Essays on the Economics of Credit Rating Agencies and Banking

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Josef Forster

Referent:	Prof. Dr. Gerhard Illing
Korreferent:	Prof. Dr. Monika Schnitzer
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Part I

General Introduction

This dissertation consists of three self-contained research papers and addresses two relevant topics from the field of the economics of financial institutions and services. The first topic (part II) studies issues on the economics of credit rating agencies and consists of two theoretical research papers (chapters 3 and 4). The second topic (part III) contributes to the economics of banking and consists of one empirical research paper (chapter 6). Chapter 1 and 2 of this general introduction provide an overview of the motivation, the related literature, and the main results of those three papers.

1 Economics of Credit Rating Agencies

1.1 The Role of Credit Rating Agencies in Financial Markets

Standard & Poor's, one of the world's leading credit rating agencies (in the following CRA), defines a credit rating of a debt issue as "[...] a current opinion of the creditworthiness of an obligor with respect to a specific financial obligation [...]. [...] The opinion evaluates the obligor's capacity and willingness to meet its financial commitments [...]."[1] The purpose of credit ratings is therefore to decrease informational asymmetry between an issuer of a debt instrument and investors and to improve

[1] see the website of Standard&Poor's: www.standardandpoors.com; other CRAs use very similar definitions of a credit rating.

the allocation of capital. The rating process consists of qualitative, quantitative and legal analysis and CRAs express their credit ratings by discrete rating categories. Cantor (2001) notes that credit ratings condense a big amount of information into one symbol, which is primarily determined by the expected loss[2] of a debt instrument. Crouhy et al. (2001) summarize that the qualitative analysis considers the quality of management, the issuer's competitiveness within its industry, the expected growth of the industry, and its vulnerability to regulatory changes, labor relations, and technological changes. The quantitative analysis is mainly concerned with the financial analysis of the issuer. Standard & Poor's uses the letter combinations AAA to BBB for investment-grade long term issues and BB to D for speculative-grade long term issues. Another global CRA, Fitch Ratings, uses the same classification as Standard & Poor's, whereas Moody's uses Aaa to Baa to assign investment-grade and Ba to C for speculative-grade. All three additionally distinguish between issue and issuer credit ratings and long- and short-term issues. Table 1.1 provides an overview of the different rating categories of Standard & Poor's and Moody's and a short definition for each rating category.[3] With increasing volume and complexity of financial markets - for example with the raise of structured finance products such as collateralized debt obligations - the reliance of both investors and regulators on credit ratings has grown rapidly over the last years. The global issuance of rated debt instruments increased enormously from roughly US$ 3,500 billion in the year 2002 to over 8,000 billion in 2006 - whereas structured finance products contributed with a compound annual growth rate of 27% in that time period.[4]

[2] The expected loss of a debt instrument is defined as the product of its expected default rate and expected loss severity. (see Cantor, 2001)

[3] For the ratings definitions see CRA's websites: www.standardandpoors.com, www.moodys.com and www.fitchratings.com

[4] The compound annual growth rate (CAGR) of corporates, public finance, financial institutions, and sovereign rated debt issuance was 21%. The the CAGR of total global debt issue between 2002 and 2006 was 23%. Source: Moody's (2006).

Moody's	S&P's	definition
Aaa	AAA	highest quality, minimal credit risk
Aa1	AA+	
Aa2	AA	high quality, very low credit risk
Aa3	AA-	
A1	A+	
A2	A	upper-medium quality, low credit risk
A3	A-	
Baa1	BBB+	
Baa2	BBB	medium quality, moderate credit risk
Baa3	BBB-	
Ba1	BB+	
Ba2	BB	speculative elements, substantial credit risk
Ba3	BB-	
B1	B+	
B2	B	speculative elements, high credit risk
B3	B-	
Caa1	CCC+	
Caa2	CCC	poor standing, very high credit risk
Caa3	CCC-	
Ca	CC	highly speculative, near default
C	C	typically in default
	D	
Source: Moody's and S&P's websites. Definitions from Moody's. Definitions from S&P's are very similar.		

Table 1.1: Rating categories and definitions.

Nevertheless, anecdotal evidence shows that the role CRAs play in financial markets is not unambiguous. On the one hand, due to the fact that the amount of rated debt instruments increased that enormously over the last years, credit ratings seem to be very important and valuable for financial markets. Therefore, CRAs seem to have enormous market influence such as informative value for investors and advantages for debt issuers, because otherwise there would be no need for debt issuers to spend money for expensive rating fees. On the other hand, in the recent past CRAs very often have been criticized for publishing inaccurate credit ratings, for their intransparent rating procedures, and have been involved in financial and corporate scandals several times. Examples are the Asian crisis, where CRAs gave

Thailand an investment-grade rating until five months after the start of the crisis, or the Enron case, where CRAs judged Enron investment-grade until days before it went bankrupt. Another recent example for public discussion about potentially inglorious behavior of CRAs is the financial crisis of 2007 that was set off by the debacle of subprime lending in the USA. Many times, the CRAs themselves refused the allegation for having issued inaccurate credit ratings and of being jointly responsible for the above mentioned incidences. They pronounced that their credit ratings have to be regarded as their opinions only and that they have to rely their rating decision on information provided by debt issuers. Furthermore, CRAs often have been suspected of being exposed to potential conflicts of interest. One example arises from the fact that the issuer of a debt instrument pays for the credit rating, not the investors which rely their investment decision on the observed credit rating. A CRA might be induced to publish a better credit rating, if the issuer offers a higher rating fee. Another example for conflicts of interest arises from additional consulting services, which CRAs offer to their clients. A CRA may then offer a more favorable credit rating, if the issuer demands additional services. Again, the crisis in subprime lending can serve as an illustration of that issue. In the recent past, the CRAs not only issued credit ratings for structured debt instruments, but also supported investment banks in designing such products in order to obtain a high rating. CRAs have been criticized for cooperating too closely with the issuers of structured debt products and for publishing too favorable credit ratings.[5]

A closer look at the market structure of CRAs shows that the market is dominated by three big global firms (Moody's Investors Services, Standard & Poor's and Fitch Ratings). According to published data from Moody's the global industry market share of the three big agencies was estimated to be 95% in 2006. The largest CRA

[5]For an overview on the role of CRAs in structured finance see for example BIS (2005).

is Standard & Poor's with a market share of 40%, followed closely by Moody's with 39% and Fitch with 16%. While Moody's is an independent joint stock company, Standard & Poor's is a subsidiary of McGraw Hill Companies and Fitch Ratings is a subsidiary of Fimalac, a French business support services group. It has been criticized several times that there is obviously a lack of competition and limited market entry with the consequences of inefficiently high rating fees and inefficiently low rating quality. The rating business is extraordinary profitable for the three dominant CRAs, too. For example, the operating margin of Moody's was 61.8% in 2006 and 54.3% in 2005. Comparably high is the profitability of Standard & Poor's, which achieved an operating margin of 43% in 2006 and 42.5% in 2005.[6] Despite those objections just described - market power and conflicts of interest - CRAs remained themselves largely unregulated, whereas credit ratings are extensively used in financial market regulation.[7] For example, many institutional investors are restricted to invest only in instruments with a high enough credit rating and in the context of Basel II, capital adequacy ratios are determined according to the credit rating of a debtor.[8] For being eligible to be used for regulatory purposes in the US, a CRA has to be "nationally recognized". For a long time only the three big agencies have received that so called NRSRO (=nationally recognized statistical rating organization) status by the Securities and Exchange Commission (SEC). For the US, regulatory authorities to some degree themselves are limiting market entry for other CRAs. Market entry is therefore limited for two reasons. First, a CRA must have enough reputation to be recognized by financial market participants, which only can be earned, if a CRA is already in the market. Second, regulatory authorities limit

[6] The sources of the data are Moody's (2006) and Standard&Poor's (2007).

[7] See for example Economist (2005).

[8] For an overview on ratings used in regulation see BIS (2000) and Cantor & Packer (1994). In the U.S., among others, banks were prohibited to purchasing "speculative securities" (1931), Savings&Loans were prohibited from investing in below-investment-grade-bonds (1989), and money market mutual funds were required to limit holdings of low-rated papers (1991).

market entry, because a CRA has to be recognized by the regulator for being eligible for regulatory purposes.[9]

In the past, it has frequently been argued - in the literature and by the CRAs themselves - that reputation is the most important asset of CRAs and that therefore self-regulation in the CRA industry works very efficient and no further regulation would be necessary. The argument was that CRAs have an incentive to maintain a reputation for accurate and high-quality credit ratings. If investors would lose confidence in the credit ratings of a certain CRA and if therefore debt issuers would no longer believe that credit ratings would reduce finance costs, debt issuers would no longer be willing to obtain a costly credit rating (see Cantor & Packer, 1994). However, the lack of competition in the CRA industry and the points of criticism mentioned above raise the suspicion that the threat of losing reputation may be not enough to assure high rating quality. In theory, CRAs have an incentive to issue accurate credit ratings and to avoid conflicts of interest in order to preserve their reputations. However, Partnoy (1999) argues that "[...] once the ratings of a small number of credit rating agencies are enshrined by regulators who incorporate credit ratings into substantive regulation, the markets become less vigilant about the agencies reputation."

