and Jackson (2006). In contrast to Hannan (2006), we use an index of fees instead of individual fees as the dependent variable and we modify the setup so as to control for greater heterogeneity in the data due to the international focus of our analysis. Unlike Brewer and Jackson (2006), the composition of the index is based on the actual behavior of a representative bank client instead of using

equal weights (the composition of the index is described in section Data and in the Appendix). We scale the fee index by total deposits per capita in a given country as that captures both the effect of the purchasing power parity adjustment and also the indication of the general development of the country's banking sector.

The use of a fee index has several important advantages when compared to the use of individual fees. Most importantly, this approach is robust to the differences in the banks' strategies in pricing their portfolios of services. As already discussed in the first chapter, only within the category of core day-to-day services there exist at least four broad pricing approaches (the account based, packaged based, transaction based and indirect revenue based pricing approaches[4]) which differ in the way how banks are generating revenues from comparable portfolios of services. Two banks may charge a completely different price for a given service while the total price of a specified set of services may be exactly equal due to cross-subsidization within the banks' portfolios. Thus, a well specified index of the total price of a typically consumed bundle of services can clearly convey better information about the international differences in the costs of basic retail bank services than any of the individual fees.

The general framework used to build our empirical model consists of four main types of factors:

1. cost of providing fee-related services,

2. competition,

3. regulation and

[4]This classification is used by the Capgemini, EFMA and ING (2005) study discussed in the first chapter.

4. demand side (client-related) factors.

The cost of providing fee-related services influences the fee level even under marginal cost pricing, i.e. under perfect competition. Competition and regulation determine the deviation of fees from marginal costs even in a single product environment and finally the client-related factors account for the deviation from marginal cost pricing due to the fact that banks offer multiple products and the basic services represent only a subset of these products.

To control for the cost factors, we follow Hannan (2006) and include bank size measured by total bank assets. The bank size can be expected to be a good proxy for many cost factors but only within a given country and a certain period of time. As our dataset includes a heterogeneous mix of countries, we have to control for labor costs and technology level which can vary significantly between countries and over time. We do it by including the individual effect and a proxy for the level of labor intensity of the banks' operations measured by personnel expenses normalized by the bank's assets. Further, as suggested by Brewer and Jackson (2006) we control for the bank's riskiness by including the share of common equity on total bank's assets.

As we have already discussed in the introduction, we have to control for potentially huge differences in the costs of providing payment services implied by the different degree of reliance on cashless payments in the different countries. To control for these differences we include a proxy for the degree of reliance on the cashless payments measured by the number of payment cards issued in a country per million inhabitants.

To measure the effect of competition on the level of fees we use the market share

of the top five banks as an indicator of the industry concentration in the banking industry. As part of the sensitivity analysis, we also control for the non-banking competition (we use the measure of total assets managed by insurance companies, investment funds and pension funds)[5].

The regulation can obviously affect fees in many different ways. Different countries have different regulatory measures some of which have a direct impact on the basic bank services. It is difficult to hypothesize what will be the effect of the different regulations but it is clearly important to control for this significant source of external influence. It is natural to expect that tighter regulation would mean a less competitive banking sector and thus higher pricing power of banks. However, the regulation can target fees directly in which case the tighter regulation can lead to lower fee levels. To control for the effect of regulation we include the Heritage Foundation's Economic Freedom Index of regulation for the given country.

Concerning the demand side (client-related) factors, i.e. the multi-product nature of the pricing process, it is important to realize that a typical bank offers at least two types of products - the basic and the intermediation (deposit and credit) services captured for example by the spread between the deposit and loan rates. These products are clearly connected. When a client wants to get credit from a bank she first needs to have an account with the bank - i.e. she needs to

[5]As suggested by one of the referees, Evan Kraft, as an alternative we could use a more direct measure of competition, the Panzar-Rosse H-statistics (based on Rosse and Panzar (1977) and Panzar and Rosse (1982, 1987)) defined as the sum of the elasticities of the bank's revenues with respect to input prices ($H \leq 0$ implies monopoly/cartel, $0 < H < 1$ implies oligopoly/monopolistic competition, $H = 1$ implies perfect competition). Unfortunately, the data on the H-statistics are not easily available for the countries and the time period in our sample (furthermore, the methodology of H-statistics estimation differs among authors), a rigorous analysis with the H-statistics is thus left for further research. As a preliminary step, we estimated the model with the historical values of H-statistics from Bikker, Spierdijk and Finnie (2007) and received a positive effect of H-statistics on the normalized fees. For a discussion of the recent use of the Panzar-Rosse H-statistics see for example Bikker, Spierdijk and Finnie (2007).

buy the basic services too. In such a context, the basic services may be used as a loss-leader (see e.g. Chevalier (2000)) and thus there might be cross-subsidization effects influencing the level of fees for these services.

As the potential cross-subsidization between the main types of bank services may significantly affect the level of fees (which can be understood as the price of the basic services), we follow the existing literature suggesting the existence of the link between net interest margins and fee income (e.g. Nys (2003), Gischer and Juttner (2003) or Demirgu-Kunt, Laeven and Levine (2004)) and include the net interest margin as a control for the connection to the intermediation services.

Based on the rationale above, the empirical model can be expressed by the following equation (for bank i, the corresponding country j and time t):

$$\begin{aligned} Y_{ijt} =& \alpha_i + \beta_1 ASSETS_{it} + \beta_2 CASHLESS_{jt} + \beta_3 EASSETS_{it} + \beta_4 NIM_{it} + \\ & \beta_5 MSHARE_{jt} + \beta_6 PERSON_{it} + \beta_7 REG_{jt} + \epsilon_{it}, \end{aligned} \tag{4.3}$$

where Y_{ijt} stands for the bank fee index relative to the total bank deposits (from non-financial institutions) in the bank's country per capita (alternatively we use the fee index relative to GDP per capita in the section Sensitivity analysis), α_i is the bank's fixed effect, $ASSETS_{it}$ are bank's total assets, $CASHLESS_{jt}$ the share of non-cash payments on total payments measured by the number of payment cards issued in the bank's country, $EASSETS_{it}$ the bank's share of common equity to total assets, NIM_{it} the net interest margin, $MSHARE_{jt}$ the market share of the top five banks in the given country, $PERSON_{it}$ the bank's share of personnel expenses on total assets and REG_{jt} the regulatory strength measured by the Economic Freedom Index of regulation.

4.4 Data

The data we use come from three main sources. The unique bank-specific data on the fee levels have been provided by Scott and Rose, s.r.o., a market research firm with long experience with analyzing the Central European banking industry. The data on the other bank-specific variables come from the Bankscope database and the data on the country-specific macroeconomic variables come from the ECB statistics. The data cover five Central European countries (Austria, the Czech Republic, Hungary, Poland and Slovakia) over the period of years 2005, 2006 and 2007.

As we have already discussed in the section Model, the data on the fee levels are in the convenient form of fee indices. The composition of the index created by Scott and Rose, s.r.o. is based on the actual behavior of a representative client in Slovakia (the choice is robust to the other countries due to the consumption similarities in the region discussed above). Each of the main categories of services/activities is assigned a weight calculated as the average frequency/intensity of its use on the aggregate level, based on the collected data about the total purchases of the retail bank services in the country. The list of services/activities included in the index as well as the values of the respective weights can be found in Table 4.12 in the Appendix.

The exact definitions and sources of the individual variables used in the analysis are given in Table 4.8 in the Appendix and a more detailed statistical description of the data can be found in the Appendix.

4.5 Results

The detailed results of the regressions are reported in Table 4.1. Here we comment on the main results and their implications.

All the coefficients in the model have the expected signs with CASHLESS, EASSETS, MSHARE and PERSON being significant. The negative sign of CASHLESS confirms the expected negative relationship between the degree of reliance on the cashless (lower cost) payment services and the fee level. The positive significant coefficient of MSHARE supports the SCP hypothesis of the positive relationship between concentration and prices. The positive significant coefficient of EASSETS proves the importance of controlling for the bank's riskiness suggested by Brewer and Jackson (2006)[6] and finally the positive significant value of the coefficient of PERSON confirms the importance of controlling for the international differences in the labor intensity and technological level of the banks' operations.

The insignificance of ASSETS should not be surprising given the fact that much of the role of ASSETS as a proxy for cost factors is in the fixed effect model captured by the fixed effects. ASSETS would arguably become significant under a more dynamic growth of assets of banks in the dataset. Although our dataset includes countries with maturing banking sectors, we did not observe this dynamic growth due to the limited available time dimension of the dataset.

[6]Our positive sign is in line with the negative one received by Jackson and Brewer (2006) as they are studying the impact on deposit interest rates instead of fees.

Table 4.1: Regression results (all observations)

Regression	(1)
Dependent variables	Log of fee to total deposits per capita
ASSETS (Total bank assets)	9.39e-07 (0.33)
CASHLESS (No. of payment cards per mil. inhabitants)	-1.005 *** (-3.04)
EASSETS (Common equity to total assets)	0.047 ** (2.16)
NIM (Net interest margin)	-6.828 (-0.91)
MSHARE (Top 5 banks market share)	0.039 ** (2.18)
PERSON (Personnel expenses per total assets)	46.076 ** (2.45)
REG (Economic Freedom Index)	0.004 (1.04)
Intercept	-0.141 (-0.12)
Estimation procedure	Bank specific fixed effects
R^2 (within, not counting the influence of fixed effects)	0.35
N	122

Note: *t*-statistics are presented in parentheses. The symbols *, ** and *** denote significance at the 10, 5 and 1 percent levels, respectively.

4.6 Sensitivity analysis

In order to check the robustness of our results, we estimate variants of the model with alternative measures of the main explained or explanatory variables and also with alternative exclusions of potential outliers. The estimation procedure remains the fixed effects model as the Hausman test rejects the random effect model on 1% significance level in all cases.

We first run the same regression as above but with an alternative dependent

variable in the form of the fee index scaled by the GDP per capita. The results of the regression are reported in Column 2 in Table 4.2 (Column 1 reports the original results for comparison). CASHLESS ceases to be significant but this can arguably be caused by relatively strong relationship between CASHLESS and PERSON variables which are both related to the economic development of the country. The fit of the regression measured by the within R squared also decreases. The coefficients of the significant variables remain on a very similar level.

Table 4.2: Regression results (all observations, alternative dependent variable)

Regression	(1)	(2)
Dependent variables	Log of fee to total deposits per capita	Log of fee to GDP per capita
ASSETS (Total bank assets)	9.39e-07 (0.33)	1.37e-06 (0.46)
CASHLESS (No. of payment cards per mil. inhabitants)	-1.005 *** (-3.04)	-0.528 (-1.52)
EASSETS (Common equity to total assets)	0.047 ** (2.16)	0.052 ** (2.26)
NIM (Net interest margin)	-6.828 (-0.91)	-10.015 (-1.27)
MSHARE (Top 5 banks market share)	0.039 ** (2.18)	0.050 *** (2.63)
PERSON (Personnel expenses per total assets)	46.076 ** (2.45)	48.933 ** (2.48)
REG (Economic Freedom Index)	0.004 (1.04)	0.005 (1.28)
Intercept	-0.141 (-0.12)	-1.690 (-1.35)
Estimation procedure	Bank specific fixed effects	Bank specific fixed effects
R^2 (within, not counting the influence of fixed effects)	0.35	0.27
N	122	122

Note: *t*-statistics are presented in parentheses. The symbols *, ** and *** denote significance at the 10, 5 and 1 percent levels, respectively.

Next, we exclude ASSETS from the regression as it is not significant and much of its role in a fixed effect model is arguably captured by the fixed effects (see the discussion in section Results). The results, reported in Column 2 in Table 4.3, show that the exclusion of ASSETS does not have an important effect on the value of the coefficients, the significance of the variables or the regression fit (Column 1 reports the regression with ASSETS for comparison).

Table 4.3: Regression results (all observations, ASSETS excluded)

Regression	(1)	(2)
Dependent variables	Log of fee to total deposits per capita	Log of fee to total deposits per capita
ASSETS (Total bank assets)	9.39e-07 (0.33)	Not included
CASHLESS (No. of payment cards per mil. inhabitants)	-1.005 *** (-3.04)	-0.985 *** (-3.05)
EASSETS (Common equity to total assets)	0.047 ** (2.16)	0.047 ** (2.20)
NIM (Net interest margin)	-6.828 (-0.91)	-6.958 (-0.94)
MSHARE (Top 5 banks market share)	0.039 ** (2.18)	0.039 ** (2.20)
PERSON (Personnel expenses per total assets)	46.076 ** (2.45)	44.744 ** (2.46)
REG (Economic Freedom Index)	0.004 (1.04)	0.004 (1.05)
Intercept	-0.141 (-0.12)	-0.121 (-0.10)
Estimation procedure	Bank specific fixed effects	Bank specific fixed effects
R^2 (within, not counting the influence of fixed effects)	0.35	0.35
N	122	122

Note: *t*-statistics are presented in parentheses. The symbols *, ** and *** denote significance at the 10, 5 and 1 percent levels, respectively.