More recently, the discussion on tighter regulation of CRAs is active among institutions of financial market supervision - especially after the financial crisis of 2007, but also already before.[10] One goal of the U.S. "Credit Rating Agency Reform Act 2006", which passed legislation in September 2006, is the promotion of competition and ficilitation of market entry, fostering accountability, transparency, and investor protection.[11] In 2004, the international organization of securities com-

[9] See White (2001).
[10] See for example Economist (2005, 2008).
[11] See Credit Rating Agency Reform Act (2006).

missions (IOSCO) published a code of conduct fundamentals for CRAs, with the goal to increase the accuracy of credit ratings and to reduce conflicts of interest (see IOSCO, 2004). After the subprime loan crisis in 2007, the EU-commission and US politicians blamed the CRAs for being jointly responsible for the credit crisis. The EU-commission considered to react with legal restrictions for the CRAs and also US authorities considered to investigate the role of CRAs in the credit crisis of 2007.

1.2 Literature and Motivation

Regarding the academic literature, Richard Cantor (2004) points to the fact that the literature on the role of CRAs has almost exclusively an empirical focus. Nevertheless, the literature on CRAs can be separated into three categories. The first category is literature on the credit rating industry, where articles describe the current and past situation and provide arguments on what should be changed by regulatory intervention or why the present oligopolistic market structure with a few dominating agencies is or is not efficient, as for example Hill (2004), White (2001), Schwarcz (2001), Partnoy (1999) or Cantor & Packer (1994). Unfortunately, the contributions in this literature category have in common a lack of theoretical foundation.

The second and clearly largest category is empirical literature on the role and performance of CRAs. For example, Ellis (1998) analyzes whether debt issuers and investors agree on the meaning of credit ratings. The paper shows that issuers feel that credit ratings overstate the riskiness of bonds while investors feel the opposite. In a similar study, Baker & Mansi (2002) show that investors and debt issuers substantially differ in their assessment whether credit ratings accurately reflect creditworthiness. Amato & Furfine (2004) study whether the business cycle influences credit ratings. They find evidence that credit ratings generally do not exhibit ex-

cess sensitivity to the business cycle. Whether CRAs are exposed to conflicts of interest is investigated by Covitz & Harrison (2003). Measuring the anticipation of rating changes, they find evidence that reputational incentives might dominate the rating decision of CRAs. However, they do not analyze whether the initial rating levels might be biased by conflicts of interest. Dodd & Setty (2003) find evidence that credit ratings have an impact on capital flows to developing countries. Galil (2003) analyzes empirically the quality of corporate credit ratings and provides evidence that credit ratings could be improved by using publicly available information and that some categorizations of credit ratings are not informative. Doherty et al. (2007) find evidence that competition in the CRA sector improves the quality of credit ratings. Brookfield & Ormrod (2000) analyze the impact of credit ratings on bond yields. They find that the official recognition of credit ratings has no market-based role and that credit ratings are used because of the success of the major CRAs in performing their market function. Löffler (2004, 2005) analyzes whether CRAs follow their claimed concept of 'rating-through-the-cycle' and shows with simulations and empirical evidence that CRAs change credit ratings, if it is unlikely to be reversed shortly afterwards. Löffler (2007) concludes that market-based measures and credit ratings have complementary characteristics, and he shows that one should give more weight to credit ratings as the risk of debt issuers decreases, or the investment horizon increases.

In the small category of theoretical literature, Millon & Thakor (1984) analyze the rationale why CRAs exist and motivate their existence with the possibility of information and risk sharing. They conclude that CRAs might not have an incentive to employ costly effort into the process of information production. However, neither conflicts of interest nor regulation of CRAs are considered. Regulation is not considered either in Kuhner (2001), where the role of CRAs in times of enhanced

systemic risk, with CRAs acting as frontrunners in a Bayesian herding process, is analyzed. Boom (2001) concentrates on the demand and the price for a credit rating of a monopolistic credit rating agency. But again, no regulatory issues are incorporated explicitly in the model. Mukhopadhyay (2004) analyzes the behavior of CRAs under consideration of moral hazard aspects. The model motivates the moral hazard problem with unobservable evaluation standards, which CRAs use in the rating process, and shows, somewhat questionable from a policy perspective, that a regulator can enforce an evaluation standard with incentive payments to the CRA. But again, this contribution neither considers conflicts of interest between the CRA and the rated issuer nor welfare implications of regulation. Another interesting theoretical motivation for the role of CRAs in financial markets is formulated in Boot et al. (2006). They show that issued credit ratings may act as a coordination mechanism in the presence of multiple equilibria and that credit ratings may be stability improving. Despite those valuable results, issues regarding possible conflicts of interest, moral hazard and regulation of CRAs are not addressed in this paper.

The motivation for doing research on CRAs arises from two sources. The first one is that the practical relevance of credit ratings and CRAs increased enormously, especially during the last years. The growth in rated debt issues points to the fact that CRAs and their credit ratings play a very meaningful role in global financial markets. As mentioned above, CRAs frequently were confronted with criticism. Open questions regarding the role CRAs actually play and the regulation of CRAs are frequently discussed among the public press as well as financial market institutions. The other source of motivation is that the theoretical literature on CRAs and credit ratings is not yet comprehensive as the relevance of several points of criticism has not yet been analyzed theoretically.

Two chapters in that dissertation contribute to an understanding of the debate

on the role of CRAs and their regulation. Those two chapters pick up two sources of criticism with which CRAs were confronted frequently in the past. Chapter 3 analyzes on the optimal regulation of CRAs in a theoretical framework. The paper motivates intransparent rating methodologies and potential conflicts of interest as a rationale for regulation and discusses the implications for optimal regulation from a welfare perspective. Chapter 4 investigates the role of CRAs regarding financial market stability in a theoretical framework. The main emphasis in that chapter is placed on the influence of the level of rating fees, mandatory and voluntary credit ratings, and which party pays the fee on financial market stability. This chapter focuses therefore on potential adverse effects of market power and inefficient high rating fees from a perspective of financial market stability.

1.3 The Optimal Regulation of Credit Rating Agencies

The first paper (chapter 3) studies the optimal regulation of CRAs in a model where rating quality is unobservable and enforcing regulation is costly. In the applied theoretical framework, credit ratings helps to allocate investment more efficiently, meaning that the informative value of a credit rating is positive. The model, which is based on Pagano & Immordino (2007), motivates a rationale for regulation by showing that due to unobservable rating quality the allocation of investment becomes inefficient and social welfare inefficiently low in comparison to the first-best result. Incentives for moral hazard arise, because the CRA has an incentive to employ lower rating quality in order to reduce costs, which leads to inaccurate credit ratings. In a next step, we introduce a regulator, which has a costly technology, that may detect compliance with a minimum rating standard with a certain probability. The model shows that the optimal rating standard is lower than the first-best rating quality.

In order to give consideration to the criticism that CRAs may be exposed to conflicts of interest, the model is extended in a next step by assuming that CRAs do not only offer the service of rating but also have the ability to offer additional consulting services to the rated issuer of a debt instrument. The compensation for consulting services can be used by the rated debt issuer to bribe the CRA in order to get the desired good credit rating. However, the effect of possible collusion on social welfare is not unambiguous. On the one hand, collusion leads to inaccurate credit ratings, which leads to less efficient investment and therefore to a reduction of social welfare. On the other hand, by rating an issuer of a debt instrument, the CRA has gained expertise to provide additional consulting services at lower costs, compared to an external firm, which leads to an increase in social welfare. Hence, the possible strategy for the regulator is either to forbid the joint provision of services or to allow it. If the regulator allows the joint provision of services, the optimal rating standard is lower compared to the case of forbidding it, because a higher rating standard invokes the CRAs to accept the bribe more often. Using social welfare as the decision criterion, it is not always optimal to forbid the joint provision of services. We show that the decision of the regulator depends on the size of the bribe and on the efficiency of regulation. If the bribe is sufficiently small and efficiency of regulation sufficiently high, it is optimal to allow the joint provision of services and not to prevent the possibility of collusion ex-ante. However, if the bribe is sufficiently large and the efficiency of regulation technology sufficiently small, social welfare could be increased, if the joint provision of services would be forbidden.