We further report the results of the same regression as in the previous case (i.e. without ASSETS) but after exclusion of e-Banka which uses a specific distribution channel in that it relies almost exclusively on internet banking. The results, reported in Column 2 in Table 4.4, show that the exclusion of e-Banka has only a marginal effect on the regression results (Column 1 shows the regression with e-Banka for comparison)[7].

Table 4.4: Regression results (e-Banka excluded, ASSETS excluded)

Regression	(1)	(2)
Dependent variables	Log of fee to total deposits per capita	Log of fee to total deposits per capita
CASHLESS (No. of payment cards per mil. inhabitants)	-0.985 *** (-3.05)	-0.986 *** (-3.00)
EASSETS (Common equity to total assets)	0.047 ** (2.20)	0.047 ** (2.18)
NIM (Net interest margin)	-6.958 (-0.94)	-6.973 (-0.91)
MSHARE (Top 5 banks market share)	0.039 ** (2.20)	0.039 ** (2.16)
PERSON (Personnel expenses per total assets)	44.744 ** (2.46)	44.796 ** (2.34)
REG (Economic Freedom Index)	0.004 (1.05)	0.004 (1.04)
Intercept	-0.121 (-0.10)	-0.097 (-0.08)
Estimation procedure	Bank specific fixed effects	Bank specific fixed effects
R^2 (within, not counting the influence of fixed effects)	0.35	0.35
N	122	120

Note: *t*-statistics are presented in parentheses. The symbols *, ** and *** denote significance at the 10, 5 and 1 percent levels, respectively.

[7]As suggested by Evan Kraft, we also estimated the model with the Transparency International Corruption Perceptions Index instead of the Economic Freedom Index. However, the estimated coefficient of this variable was also not significant (furthermore, the coefficient of CASHLESS also ceased to be significant which was arguably caused by high correlation between the Transparency International Corruption Perception Index and CASHLESS).

Austria is arguably the source of great portion of the variation in our data. Thus, it is interesting to assess how much the results change if we exclude the observations for the Austrian banks in the dataset. The results, reported in Column 2 in Table 4.5, show that the exclusion of the Austrian banks leaves the values of the parameters on a similar level but decreases the significance of CASHLESS and EASSETS (Column 1 shows the regression with all observations for comparison). The lower significance of CASHLESS is intuitive given the large difference in the value of CASHLESS between Austria and the other countries in the dataset. Our results thus seem to be robust even to the exclusion of the Austrian banks.

Table 4.5: Regression results (Austrian banks excluded, ASSETS excluded)

Regression	(1)	(2)
Dependent variables	Log of fee to total deposits per capita	Log of fee to total deposits per capita
CASHLESS (No. of payment cards per mil. inhabitants)	-0.985 *** (-3.05)	-0.872 ** (-2.57)
EASSETS (Common equity to total assets)	0.047 ** (2.20)	0.043 * (1.85)
NIM (Net interest margin)	-6.958 (-0.94)	-5.218 (-0.68)
MSHARE (Top 5 banks market share)	0.039 ** (2.20)	0.045 ** (2.38)
PERSON (Personnel expenses per total assets)	44.744 ** (2.46)	54.482 ** (2.61)
REG (Economic Freedom Index)	0.004 (1.05)	0.003 (0.74)
Intercept	-0.121 (-0.10)	-0.530 (-0.41)
Estimation procedure	Bank specific fixed effects	Bank specific fixed effects
R^2 (within, not counting the influence of fixed effects)	0.35	0.38
N	122	107

Note: *t*-statistics are presented in parentheses. The symbols *, ** and *** denote significance at the 10, 5 and 1 percent levels, respectively.

In the next step, we include loan loss provisions scaled by net profit as an additional variable in the model. This variable could be understood as an imperfect proxy for the degree of asymmetric information the given bank is facing. The intuition is the following. Based on the results of our theoretical work, we hypothesize that the level of fees may be positively related to the degree of asymmetric information in the given country. To measure the effect of asymmetric information on the level of fees and thus to test our theoretical model we include the share of loan loss provisions on the bank's profit before provisions and taxes as a proxy for the quality of loans. Under higher level of noise (borrowers' misperception of their abilities - see the first chapter) or lower testing quality, banks face a relatively worse pool of borrowers and thus use higher fees to compensate for the implied lower expected borrowers' repayments. Internationally harmonized regulatory systems require banks to create loan loss provisions in a volume reflecting the expected repayments of loans and thus we should observe higher loan loss provisions in countries with higher noise or lower testing quality. In order for the predictions of the theoretical model to be confirmed, the effect of this variable should be significant and positive which happens to be true.

Table 4.6: Regression results (all obs., ASSETS excluded, LLPR included)

Regression	(1)	(2)
Dependent variables	Log of fee to total deposits per capita	Log of fee to total deposits per capita
CASHLESS (No. of payment cards per mil. inhabitants)	-0.985 *** (-3.05)	-0.852 ** (-2.60)
EASSETS (Common equity to total assets)	0.047 ** (2.20)	0.046 * (1.78)
NIM (Net interest margin)	-6.958 (-0.94)	-9.067 (-1.22)
MSHARE (Top 5 banks market share)	0.039 ** (2.20)	0.031 (1.64)
PERSON (Personnel expenses per total assets)	44.744 ** (2.46)	52.003 *** (2.78)
REG (Economic Freedom Index)	0.004 (1.05)	0.002 (0.61)
LLPR (Loan loss provisions to profit)	Not included	0.001 * (1.92)
Intercept	-0.121 (-0.10)	0.325 (0.27)
Estimation procedure	Bank specific fixed effects	Bank specific fixed effects
R^2 (within, not counting the influence of fixed effects)	0.35	0.35
N	122	113

Note: *t*-statistics are presented in parentheses. The symbols *, ** and *** denote significance at the 10, 5 and 1 percent levels, respectively.