1.4 Credit Rating Agencies and Financial Market Stability

The second paper (chapter 4) asks and answers two main questions in a theoretical framework. The first question is, in how far the useful role of credit ratings is influenced by the size of the rating fee. By analyzing that question, we give consideration to adverse effects of market power of some few CRAs, which obviously have the possibility to set higher rating fees compared to the competitive level. The second question is, in how far the valuable role of credit ratings is influenced by the way CRAs exactly generate their revenues and whether credit ratings should be mandatory rather than voluntary. The paper is an extension of the model in Boot et al. (2006), who show that CRAs can help to increase financial market stability by coordinating investors' expectations in situations, where multiple equilibria exist. Under certain conditions, the decision of the debt issuer to invest in either a good or a bad portfolio depends on the expectations of the external investors. Hence, multiple equilibria are present for credit qualities of a good portfolio in an intermediate range. In the model framework, the role of CRAs can be described as acting as a coordination mechanism. The key assumption is that a certain fraction of the investor community, which are characterized as "institutional investors", is restricted by regulation to invest only in instruments with low risk and with a credit rating that reflects investment-grade. In the presence of multiple equilibria, those institutional investors, which rely their investment decision on the observed credit rating, can lead the debt issuer to choose the low risk portfolio and hence to establish the desired "good" equilibrium and therefore to reduce financial market fragility.

By extending the approach of Boot et al. (2006), we show that the size of the rating fee and the question, which party pays the fee - issuer of a debt instrument or investors - influences the utility of credit ratings. We show that a reduction of

the rating fee always increases financial market stability and that it may be optimal to charge the rating fee from institutional investors, which base their investment decision on the observed credit rating, instead of the issuer of a debt instrument. Furthermore, the model concludes that mandatory credit ratings may be more valuable than voluntary credit ratings.

2 Economics of Banking

2.1 The Capital Decision of Banks

Costly bank capital has been motivated in the theoretical literature with real life observations and with the special function of the banks as liquidity providers, among others. Most of the time, however, the modelling approaches used result in a corner solution of the regulatory capital requirement (see e.g. Bolton & Freixas, 2000, and Helman et al., 2000). As a consequence, a lot of theoretical literature concentrates on regulatory incentives. The real life observation of bank capital being around the regulatory minimum requirements is, however, somewhat questionable. In particular in less developed countries, banks seem to exhibit much higher capital levels. This raises the question of a possible trade-off in the bank's capital decision.

In explaining the costs of bank capital, two complementary theories based on the liquidity creation function of the bank have emerged. Whereas Diamond & Rajan (2000, 2001) stress the asset side, Gorton & Winton (1995, 2000) derive a relation between the cost of capital and the heterogenous liquidity needs of consumers that buy shares. The basic trade-off in Diamond & Rajan (2000) between deposits and capital is that on the one hand, more capital, due to the hold-up problem between the bank as a relationship lender and the capital owners, increases the rents ex-

tracted by the bank and decreases the amount the bank is able to raise and invest. On the other hand, deposits, due to the sequential service principle, alleviate the rent extraction problem, but increase the probability of inefficient liquidation of the bank in presence of uncertainty on asset values. Diamond & Rajan (2000) assume that there is no aggregate shortage of liquidity or of capital. Therefore, the supply side does not play a role here. The model implicates that the amount of capital is higher the more uncertainty there is, the less developed the financial market is and the smaller the market is. Gorton & Winton (1995) offer another approach for costly capital in a general equilibrium model. In the model, capital is informationally sensitive, and because information is costly, there are both informed and non-informed traders in the market. Unlike in Diamond & Rajan (2000), the distribution of shares now matters. Since consumers have heterogenous liquidity needs, these needs determine the cost of capital. Therefore, in addition to the characteristics of the market where the bank operates, the characteristics of the shareholders make a difference. Implications of Gorton & Winton (1995) are that the amount of capital is higher, the lower the liquidity needs of the shareholders are and the wealthier they are. Empirical literature on bank capital has mainly concentrated on bank specific factors as explanatory variables, like in Altunbas & al. (2000) and Barrios & Blanco (2003) for Spain, Yu (2000) for Taiwan and De Bondt & Prast (1999) for five European Union (EU) countries and for the US. All these papers find evidence that bank specific, solvency related factors such as return on equity, bad loans, and liquidity measures matter. Additionally, regulatory pressure seems to matter in Spain. However, none of the contributions controls for factors that may have to do with the shareholder characteristics. For the US, Marcus (1983) and later on Benston & al. (2003) find evidence that the tax treatment of capital items and deposits has had a significant effect on the amount of bank capital. But again, the

institutional environment in their study affects the demand of capital of the banks, not the supply by the shareholders.

2.2 Costly Bank Capital - Demand and Supply Side Considerations

The third paper of the dissertation (chapter 6) asks what drives the capital decision of a bank and in particular whether supply side restrictions play a determinant role.[12] In so doing, we take directly a stand on a debate in modern theories of bank capital determination. We test the determinants of bank capital in five Central and Eastern European and the three Baltic (CEB) countries that have recently joined the EU. We analyze whether there is a difference in the bank capital ratios between multinational and national banks in one specific market. With the empirical analysis of bank capital of national and multinational banks, operating in the CEB countries, we are able to analyze supply and demand side factors separately, in order to discriminate between the theories of Diamond & Rajan (2000) and Gorton & Winton (1995). Focusing on subsidiaries of multinational banks in our sample, we investigate whether the home market conditions have an impact on bank capital, when the effect of host country factors is controlled for. This is possible due to the fact that in the sample of subsidiaries of multinational banks the market of the source of capital differs from the market of operation. Furthermore we derive stability implications of international banking in a specific market area.

The CEB region is a good candidate to analyze these questions because it hosts many international banks and is almost entirely a host market. Summary statistics show that there is a robust difference between the capital ratios of domestic and

[12] This paper is based on joint work with Katri Mikkonen.

foreign banks, indicating that the supply side may matter. A closer look at the stock market measures and the GDP per capita in the home and the host countries reveals that there is a large difference between the two markets. Using panel data methods, we find evidence that home country factors, attributable to the supply side of bank capital, play a significant role in determining bank capital. Furthermore we find a significant positive impact of host country factors which refer to the demand side of bank capital. Both observations reveal that banks face a trade-off between costly bank capital and the probability of being allowed to continue their operations and preserve their charter value. Our results suggest that international banks can improve the stability of financial markets even if investment is made in terms of subsidiaries, if the host market suffers from a domestic shortage of capital. However, as the difference between the home and host capital markets becomes smaller, the motives driving internationalization may change. It may then be that the international banks are both more likely to go bankrupt and leave the market when bad times occur.

Part II

Credit Rating Agencies

3 The Optimal Regulation of Credit Rating Agencies

3.1 Introduction

Credit rating agencies (CRA) play a very meaningful role in today's financial markets. According to Moody's (2007) - the second largest CRA worldwide - , the volume of rated debt issues increased globally from US$ 3,500 billion in the year 2002 to over 8,000 billion in 2006. In principle, credit ratings should serve as third-party opinions about the solvency of a debt instrument and should reduce the information asymmetry between an issuer of a debt instrument and the potential investors, and therefore improve efficiency and transparency in financial markets. The CRAs pronounce that their credit ratings should not be interpreted as default probabilities and that credit ratings are rather opinions about risk only. The higher is the credit rating of a debt instrument, the less likely it should be to default and the longer it should take to default. A closer look at corporate scandals and financial crisis during the last years reveals that CRAs have been involved several times and have been confronted with heavy criticism for publishing inaccurate credit ratings. Examples are the Asian crisis, where the CRAs gave Thailand an investment-grade rating until five months after the start of the crisis or the Enron case, where the CRAs gave Enron investment-grade until days before it went bankrupt. Another recent example

for public discussion about the behavior of CRAs is the debacle of subprime lending in the USA with its impact on financial markets globally.[13] Furthermore, CRAs very often are confronted with the suspicion of being exposed to conflicts of interest as mostly the issuers of the debt instrument pay for the credit rating, which fees account for about 90 per cent of the CRAs' revenues, and as CRAs offer additional consulting services to their clients. Again, the crisis in subprime lending can serve as an illustration of that issue. The CRAs not only issued credit ratings for structured finance instruments, but also supported investment banks in designing them (see for example Mason & Rosner, 2007).

Despite these objections, CRAs remained themselves largely unregulated, but the discussion on further regulation is active in the media as well as in institutions of financial market supervision. In 2005 the SEC (securities and exchange commission) published a report on the behavior of CRAs and issued a concept release on how the regulation of CRAs should be changed. Amongst others regulation would be needed for requirements on the qualifications of rating-analysts, the avoidance of conflicts of interest in the presence of additional services of CRAs and the current monitoring of CRAs.[14] In 2004 the IOSCO[15] published a code of conduct fundamentals for CRAs in which was proposed amongst others that the quality and integrity of the rating-procedure should be warranted and that credit ratings should be free from conflicts of interest.[16] In September 2006, the U.S. legislations passed the "Credit Rating Agency Reform Act 2006", with the goal to improve the quality of credit ratings

[13] Due to the rise in housing prices the volume of subprime loans increased rapidly. Those loans where securitized into mortgage backed securities and again these were securitized into collateralized debt obligations (CDOs). Those complex debt contracts received a very high rating from the CRAs, comparable to government bonds. In the first half of 2007 CDOs lost almost 40% of their value. In order to limit turbulences, the ECB injected around 200 billion Euro and the FED around 40 billion US Dollars emergency liquidity in August 2007.

[14] see Bafin (2004)

[15] The IOSCO (International organization of securities commissions) is a union of national institutions of financial supervision of over one hundred countries.

[16] see IOSCO (2004) and Bafin (2004).

"for the protection of investors and in the public interest by fostering accountability, transparency, and competition in the credit rating industry" (see CRA Reform Act, 2006). After the subprime loan crisis in 2007, the EU-commission and US politicians blamed the CRAs of being jointly responsible for the financial crisis. The EU-commission considered to react with legal regulations for the credit rating agencies and also US authorities announced to investigate the role of CRAs in the subprime loan crisis that was set off in August 2007. However, very little progress has been made in implementing those proposals in national laws and regulations.

This paper contributes to the question whether CRAs should be regulated and especially concentrates on the allegation of inaccurate credit ratings and adverse effects of conflicts of interest. The paper studies the optimal regulation of CRAs in a model where rating quality is unobservable and enforcement of regulation is costly. The applied theoretical model is based on Pagano & Immordino (2007), where the regulation of auditing firms is analyzed. The model considers a representative investment bank[17] that wants to invest in a risky portfolio and needs to raise debt from external investors to finance the investment. A CRA has a costly evaluation technology and issues a credit rating for the debt contract, which is made available for external investors. The credit rating is based on the risk of the underlying portfolio and a credit rating is being issued, if a CRA is assigned by the investment bank. In the setup, the external investors use the credit rating for their investment decision and the credit rating helps to allocate investment more efficiently, compared to the case without a credit rating. If rating quality is unobservable, the CRA has an incentive to lower the rating quality, because the costs can then be reduced and hence the profits increased.

[17] By using an investment bank in our model setup we give consideration to the extensive public discussion about the role of credit rating agencies in the subprime loan crisis in 2007. Our model of course can be generalized by using the term "firm" or "financial intermediary", that has a risky investment project and needs external funds to finance the project.

3. THE OPTIMAL REGULATION OF CRAS

The model motivates a rationale for regulation by showing that due to the unobservable rating quality the allocation of investment becomes inefficient and social welfare inefficiently low. In a next step a regulator with a costly technology may detect compliance with a minimum rating standard with a certain probability. Being benevolent, the regulator decides on the minimum rating standard and the costly detection effort employed in regulation in order to maximize social welfare. The introduction of regulation leads to the trade-off that more efficient allocation of investment leads to a rise in social welfare, but because regulation is costly, to a reduction in social welfare. The results show that the optimal rating standard is lower than the first-best rating quality. In order to give consideration to the fact that CRAs may be exposed to conflicts of interest, the model is extended in a next step by assuming that the rated issuer may bribe the CRA in exchange for a better credit rating and that CRAs do not only rate but also have the ability to offer consulting services.[18] It will be shown that with the joint provision of ratings and consulting services the possibility of collusion may arise, which could have negative effects on social welfare. The model shows that on the one hand the regulator could get rid of the collusion problem by forbidding the joint provision of ratings and consulting services, but on the other hand that this may not always be optimal from a welfare perspective. That chapter gives a contribution to the theoretical literature on CRAs by filling the gap on the optimal regulation of CRAs and by giving consideration to broadly discussed issues regarding the alleged inglorious role of CRAs in financial markets in the recent past.

The remainder of this chapter is organized as follows: Section 3.2 presents a review of the related literature about the role of CRAs in financial markets and the

[18] Associated with the subprime loan crisis in August 2007, CRAs were under suspicion to give too favourable credit ratings for structured debt products, because CRAs did not only rate the products, but also were involved in designing products with a good credit rating.

regulation of CRAs. Section 3.3 introduces the framework of the model, motivates the rationale for regulation when rating quality is unobservable and analyzes the optimal regulation. In section 3.4 the model is extended by introducing conflicts of interest between the issuer of the debt instrument and the CRAs which may emerge by the joint provision of ratings and additional consulting services. Finally, section 3.5 concludes.

3.2 Related Literature

Richard Cantor (2004) points to the fact that the literature on the role of CRAs has almost exclusively an empirical focus. In the small category of theoretical literature, Millon and Thakor (1984) analyze the rationale, why CRAs exist and motivate their existence with the possibility of information and risk sharing. They conclude that CRAs might not have an incentive to employ costly effort into the process of information production. However, neither conflicts of interest nor regulation of CRAs are considered. Regulation is not considered either in Kuhner (2001), who analyzes the role of CRAs in times of enhanced systemic risk, where CRAs act as frontrunners in a Bayesian herding process. Boom (2001) concentrates on the demand and the price for a rating of a monopolistic rating agencies. But again, no regulatory issues are incorporated explicitly in the model. Mostly related with our approach is the contribution of Mukhopadhyay (2004), where moral hazard aspects are considered. That paper motivates the moral hazard problem with unobservable evaluation standards, which CRAs use in the rating process, and show, somewhat questionable from a policy perspective, that a regulator can enforce an evaluation standard with incentive payments to the rating agency. But again, this contribution neither considers conflicts of interest between the CRA and the rated firm nor welfare

implications of regulation. Another interesting theoretical motivation for the role of CRAs in financial markets is Boot et al. (2006). They show that credit ratings can act as a coordination mechanism in the presence of multiple equilibria and that credit ratings then have the ability to improve financial market stability. Despite those valuable results, issues regarding possible conflicts of interest, moral hazard and regulation of CRAs are not addressed in this paper. As will be shown in section 3 in more detail, credit ratings of CRAs and auditing reports of auditing firms are products with related characteristics. Hence, the framework of analyzing the behavior and regulation of auditing firms is closely related to the analysis of CRAs. Dye (1993) analyzes the role of auditing standards and litigation against auditors. They derive auditors' responses to auditing standards and optimal liability rules. Pagano & Immordino (2007) extend the analysis of auditing firms by focusing on unobservable auditing quality, conflicts of interest and optimal regulation.

3.3 The Model

This section introduces a framework for analyzing the regulation of credit rating agencies. The model is based on Pagano & Immordino (2007), where the optimal regulation of auditing is analyzed, and on Dye (1993), who studies the relationship between auditing standards and auditor's wealth. The rationale for regulation will be derived by the assumption that the quality of credit ratings is neither observable nor contractible. It will be shown that a minimum rating standard, set by the regulator, can improve the outcome from a welfare perspective. The regulatory issues for auditing firms in Pagano & Immordino (2007) are closely related to those of CRAs. Similar to CRAs, auditing firms serve as information providers for investors and are assigned and remunerated by the audited firm. One difference is that auditing

firms provide information to shareholders, who provide equity, whereas the CRAs provide information to investors, which provide debt finance. Another difference is that firms are legally forced very often to be audited whereas getting rated is mostly voluntary. At last, the product of auditing firms and CRAs is different from a legal perspective. As mentioned in the introduction, until today a credit rating has to be regarded as an opinion on the default probability only, whose accuracy cannot be sued by the clients of the CRA in contrast to auditing firms.[19]

At first we construct a benchmark model with the assumption that the rating quality is observable and contractible. After relaxing this assumption, we show in a next step that the equilibrium rating quality becomes inefficiently low. By introducing a regulator with a costly detection technology, we show that a minimum rating standard improves efficiency in the allocation of investment and that welfare will be increased. Taking into account that CRAs in the real world have often been blamed to profit from market power, we extend our analysis by distinguishing the cases of perfect competition and market power in the CRA sector.

3.3.1 Investment Bank, Investors, and the Credit Rating Agency

We assume an environment with universal risk neutrality and a continuum of investment banks (IB). A representative IB has the possibility to invest in a risky portfolio. To finance investment of the portfolio, it has to raise debt finance d from external investors.[20] The goal of the representative IB is to maximize its profits from its investment possibilities. Without debt finance, we assume that the IB is

[19] In the aftermath of the Enron debacle, CRAs avoided regulatory scrutiny and litigation in contrast to auditing firms, who were convicted to pay high fines. Also the regulatory oversight of auditing firms was strengthend in contrast to CRAs (see for example Zachariahs, 2007).