Above we always used MSHARE as a measure of the degree of competition in the given banking market. Column 2 of Table 4.7 shows the results after exchanging MSHARE for HHI (i.e. the Herfindahl-Hirschman Index as in Hannan (2006)) and Column 3 shows the results with MSHARE and after including also total assets managed by insurance companies, investment funds and pension funds scaled by total bank assets in the country (OTHCOMP) as a proxy for non-banking competition. Although the inclusion of OTHCOMP makes both OTHCOMP and MSHARE insignificant, the two variables are jointly significant.

Table 4.7: Regression results (all observations, ASSETS excluded, alternative measures of competition)

Regression	(1)	(2)	(3)
Dependent variables	Log of fee to total deposits per capita	Log of fee to total deposits per capita	Log of fee to total deposits per capita
CASHLESS (No. of payment cards per mil. inhabitants)	-0.985 *** (-3.05)	-1.092 *** (-3.23)	-1.010 ** (-2.52)
EASSETS (Common equity to total assets)	0.047 ** (2.20)	0.046 ** (2.08)	0.053 ** (2.21)
NIM (Net interest margin)	-6.958 (-0.94)	-9.958 (-1.34)	-8.632 (-1.05)
MSHARE (Top 5 banks market share)	0.039 ** (2.20)	Not included	0.043 (1.63)
PERSON (Personnel expenses per total assets)	44.744 ** (2.46)	44.218 ** (2.36)	51.673 ** (2.61)
REG (Economic Freedom Index)	0.004 (1.05)	0.004 (2.36)	-0.055 (-0.17)
HHI (Herfindahl-Hirschman Index)	Not included	0.001 (1.30)	Not included
OTHCOMP (Assets managed by non-banking institutions scaled by total bank assets)	Not included	Not included	0.087 (0.18)
Intercept	-0.121 (-0.10)	1.640 ** (2.47)	2.494 (0.16)
Estimation procedure	Bank specific fixed effects	Bank specific fixed effects	Bank specific fixed effects
R^2 (within, not counting the influence of fixed effects)	0.35	0.32	0.38
N	122	122	113

Note: *t*-statistics are presented in parentheses. The symbols *, ** and *** denote significance at the 10, 5 and 1 percent levels, respectively.

4.7 Conclusions

This chapter uses a unique dataset to analyze the determinants of retail bank fees in the Central European region. A representative client approach is used to

overcome the problems inherent to the previous analyses of individual fees, namely the potential bias caused by neglecting the possible links between the different fee-related products in the banks' portfolios.

The results of the analysis support the predictions of the Structure Conduct Performance hypothesis, i.e. the positive relationship between industry concentration and prices. The results also confirm our hypothesis that the degree of reliance on cashless payments and the differences in the labor intensity and technological level of the banks' operations are significant cost factors determining the fee level in a given country. Our results are robust to alternative measures of the fee level and the main explanatory factors and also to the exclusion of Austria from the sample (although the significance of some of the factors decreases).

Based on the results of our analysis, it can be expected that the levels of fees will converge in the future in line with the convergence of the economic fundamentals of the emerging countries towards those of the developed ones. Specifically, we can expect this to happen due to the convergence in the degree of competition through the continuing elimination of barriers to international competition between banks (for example, some of the countries in our dataset are expected to enter the Eurozone soon), in the degree of reliance on cashless payments (with the increasing buying power of consumers) and the labor intensity and technological level of the banks' operations (with the continuing proliferation of more advanced technologies and converging cost of labor).

The crucial message of our results is that the apparent international differences in the levels of fees can be explained by fundamental economic factors. Our results thus oppose simplified explanations of the fee differences based on pure cartelization of the banking market. Thus, the analysis in this chapter is also a contribution

to the continuing public debate about the implications of the prevailing fee levels for competition policy and approach of regulatory institutions to banks.

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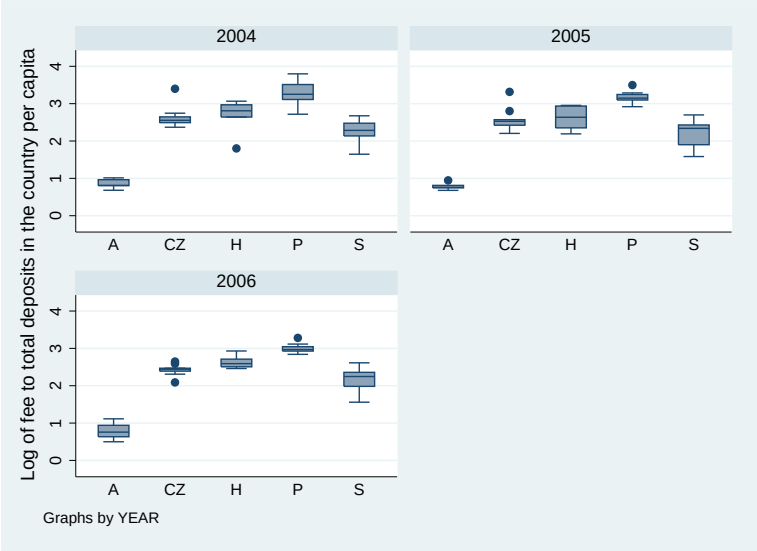
4.8 Appendix

This part of the Appendix presents selected characteristics of the dataset used in the analysis. Figures 4.1 and 4.2 show the vast difference between the fee levels in Austria and the other countries in the sample.

Figure 4.1: Log of fee to total deposits in the country per capita



This phenomenon is visible in the case of both alternative measures of the fee level in a country, the log of fee to total deposits in the country per capita and the log of fee to GDP per capita.

Figure 4.3 illustrates the international differences in the degree of reliance on cashless payments, in this case measured by the number of payment cards issued in a country per million of inhabitants. We can see that Austria is the clear leader in the use of cashless payments among the countries in the dataset, whereas Poland visibly lags behind.