[20] We assume that the IB has no own funds initially and therefore has to finance its operation entirely via debt. To keep the model tractable, we assume that external investors require an interest rate of zero.

not able to invest and the final profit of the IB would then be zero.

The risk of the portfolio can be characterized as follows: the final return of the portfolio may turn out to be high or low, so there are two possible states (s) of the portfolio $s = g$ (good) or $s = b$ (bad). The type of the portfolio is a priori unknown to the IB. If the portfolio is in the good state, its final value $\widetilde{\Psi}$ is given by a high payoff Ψ_g, and if the portfolio is in the bad state, the final value $\widetilde{\Psi}$ is given by a low payoff Ψ_b. We assume that each investment bank in the economy invests only in one portfolio in one period. Therefore, the final value of the portfolio is equal to the gross profit of the IB in one period. The portfolio will be in the good state with unconditional probability p and in the bad state with probability $1 - p$. Since we assume a continuum of IBs, the unconditional probability p is also the fraction of IBs in the economy, which has the possibility to invest in a good portfolio.[21] We assume that p is exogenous and a priori known by the IBs and the external investors and that neither IBs nor investors have further private information about the quality of the portfolio. If the portfolio is in the good state, the payoff is assumed to be higher than the required debt repayment to the investors d, but if the project turns out to be in the bad state, the payoff is assumed to be lower than d: $\Psi_g > d > \Psi_b$. Given that the fraction of good IBs p is publicly known, the expected unconditional gross profit of the representative IB is given by $\bar{\Psi} = p\Psi_g + (1-p)\Psi_b$. We assume that the expected gross profit of the IB exceeds the required debt repayment ($\bar{\Psi} > d$). Therefore, risk neutral investors are willing to provide debt finance, given the information about p. Obviously, all IBs that seek debt finance, will be served irrespective if their portfolio is actually good or bad.

The representative credit rating agency (CRA) has a costly technology that enables the CRA to distinguish, whether an IB has the possibility to invest in a

[21] In the paper we will analogously use the terms "good" IB and "bad" IB.

good or a bad portfolio. A single CRA is assumed to rate only one portfolio per period. The CRA is able to detect a signal about the state of the IB's portfolio and accordingly issues a credit rating r that reflects whether the bank's portfolio is good or bad. If the CRA comes to the conclusion that the portfolio is good, it issues a good credit rating $r = g$ and reversely a bad credit rating $r = b$.[22] Since the rating technology is costly, the CRA charges a rating fee θ from the rated investment bank. The issued credit rating, which is made available to external investors, influences the expected profits of the IB and the decision of the investors to provide debt finance.[23] According to Dye (1993)[24] we assume that the CRA can choose the precision of the signal about the state of the rated portfolio. We interpret the precision of the CRA as the quality of a credit rating q. The quality of a credit rating can be interpreted as the qualification of the staff, the information technology or the internal organization of the CRA. The CRA can choose the quality of the credit rating $q \in [0; 1]$. The rating technology is assumed to be perfectly accurate, if the CRA observes a good signal, but that it may be inaccurate after observing a bad signal. The conditional probabilities that the issued credit ratings after observing a good and a bad signal are correct are given by:

$$\begin{aligned} \Pr(r &= g \mid s = g, q) = 1 \\ \Pr(r &= b \mid s = b, q) = q \end{aligned} \tag{1}$$

It is obvious that the credit rating is always accurate in the case of a good signal.

[22] A good credit rating r=g can be regarded as reflecing an "investment grade" credit rating and a bad credit rating r=b as a "speculative grade" credit rating.

[23] Since we assume that an IB invests in only one portfolio for which it seeks external finance, the rating of the portfolio is identical to a rating of the IB itself. Unlike in reality, the model does not discriminate between issuer and issue credit ratings.

[24] The assumptions on the rating technology of the CRA are based on Dye (1993), who analyzes the relationship between auditing standards, auditor's wealth and litigation.

In the case of a bad signal, the accuracy of the credit rating increases with the quality that is employed in the rating process. The technology of the CRA can be described in such a way that credit ratings are biased upwards, meaning that after observing a good signal, the credit rating is perfectly accurate, but after observing a bad signal only with a certain probability. In the case of a bad signal, the CRA will issue an inaccurately good credit rating with a probability $(1-q)$, while the probability of issuing a bad credit rating after observing a good signal is zero.[25]

Given the technology of the CRA, the conditional probability of a rated portfolio being in a bad state after getting a bad credit rating can be calculated using Bayes' rule:

$$\Pr(s = b \mid r = b) = \frac{\Pr(s = b \cap r = b)}{\Pr(r = b)} = 1,$$

while the conditional probability of a portfolio with a bad credit rating, being in a good state is given by:

$$\Pr(s = g \mid r = b) = 0.$$

The probability that the rated IB is in a good state, conditional on a good credit rating, is given by the following expression:

$$\Pr(s = g \mid r = g) = \frac{\Pr(s = g \cap r = g)}{\Pr(r = g)} = \frac{p}{p + (1-p)(1-q)},$$

while the probability that the rated IB is in a bad state, conditional on a good credit rating, is given by:

$$\Pr(s = b \mid r = g) = \frac{(1-p)(1-q)}{p + (1-p)(1-q)}.$$

[25] With that assumption about the technology of CRA we take into account the real world criticism that CRA may issue too favourable ratings and that ratings may be inaccurately adjusted in the case of a deterioration of an instrument's or a firm's conditions.

Using the conditional probabilities above, the expected final profit of the rated IB after deduction of the debt repayment to external investors d, conditional on a good credit rating, can be formulated as:

$$E\left(r=g\right)=\Pr(s=g\mid r=g)\Psi_g+\Pr(s=b\mid r=g)\Psi_b-d$$

$$\longleftrightarrow E(r=g)=\frac{p\Psi_g+\left(1-p\right)\left(1-q\right)\Psi_b}{p+\left(1-p\right)\left(1-q\right)}-d\geq\overline{\Psi}-d. \tag{2}$$

and the expected final profit of the rated IB, conditional on a bad credit rating can be written as:

$$E\left(r=b\right)=\Pr(s=g\mid r=b)\Psi_g+\Pr(s=b\mid r=b)\Psi_b-d$$

$$\longleftrightarrow E\left(r=b\right)=\Psi_b-d<0.$$

Given the technology of the CRA, the expected profit of the rated IB in the case of a good credit rating is larger than the expected profit without a credit rating (see equation (2)). Conversely, the expected value of the IB with a bad credit rating is smaller compared with the case without a credit rating ($\Psi_b<\overline{\Psi}$). Since $\Psi_b<d$, it is rational for the external investors not to provide d and the final expected profit in the case of a bad rating is zero ($E\left(r=b\right)=0$). It is obvious that investment will only take place in the cases of a good credit rating or without a credit rating, since the expected profit of the IB is positive in these two cases, meaning that the investors get back their funds. In the case of a bad credit rating investors are not willing to provide debt finance.[26]

[26]The pivotal criterion for external investors is the expected profit of the IB. The group of external investors is assumed to be homogenous and they are not restricted by regulation to invest only in products with a certain credit rating.

3. THE OPTIMAL REGULATION OF CRAS

The question on hand is: when is the IB willing to obtain a credit rating from a CRA? The IB can only observe the unconditional probability p and is only willing to pay a rating fee θ for a credit rating, if the expected profit with a credit rating is larger than the expected profit without a credit rating. The expected profit with credit rating net of the rating fee is given by:

$$\Phi^R = \Pr(r = g)\, E(r = g) + \Pr(r = b) E(r = b) - \theta.$$

If no credit rating is assigned, the expected profit is given by: $\Phi^n = \overline{\Psi} - d$. The expected profit of a credit rating for the IB (Π^{IB}) that can be interpreted as the "informative value" is therefore given by:

$$\Pi^{IB} = \Phi^R - \Phi^n \tag{3}$$

$$\longleftrightarrow \Pi^{IB} = q\,(1-p)\,(d - \Psi_b) - \theta \tag{3'}$$

If equation (3) is larger or equal zero $\left(\Pi^{IB} \geq 0\right)$, a credit rating has informative value and it is then optimal for the IB to obtain a credit rating.[27] If instead equation (3) would be negative $\left(\Pi^{IB} < 0\right)$, the credit rating has no informative value and henceforth the IB would decide not to assign a credit rating. In that case, credit ratings do not play a useful role. From equation (3) can be derived that the value added of a credit rating is increasing in the quality of the credit rating q, decreasing in the unconditional probability p and the rating fee θ. If the fraction of good portfolios becomes larger, the informative value of a credit rating decreases. Furthermore, equation (3) is increasing in the term $(d - \Psi_b)$, which can be interpreted as a measure

[27] We assume that credit ratings are not mandatory. If equation (3) is zero, the IB is indifferent between getting a rating or not. In case of indifference we assume that the IB chooses to obtain a credit rating.