The difference in cashless payments between Austria and the other countries is even more profound when measured by the transaction value achieved by all pay-

Figure 4.2: Log of fee to GDP per capita

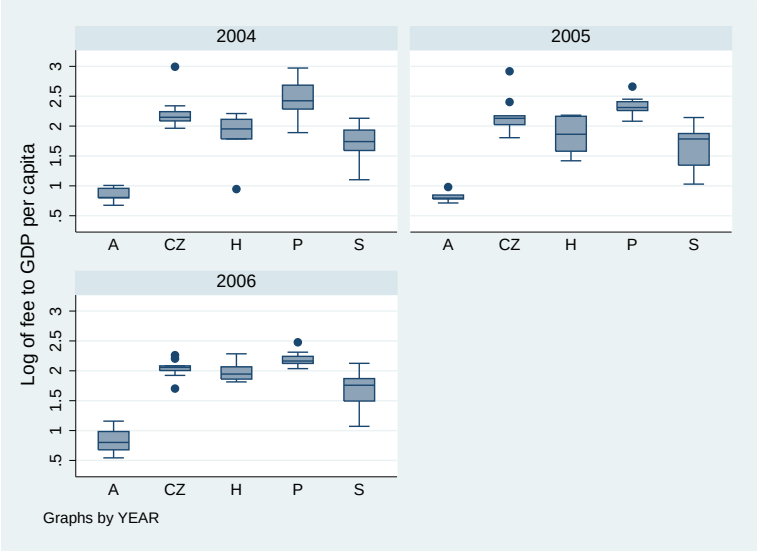
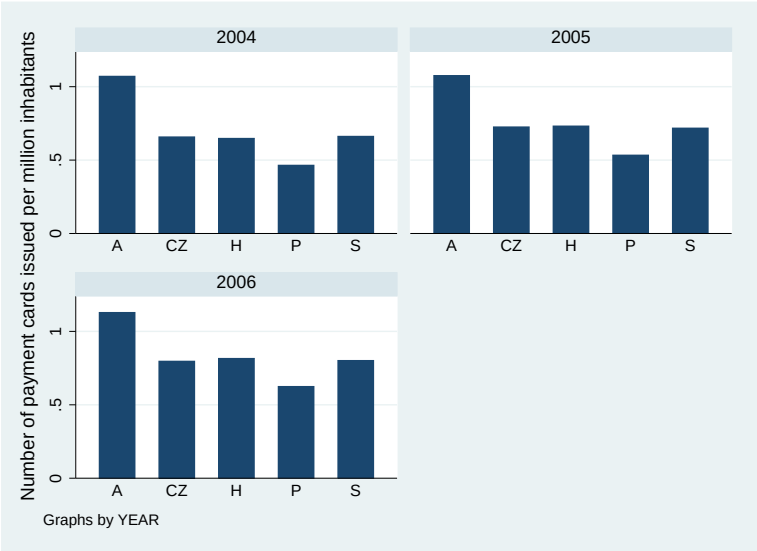


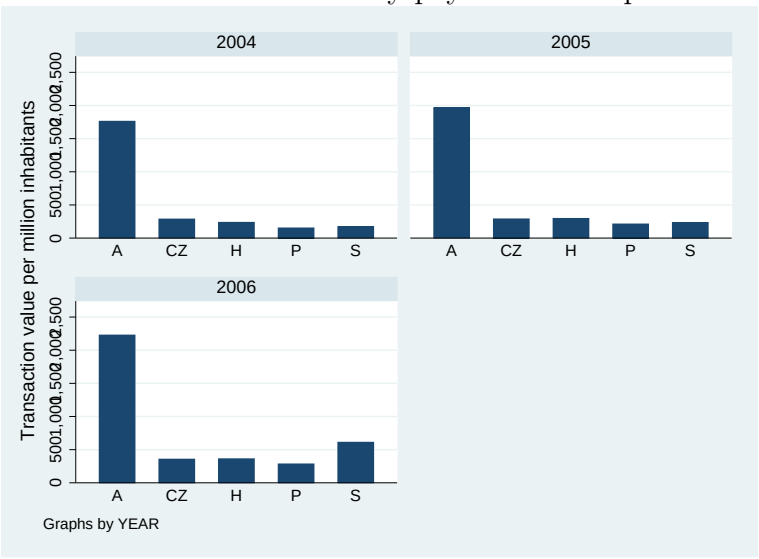
Figure 4.3: Number of payment cards issued per million of inhabitants



ment cards (except e-money) per million inhabitants. According to this measure depicted by Figure 4.4, Slovakia is getting ahead of the other maturing countries in 2006.

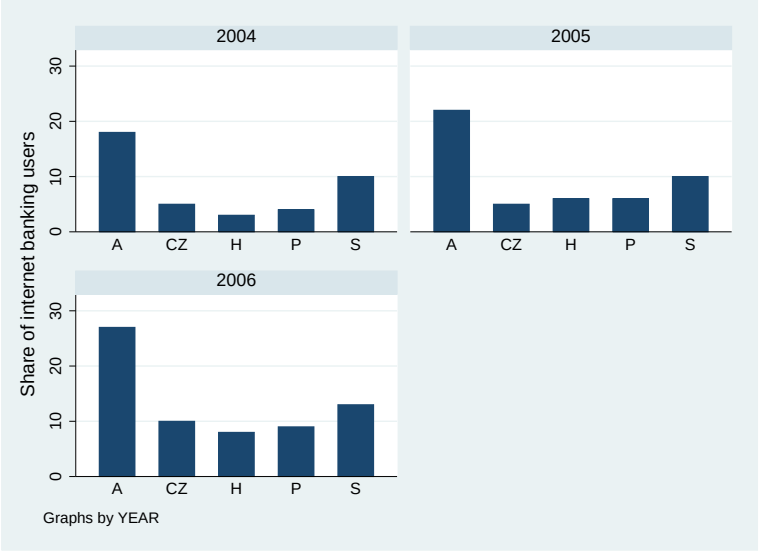
The third measure of cashless payments depicted by Figure 4.5, the percentage

Figure 4.4: Transaction value achieved by payment cards per million inhabitants



of people older than 16 who used internet banking within the last three months, shows a similar picture, but with Slovakia ahead of the other maturing countries.

Figure 4.5: Share of internet banking users



Figures 4.6 and 4.7 illustrate the degree of oligopoly power in the different countries in our dataset. Both the market share of the top five banks in the

country and the Herfindahl-Hirschman Index show a very similar picture. Austria emerges as the least concentrated, most competitive market, whereas the Czech Republic and Slovakia occupy the other extreme.