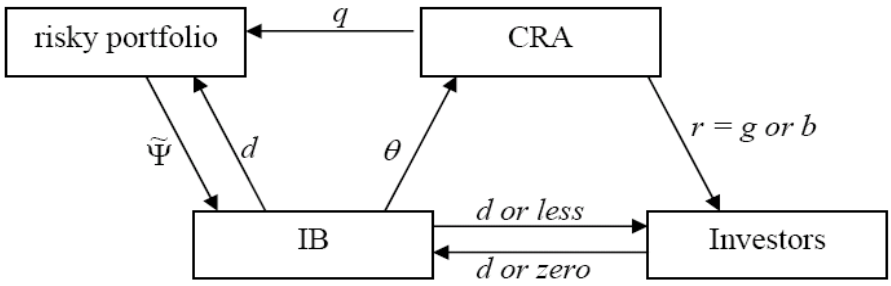

Figure 3.1: Interactions between CRA, IB, and investors.

of potential misallocated investment that can be prevented by a credit rating of a CRA about the IB's portfolio. The larger the possible misallocation, the higher is the value of the credit rating. To simplify notation in the following, we define $m \equiv d - \Psi_b$. We assume that the parameters p, θ, Ψ_b and d are public observable and given exogenous. Hence, the value of equation (3) depends on the rating quality, which is set by the CRA. Obviously, if the rating quality would be observable for the IB, the IB would be able to observe the exact value of the credit rating via equation (3), while it is not the case if rating quality would be unobservable. We take a closer look at that issue in part 3.3.2. Figure 3.1 summarizes the interactions between the three agents - IB, CRA and external investors - in the framework of the model.

3.3.2 Demand and Supply of Observable and Unobservable Rating Quality

We assume that the CRA produces only one credit rating per period and that it faces costs per rating $c(q)$, which are increasing and convex in the rating quality q.[28] Revenues are created by charging a rating fee θ from the rated IB. Regarding the

[28] The cost function has the following properties: $c'(q) > 0$, $c''(q) > 0$ with $\lim_{q \to 0} c'(q) = 0$ and $\lim_{q \to 1} c'(q) = \infty$, and $c(0) = 0$.

setting of the rating fee we distinguish the case of perfect competition and market power in the sector of CRAs.

i. More CRAs than clients: If there are more CRAs than clients in the economy, the situation can be regarded as perfect competition among CRAs. In that scenario, the CRA would set the rating fee equal to the costs per rating: $\theta(q) = c(q)$ and therefore make zero profits. If the quality of the credit rating is observable and contractible, the IB would demand a rating quality that maximizes the additional profit of getting rated in equation (3) that includes the rating fee $\theta(q)$. We have assumed above that the costs per rating are increasing and convex in q. Since the rating fee θ has to cover the costs per rating, the rating fee is increasing and convex in q, too. Due to the convexity of c, the IB's profit from getting rated $\left(\Pi^{IB}\right)$, expressed in equation (4), is concave and maximization with respect to the rating quality leads to an internal maximum:

$$\max_{q} \Pi^{IB}(q) = q(1-p)m - c(q) \tag{4}$$

The first order condition is given by:

$$(1-p)m = c'(q) \tag{5}$$

If the rating quality would be observable and contractible, the IB would require a quality, where the marginal cost of increasing the rating quality equals the marginal revenue of a higher rating quality. Solving the first order condition for q leads to the first-best rating quality $q^* \in [0,1]$. The characteristics of the first-best rating quality are summarized in proposition 1.[29]

[29] All proofs are located in the appendix.

Proposition 1 *If rating quality is observable and contractible, the first-best rating quality q^* becomes smaller, if the unconditional probability of the IB's portfolio being in a good state p increases and becomes larger, if the size of the potential misallocation of investment m without a rating increases. The first-best rating quality becomes larger, if the marginal costs per rating $c'(q)$ become smaller.*■

The value of getting a credit rating becomes larger, if the fraction of good portfolios in the economy decreases. Therefore it is optimal for the IB to demand a higher rating quality and to pay a higher fee for the CRA's rating service. From the optimality condition (5) it is obvious that a credit rating becomes more valuable, the higher is the potential loss m, if the IB's portfolio turns out to be in a bad state, expressed in a higher amount of debt relative to the portfolio's payoff in the bad state. Therefore, a higher rating quality will be demanded by the investment bank. The last point of Proposition 1 refers to the cost efficiency of CRAs. If the cost efficiency of CRAs increases - meaning lower marginal costs per rating for a given quality - IBs would demand a higher rating quality. From a welfare perspective, the IB's individual gains from getting a credit rating can be interpreted as the "social value" of a credit rating, where the first-best rating quality q^* maximizes the social value of a credit rating.

ii. More clients than CRAs: If in the economy are more IBs than CRAs there is market power on the side of CRAs. In that case, the rating fee, required by the CRA, increases as follows. In order to maximize its profits from "producing" a credit rating, the CRA will set the rating fee to the highest possible level. It optimally sets the rating fee such that it is equal to the informative value of a credit rating for the rated investment bank in equation (3):

$$\theta(q) = q(1-p)m$$

Since we assume that credit ratings are not mandatory, the IB is willing to obtain a credit rating, if the informative value of the rating minus the rating fee is larger or equal zero. In case ii. the expected additional profit for the IB of getting rated will be zero. If the IB would set a higher rating fee, the IB would not be willing to obtain a credit rating. The decision problem of the CRA is now to choose a rating quality that maximizes its profit - the difference between the fee per rating and the costs per rating: $\Pi^{CRA}(q) = q(1-p)m - c(q)$. Given the fee setting behavior above, the maximization problem is exactly the same as in case i. (see equation (4)) and therefore the supplied first-best rating quality that maximizes the profits of the CRA is the same ($q = q^*$). The only thing that differs, is the distribution of the profits originating from the credit rating. In case i., only the IB profits from getting rated, while in case ii., the value of the credit rating is taken entirely by the CRA. The overall social surplus of a credit rating is the same in both cases. Therefore, the characteristics of the first-best rating quality in equilibrium, as described in proposition 1, applies for the case of market power of CRAs, too. It has often been a point of criticism in the real world that CRAs have market power and that the quality of credit ratings would be higher if there were more competition in the rating sector. As was shown above, the model concludes that market power in itself is no reason for regulatory intervention if rating quality is observable and contractible, since the optimal rating quality is the same in the monopoly and the perfect competition case.

However, the equilibrium rating quality would change, if the rating quality becomes unobservable and not contractible. In that case the CRA has an incentive to lower rating quality after it was assigned to issue a credit rating, because this would reduce the rating costs and increase the profits. The model does not consider a repeated game or a reputation mechanism, instead the model concentrates on pos-

sibilities of regulation in a one period game. Therefore, it is even optimal for the CRA to set the rating quality equal zero after it was hired for a rating service by the IB, because this would maximize the profit per credit rating. According to the rating technology, the CRA would in the case of a rating quality of zero issue inaccurate good credit ratings and the social value of credit ratings would vanish. The misallocation of funds therefore increases in the case of unobservable rating quality and a rationale for regulation emerges in order to preserve the potential social value of credit ratings. Real world experience - as presented by anecdotal evidence in the introduction - has shown that the threat of losing reputation alone obviously is not enough to discipline the CRAs. Partnoy (1999) argues that CRAs "have not maintained good reputations, based on the informational content of their credit ratings. Instead, credit rating agencies have thrived, profited, and become exceedingly powerful because they have begun selling regulatory licenses, i.e. the right to be in compliance with regulation." The next section analyzes the optimal regulation by a regulator, which sets a minimum rating standard and the implications for social welfare.

3.3.3 The Optimal Rating Standard

If rating quality is neither observable nor contractible, the CRA has an incentive to lower the rating quality. This would decrease the costs per credit rating and increase the CRA's profits, which again decreases the social value of a credit rating. In order to preserve the potential social value added of a credit rating, a regulator can set a minimum rating standard.[30] We assume that a regulator has a costly

[30]The content of minimum rating standards could for example be oversight of CRA's staff, transparency of the rating process or parts of the IOSCO code of conduct fundamentals which can be summarized in three categories: 1. Quality and integrity of the rating process, 2. CRA independence and 3. CRA responsibilities to the investing public and issuers. (see IOSCO, 2004)

technology, which may detect whether a CRA incorporates a rating quality below a certain minimum rating standard, which is set by the regulator. The detection technology is designed in such a way that the regulator can detect compliance with a rating standard with a certain probability $h \in [0,1]$, which is an increasing and concave function of the employed costly effort e: $h'(e) > 0$, $h''(e) < 0$ and $h(0) = 0$, $\lim_{e\to\infty} h(e) \leq 1$, $\lim_{e\to\infty} h'(e) = 0$, $\lim_{e\to 0} h'(e) = \infty$. If the regulator detects that the rating quality of a CRA is below the rating standard, the CRA has to pay a penalty η. Since a deviating CRA will not be detected with certainty, it faces an expected penalty P. The profit of the CRA is now given by the fee per rating minus the costs per rating minus the expected penalty:

$$\Pi^{CRA}(q) = \theta(q) - c(q) - P$$

Lemma 1 describes the expected penalty in case of deviation and compliance with the rating standard.