Figure 4.6: Herfindahl-Hirschman Index

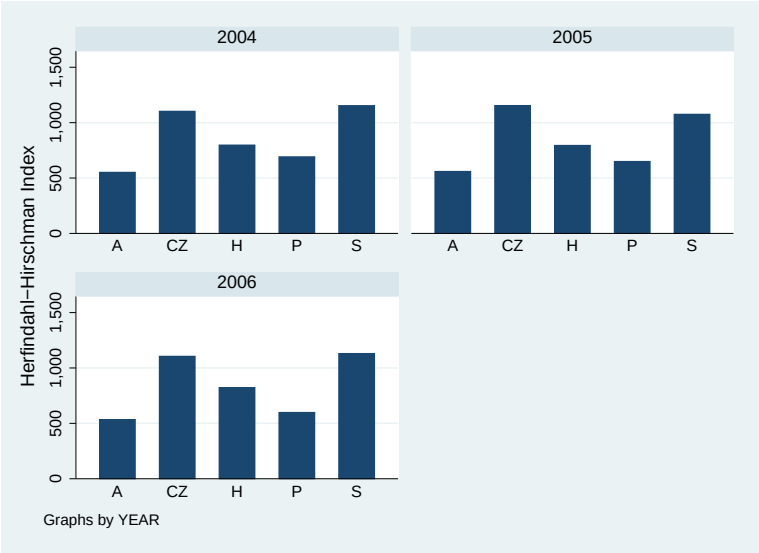
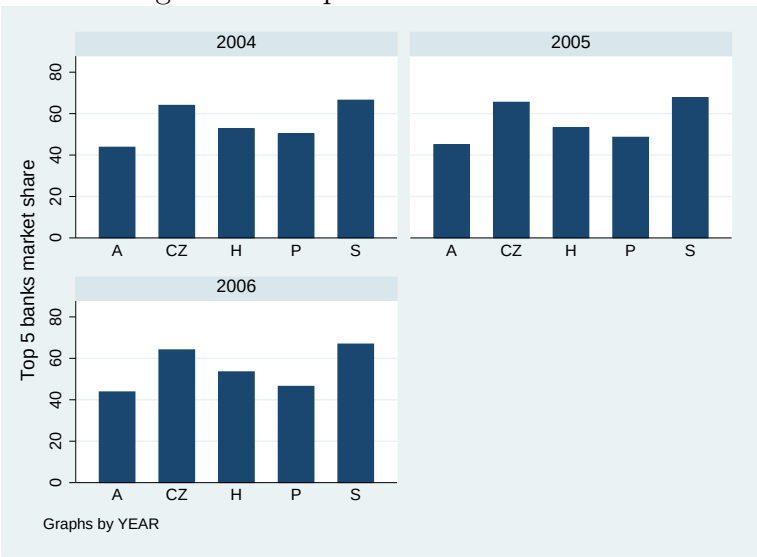


Figure 4.7: Top 5 banks market share



We have discussed above that we expect the cross-sectional heterogeneity to

show up also in the degree of labor intensity and technological level of the bank's operations. Figure 4.8 illustrates this phenomenon on the comparison of international differences in the share of personnel expenses on total bank's assets. The lowest share is attained by Austria, whereas the highest by Poland.

Figure 4.8: Personnel expenses to total assets

Figures 4.9 and 4.10 show the alternative measures of fee level and the measures of the degree of reliance on cashless payments. The simple regression suggests a negative relationship between the two variables.

Figures 4.11 and 4.12 compare the data on the fee level with the personnel expenses normalized by assets of the given bank. The simple regressions suggest a positive relationship between these variables. It should also be noted that the two extreme values of the personnel expenses to assets belong to e-Banka, the Czech bank with a special distribution channel strategy which relies almost exclusively on internet banking.

Figures 4.13 and 4.14 compare the data on common equity to total assets with

Figure 4.9: Cashless payments versus fees (1)

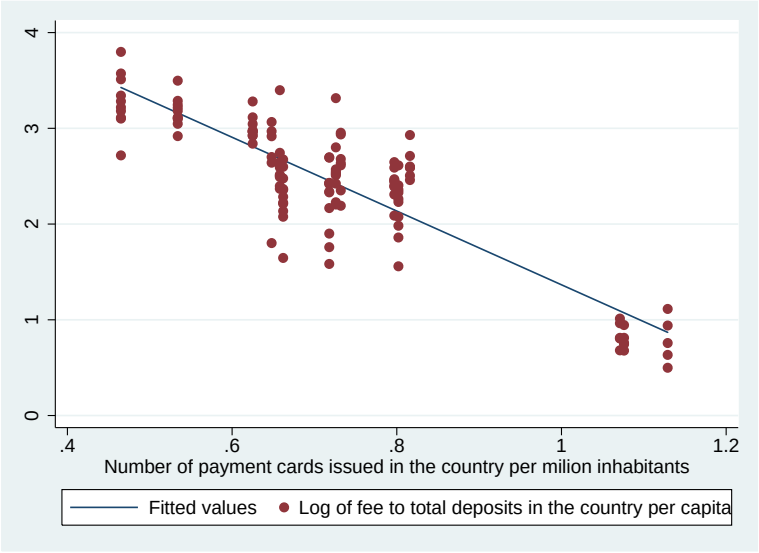
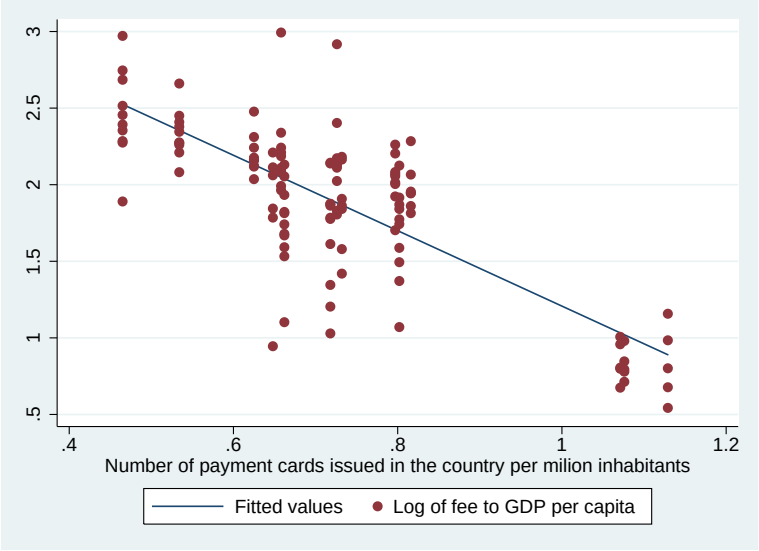


Figure 4.10: Cashless payments versus fees (2)



the two alternative measures of the fee level.

Finally, Figure 4.15 illustrates the relative size of assets held by banks in the different countries in our dataset. It clearly shows the dominant size of the Austrian banks relative to their counterparts from the other countries in the dataset.