Lemma 1 *If the regulator sets a rating standard $\hat{q}$, and if deviation from the standard is detected with probability $h(e)$, the CRA faces an expected penalty P with* $P = \begin{cases} h(e)\,\eta, \text{ if } q < \hat{q} \\ 0, \text{ if } q \geq \hat{q} \end{cases}$.

Since we assume limited liability of the CRA, the penalty η in case of deviation from the rating standard and detection by the regulator has an upper limit. This upper limit can be characterized by the total wealth W of the CRA, accumulated from past activities plus the rating profits in the actual period in the case of deviation from the rating standard (i.e. $c(q) = 0$): $\eta \leq W + \theta$.

The sequence of events in the model is summarized in figure 3.2. At first, nature determines, whether the portfolio of the IB is good or bad. In the next step, the

regulator has to decide on the rating standard $\hat{q}$, the penalty for the CRA in case of deviation from the standard η, and the effort employed in the detection technology e. Taking the parameters, chosen by the regulator, as given, the IB decides to buy a

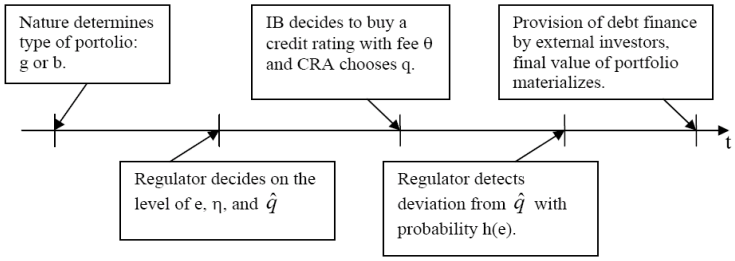

Figure 3.2: Sequence of events.

credit rating at quality $\hat{q}$, if the informational value of the credit rating is larger or equal zero and pays the rating fee θ. Then the CRA decides on the rating quality q and issues a credit rating ($r = b$ or $r = g$). After the credit rating is published, the regulator detects deviation from the rating standard with probability $h(e)$ and the CRA has to pay the penalty η in case of deviation from the standard. Debt finance d is being provided, conditional on the issued credit rating, and finally, the value of the portfolio (Ψ_g or Ψ_b) materializes.

We assume that the objective of the regulator is to maximize the social value (V) of the credit rating. If we take into account that regulation needs costly effort e, the decision problem of the regulator is to maximize the social value of the credit rating, given by equation (4), minus the effort costs of regulation e, by deciding on the rating standard q, the detection effort e and the penalty η:

$$\max_{\hat{q},e,\eta} V(\hat{q}) = q(1-p)m - c(q) - e \tag{6}$$

3. THE OPTIMAL REGULATION OF CRAS

The incentive compatibility constraint that induces the CRA to comply with the rating standard is given by:

$$\theta(\hat{q}) - c(\hat{q}) - P(q \geq \hat{q}) \geq \theta(\hat{q}) - c(q) - P(q < \hat{q}) \tag{7}$$

The incentive compatibility constraint states that the expected profit of the CRA in case of compliance with the rating standard net of rating costs and expected penalty must be larger or equal the expected profit in case of deviation from the standard net of the expected penalty. Since in the case of deviation the CRA chooses the lowest rating quality $q = 0$ in order to minimize costs ($c(0) = 0$), and since the optimal policy of the regulator requires the incentive compatibility constraint to be binding, equation (7) can be rewritten, using lemma 1, as:

$$c(\hat{q}) = h(e)\,\eta \tag{8}$$

The rating costs c are increasing and convex in $q \in [0;1]$ and the probability that regulation will detect deviation from the rating standard $h(e)$, which could be considered as the efficiency of regulation, is monotonous increasing and concave in the employed effort e as we have defined above. Therefore, the function $h(e)$ can be inverted and equation (8) be solved for the optimal regulatory effort, depending on the quality standard $\hat{q}$, and be rewritten as:

$$e(\hat{q}) = h^{-1}\left(\frac{c(\hat{q})}{\eta}\right) \tag{9}$$

This function reveals the optimal regulation effort for a given quality standard, such that the quality standard is implementable, meaning that the incentive compatibility constraint is binding. For a given penalty and due to the assumed characteristics

of the cost function $c(q)$, the optimal effort, which is employed in regulation, is increasing and convex in the rating standard $\hat{q}$. The intuition of this equation is straightforward. If the rating standard increases, the costs of rating increase, too. Therefore, the incentive for a CRA to deviate from the standard (i.e. setting the rating quality equal zero) increases. In order to make the higher standard incentive compatible, the expected penalty must increase. For a given penalty η, the regulator has to increase effort e to implement the more demanding rating standard $\hat{q}$. We have mentioned above that due to limited liability, the penalty, the CRA has to pay in case of deviation from the standard is limited by the wealth, accumulated in the past plus the profits of rating in the actual period. Furthermore, equation (6) shows that effort, employed in regulation, reduces social welfare. In order to set the expected penalty such that the incentive compatibility constraint is binding, it is optimal from a welfare perspective, to set the penalty in case of deviation to its highest possible level: $\hat{\eta} = W + \theta$. A lower penalty would require the regulator to employ more effort to keep $h(e)\,\eta$ constant, which would reduce social value.

The maximization problem of the regulator in equation (6) can now be reduced to the optimal choice of the rating standard. The optimal penalty is given by $\hat{\eta}$ and the optimal effort e is the optimal response to q according to equation (9). Inserting equation (9) in equation (6) leads to:

$$\max_{\hat{q}} \hat{V}(\hat{q}) = \hat{q}\,(1-p)\,m - c(\hat{q}) - e(\hat{q})$$

Because rating costs and effort costs are convex in the rating quality, the objective function leads to an interior solution. The first-order condition is given by:

$$(1-p)\,m = c'(\hat{q}) + e'(\hat{q}),$$

which leads to the optimal rating standard that maximizes social welfare, under the assumption that rating quality is unobservable. In part 3.3.2 we have shown that the first-best rating quality in the case of observable and contractible rating quality was given by $(1-p)\,m = c'(q^*)$. A comparison with the optimal rating standard under regulation shows that $\hat{q} < q^*$. The intuition is straightforward. Monitoring of a certain rating standard is costly, which reduces social welfare. Therefore a lower rating standard compared to the first-best will be implemented by the regulator. The influence of the exogenous parameters is analog to proposition 1 and are summarized in proposition 2 point (i) to (iii). Additionally, the optimal rating standard is increasing in the efficiency of regulation (i.e. the optimal rating standard is higher, if the marginal effort costs of increasing the standard are lower).

Proposition 2 *A regulator, who maximizes social welfare, chooses a rating standard $\hat{q}$ which is lower than the first-best rating standard q^*. The optimal rating standard $\hat{q}$ becomes*

(i) smaller, if the unconditional probability of the IB's portfolio being in a good state p increases.

(ii) larger, if the size of the potential misallocation of investment m without increases.

(iii) larger, if the cost efficiency of the CRA and the regulator increases.

(iv) The optimal rating standard $\hat{q}$ is higher, if the wealth of the CRA increases.■

Part (iv) of proposition 2 implicitly points to the difference in the optimal rating standard in the case, where CRAs make zero profits, i.e. "perfect competition" on the CRA market, and the case, where CRAs takes the informational value of rating, i.e. the "market power case" (see for these two cases part 3.3.2). In the market power

case (m), the wealth of the CRA that can be penalized by the regulator may be assumed to be larger than the wealth in the perfect competition case (c). Therefore, the optimal penalty, which is set by the regulator, would have the following property: $\hat{\eta}_m > \hat{\eta}_c$. The modified incentive compatibility constraint (9) shows that the optimal regulatory effort for a given rating standard is decreasing as the optimal penalty increases. Therefore, enforcement of regulation becomes more efficient, if the CRA has "more to lose", since less costly effort has to be employed to enforce a given rating standard. From this follows that costly regulatory effort has a less negative impact on social welfare. The optimal rating standard increases, if the representative CRA has more to lose, i.e. if the CRA has a higher "charter value". The model shows again that from this perspective, market power of some few CRAs is not in itself a rationale for regulatory intervention. In the first-best case, where rating quality is assumed to be observable and contractible, the optimal rating quality and social value of ratings is independent of the structure of the CRA market. In the case of unobservable rating quality, the model shows that a higher charter value of CRAs moves the optimal rating standard and social value of credit ratings closer to the first-best result.[31]

[31] However, even if this is true in the framework used here, this finding should be read with caution with regards to generalization. The only consequence of market power in the model is that the surplus of credit ratings is reallocated from the IB to the CRA, the overall surplus remains unchanged. The model does not take into account potential adverse effects of CRA market power with consequences on the level of the rating fee and the overall social value of credit ratings. Inefficient high rating fees might for example induce the debt issuer to engage in riskier portfolios, which may decrease financial market stability (see chapter 4).