Figure 4.11: Personnel expenses versus fees (1)

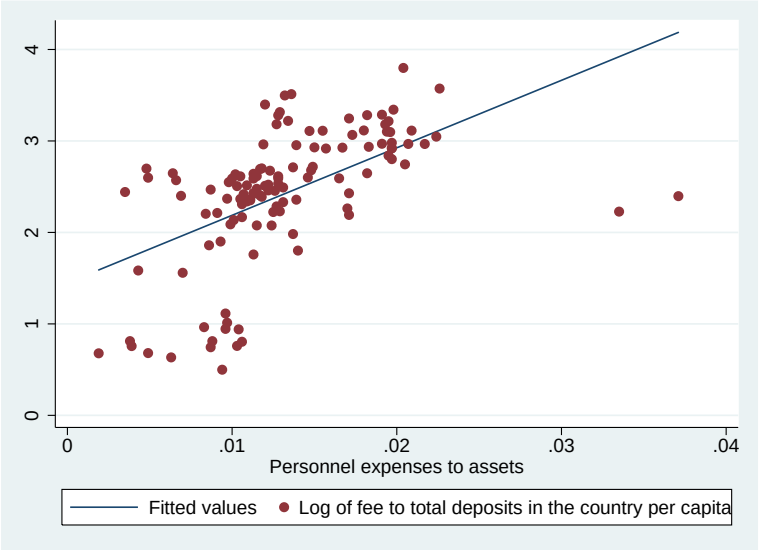


Figure 4.12: Personnel expenses versus fees (2)

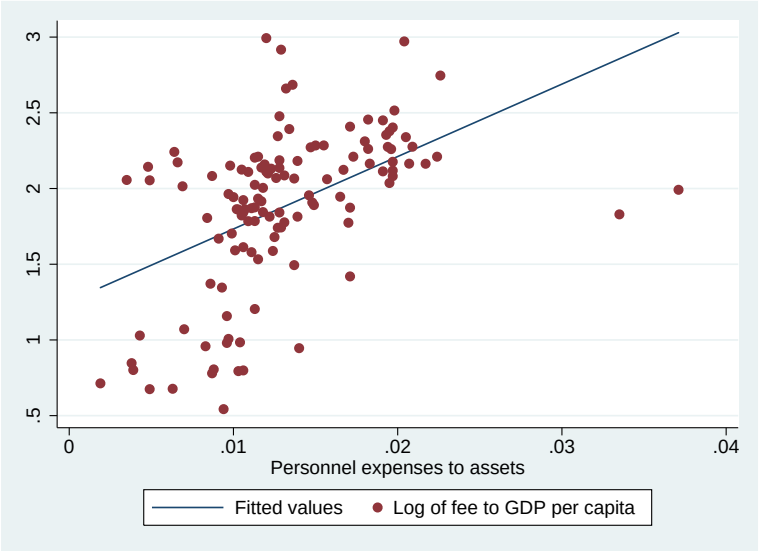


Figure 4.13: Common equity to total assets versus fees (1)

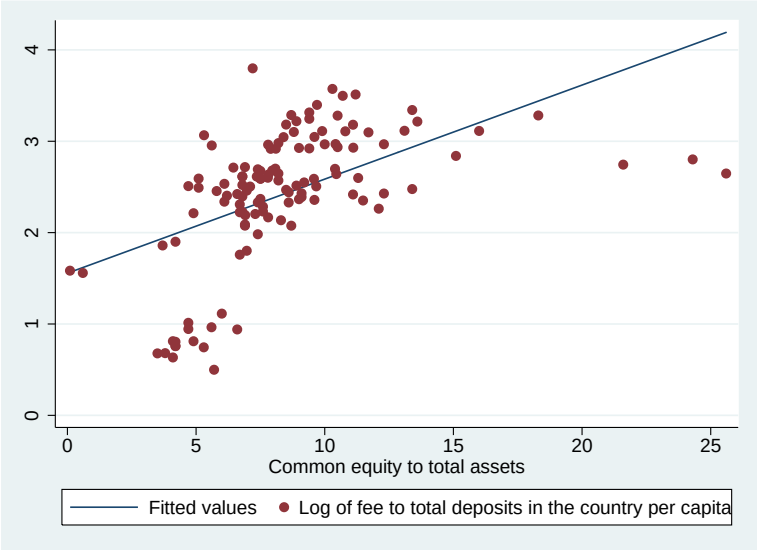


Figure 4.14: Common equity to total assets versus fees (2)

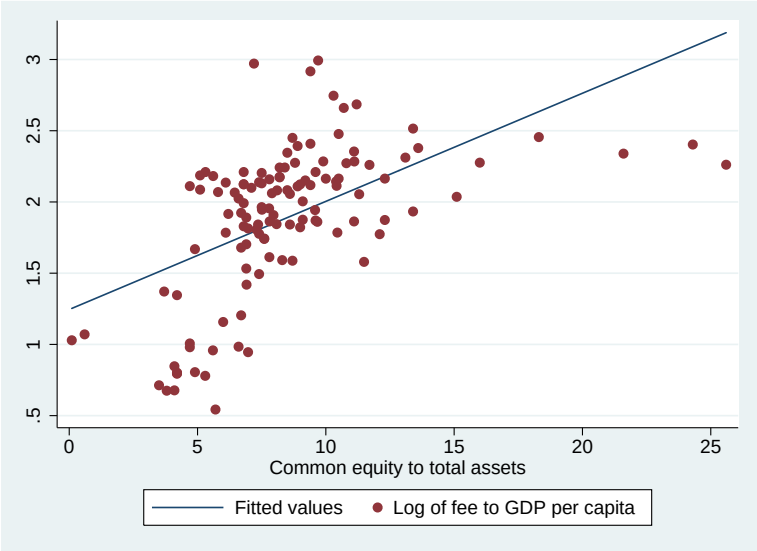


Figure 4.15: Total assets of the banks in the dataset

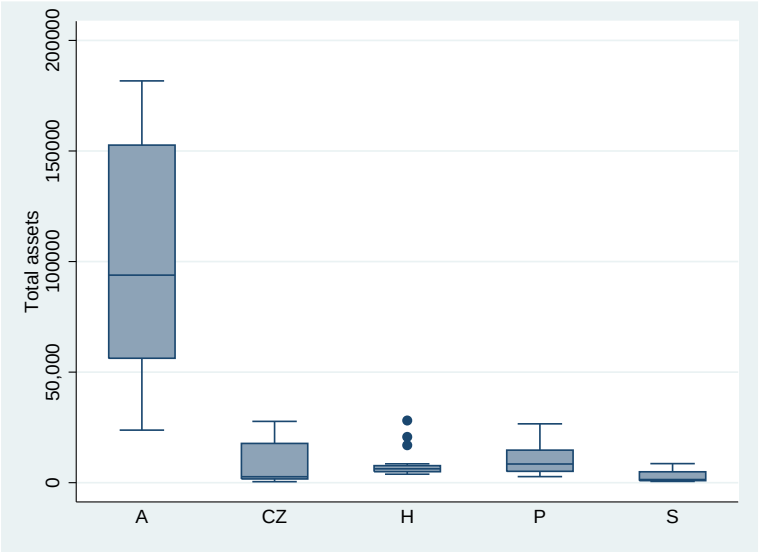


Table 4.8: Definition and source of the variables used in the analysis

Variable	**Definition**	**Source**
Y_{ijt}	Fee index of bank i in country j at time t / total bank deposits per capita in country j at time t	Scott & Rose, s.r.o. (fee index), ECB statistics (total deposits)
$\bar{Y}_{ijt}$	Fee index of bank i in country j at time t / GDP per capita in country j at time t	Scott & Rose, s.r.o. (fee index), ECB statistics (GDP)
$CASHLESS_{jt}$	Number of payment cards issued in a country j at time t per million inhabitants	ECB Statistics
$ASSETS_{it}$	Total assets of bank i at time t	Bankscope database
$EASSETS_{it}$	Common equity as a share of total assets of bank i at time t	Bankscope database
NIM_{it}	Net interest margin of bank i at time t = (interest income – interest expense)/total assets	Bankscope database
REG_{jt}	Economic Freedom Index of Regulation	The Heritage Foundation
$MSHARE_{jt}$	Market share of the top five banks in country j at time t	EU Banking Structures 2007, ECB
HHI_{jt}	Herfindahl-Hirschman index of industry concentration (the sum of the squared market shares of the individual banks in country j)	EU Banking Structures 2007, ECB
$OTHCOMP_{jt}$	Assets managed by insurance companies, investment funds and pension funds as a share of total assets of credit institutions in country j at time t	EU Banking Structures 2007, ECB
$PERSON_{it}$	Personnel expenses of bank i as a share of its assets	Bankscope database
$LLPR_{it}$	Provisions for loan losses as a percentage of net profit of bank i at time t	Bankscope database

Table 4.9: Characteristics of the banks in the dataset

Year	Austria	Czech Republic	Poland	Slovakia	Hungary
Number of banks in the dataset					
2004	5	10	10	11	6
2005	5	10	10	11	7
2006	5	9	10	10	7
Total assets of banks in the dataset (mil. EUR) (share on the total assets of credit institutions in the country in brackets)					
2004	434299 (68%)	69407 (80%)	89130 (63%)	23067 (75%)	47763 (70%)
2005	518100 (72%)	82897 (82%)	100370 (61%)	30845 (82%)	55630 (71%)
2006	569822 (72%)	96556 (84%)	112888 (60%)	32723 (78%)	70620 (75%)

Table 4.10: Summary statistics

Variable	Description of the variable	Number of observations	Mean	Std. Dev.	Min	Max
Y	Log of fee to total deposits in a country per capita	126	1.88	0.52	0.54	2.99
$\bar{Y}$	Log of fee to GDP per capita	126	2.42	0.73	0.50	3.80
ASSETS	Total assets of a bank	127	18,378.88	35,518.66	455.80	181,703.20
CASHLESS	Number of payment cards issued per million inhabitants	129	0.73	0.16	0.47	1.13
EASSETS	Common equity to assets of a bank	125	8.41	3.72	0.10	25.60
NIM	Net interest margin	127	0.03	0.01	0.01	0.07
MSHARE	Top 5 banks market share	129	57.21	8.88	43.80	67.70
HHI	Herfindahl-Hirschman Index	129	892.74	235.94	534.00	1,155.00
PERSON	Personnel expenses per assets of a bank	126	0.01	0.01	0.00	0.04
REG	Economic Freedom Index (Regulation)	129	51.62	5.33	50.00	69.00
LLPR	Provision for loan losses / Profit before provisions and taxes	116	18.66	45.32	-249.20	330.40

Table 4.11: Correlation analysis

	Y	Y2	ASSETS	CASHLESS	EASSETS	NIM	MSHARE	HHI	PERSON	REG	LLPR
Y	1.00										
Y2	0.97	1.00									
ASSETS	0.66	0.59	1.00								
CASHLESS	0.90	0.84	0.70	1.00							
EASSETS	0.65	0.63	0.33	0.57	1.00						
NIM	0.62	0.55	0.35	0.48	0.52	1.00					
MSHARE	0.09	0.13	0.50	0.15	0.10	0.01	1.00				
HHI	0.09	0.14	0.49	0.14	0.11	0.02	0.99	1.00			
PERSON	0.55	0.51	0.26	0.54	0.44	0.60	0.18	0.17	1.00		
REG	0.09	0.10	0.14	0.13	0.10	0.05	0.37	0.35	0.09	1.00	
LLPR	-0.13	0.13	0.12	0.18	0.16	0.05	0.16	0.17	0.11	0.05	1.00

Table 4.12: Behavior of the representative client (Source: Scott&Rose,s.r.o.)

Average account balance in SKK	**23,000**
Account statements	
Monthly	64%
Quarterly	36%
Distribution of the statements	
- sent by post	76%
- at a branch	24%
Cash	
Number of cash deposits per month (4 000,- SKK on average)	0.35
Number of cash withdrawals at a branch per month (4 000,-SKK on average)	0.59
Number of cash withdrawals at an ATM of the client's bank per month (1500,- SKK on average)	1.97
Number of cash withdrawals at an ATM of another bank per month	0.55
Payments (within the country)	
Number of incoming payments per month	1.93
Number of outgoing payments per month (not including permanent orders) (1 000 SKK on average)	2.33
Number of outgoing payments per month by a permanent order	2.11
Share of inter-bank outgoing payments	81%
Share of intra-bank outgoing payments	19%
Frequency per year	
Initiation of a permanent payment order	1.77
Change of a permanent payment order	1.83
Cancellation of a permanent payment order	0.76
Communication with the bank	
At a branch	62%
Direct banking (internet, telephone, GSM)	38%
Payment cards (percent of clients)	
Electron	85%
Embossed	15%