3.4 Conflicts of Interest and Optimal Regulation

So far, the unobservability of rating qualities was considered as the only rationale for the regulation of CRAs. What has not yet been included in the model are potential adverse effects of conflicts of interest between the CRA and the rated firm (in our framework the rated IB). One potential source of conflicts of interest is the fact that credit ratings usually are paid by the issuer of a debt instrument and not by the investors. Facing the fact that since the early 1970[32] CRAs mainly are paid by their clients[33], the client could in principle directly bribe the CRA in exchange for a better credit rating. Another potential conflict of interest emerged in the special role of CRAs in the rise of structured finance products during the last years. While interaction between the issuer of a traditional debt security and the CRA was rather limited, the case is different in the rating of structured finance transactions. In the rating process of those structured finance products, CRAs are involved in an iterative process with the issuer. The structuring process of these products includes implicit structuring advice by the CRAs, meaning that the CRA indicates what needs to be done to receive the desired credit rating.[34] Broadly speaking, CRAs not only offer the service of the pure rating, but also offer additional consulting services. This deeper involvement of CRAs has been heavily criticized in the public, especially in association with the crisis in the subprime loan market. This problematic is also captured to some degree in the U.S. "Credit Rating Agency Reform Act 2006",

[32] For an overview on the history of credit rating agencies see for example Hill (2004) or Cantor&Packer (1995).

[33] An argument for this payment scheme is the emergence of information technology during the last 30 years, which gave information, once it is originated a public good character (a single investor would only be willing to pay for a rating if it is not made public). Another argument is that it is more efficient to let the issuer pay instead of each single investor of a large and dispersed investor community, that uses the credit rating for its investment decision. (see White, 2001)

[34] For a summary of the role of CRAs in structured fincance products see Rosner and Mason (2007) and BIS (2005). According to BIS (2005) "[...] it has become common for rating agencies to offer special services relating to firms' bond ratings [...] that could impact rating levels. These services may be separately rewarded and may thus exacerbate any potential conflicts of interst arising from 'issuer fees'."

which among others "directs the SEC to issue final rules to prohibit unfair, coercive, or abusive acts or practices by NRSROs[35] [...] such as conditioning or threatening to condition an issuer's credit rating on the purchase of other services or products" (see CRA Reform Act, 2006). Based on Pagano & Immordino (2007) for the case of auditing firms, we extend in the following section the model by allowing the CRA to offer additionally consulting services to the rated investment bank (IB). We assume that the portfolio, for which the IB seeks debt finance from external investors, is managed by a portfolio-manager, who's salary partly consists of a payment which is proportionally to the volume of managed portfolios. Hence, the manager has an interest that the IB receives financing by external investors with certainty, since this would increase his salary. As we have shown above, external investors only finance a portfolio, if it receives a good credit rating ($r = g$), therefore the portfolio-manager has an incentive to engage in activities to ensure a high credit rating for the portfolio.[36] One possibility to achieve that goal would be a direct bribe to the CRA in exchange for a higher credit rating. Another way of modelling conflicts of interest in our model arises from the joint provision of credit ratings and consulting services by a single CRA, from which emerges a more sophisticated possibility of collusion between the CRA and the rated IB as follows. Since the CRA is very well informed about its client in the course of the rating process, we assume that the CRA has the expertise to offer consulting services to the IB at lower costs compared with competitors due to economies of scope. The possibility of collusion now arises, if the IB is only willing to pay for an additional consulting contract, if in exchange the CRA issues a good credit rating. Since we assume that the CRA can provide

[35] NRSRO = nationally recognized statistical rating organization; a CRA has to be recognized by the SEC (securities and exchange commission), in order to be used for regulatory purposes. The "Credit Rating Agency Reform Act 2006" includes the simplification of the recognition process.

[36] Note, that we assume that the IB decides to get rated only, if the informational value of a credit rating is larger or equal zero (see section 3.1).

such services at lower costs, the received market fee for the consulting service can be regarded as a rent for the CRA. The conflict of interest is clear: the consulting fee acts as a bribe, and the CRA only gets the fee in exchange for a good credit rating. Section 3.4.1 extends the model and analyzes consequences for the optimal rating standard which is set by the regulator. In section 3.4.2, we analyze, if forbidding the joint provision of rating and consulting services is optimal from a welfare perspective.

3.4.1 Optimal Rating Standard in the Presence of Conflicts of Interest

The analysis is now extended by assuming that the IB employs a portfolio-manager, whose salary consists of a proportion $\alpha \in [0,1]$ of the portfolio value. After deducting the rating fee and repayment of debt to external investors, the net profit of the IB after the true value of the portfolio materialized with consideration of the management compensation, is given by: $\tilde{\Psi} - \theta - d - \alpha\tilde{\Psi}$. According to the compensation scheme, the manager has an interest that investment takes place with certainty, which is the case without a credit rating and with a "good" credit rating $r = g$. Therefore, the manager - if he is opportunistic - has an incentive to induce the CRA to issue a good credit rating. The manager - who requires the CRA to issue a good credit rating in exchange - may either bribe the CRA directly by offering a bribe $\beta > 0$ or indirectly by engaging the CRA for rating and additional consulting services. In the following it will be shown that both forms of corruption have similar implications regarding the optimal rating standard. The CRA is assumed to be able to offer consulting services additionally to the rating service. Due to economies of scope, the CRA is assumed to offer the same consulting service as an external competitor ($Comp.$) at lower costs ρ: $\rho_{CRA} < \rho_{Comp.}$.[37] Under the assumption of perfect

[37] From performing the rating procedure, we assume that the CRA has gained expertise to offer additional consulting at lower costs, compared to a third competitior.

competition in the consulting sector, the market consulting fee φ is equal to the consulting costs: $\varphi = \rho_{Comp.}$. If the CRA, instead of an external firm, gets employed for performing the consulting service, the CRA receives the market consulting fee φ and therefore earns a rent $\Delta\rho \equiv \varphi - \rho_{CRA} > 0$. At the same time, making use of the CRA's economies of scope, the rent $\Delta\rho$ increases social welfare, due to efficiency gains.

Given those assumptions, the portfolio-manager has an incentive to offer a consulting contract, contingent on a good credit rating. If the CRA accepts this offer, the profits of the CRA from rating and consulting are given as follows:

$$\Pi^{CRA}(q) = \theta(q) - c(q) + \varphi - \rho_{CRA} - P \tag{10}$$

The requirement for getting offered the contract for the joint provision of credit rating and consulting is that the CRA issues a good credit rating. Therefore, it is optimal for the CRA to set $q = 0$, since that minimizes the costs (i.e. $c(0) = 0$). Using $\Delta\rho \equiv \varphi - \rho_{CRA} > 0$ and considering the expected penalty in the case of deviation from the rating standard $h(e)\hat{\eta}$, equation (10) can be rewritten as:

$$\Pi^{CRA}(q) = \theta(q) + \Delta\rho - h(e)\hat{\eta} \tag{10'}$$

Now it is obvious that the additional rent for the consulting service acts as a bribe. The bribe makes sure that the IB receives a good credit rating and that financing by external investors happens for sure. Therefore, the portfolio-manager gets the partial salary $\alpha\tilde{\Psi}$ with certainty. In the case of a direct bribe β, the profit equation can be formulated analogously by replacing $\Delta\rho$ with β. While the consequences of corruption regarding the social value are clear in the case of the direct bribe,

they are twofold in the case of joint provision of services. In both cases the IB receives a good credit rating and the IB's portfolio receives even then financing, if the portfolio would have received a bad credit rating without the bribe. Henceforth, the misallocation of funds increases, which reduces the social value of a credit rating. An additional positive impact on the social value occurs with the joint provision of services, because the CRA is assumed to offer consulting services more efficiently in terms of costs compared to a third party. Therefore, the social value increases by $\Delta\rho$ in that case. We assume that the possibility of collusion cannot be prevented by the external investors, since the large investors community is assumed to have a collective action problem.[38] Taking into account the opposed effects of the joint provision of services by a single CRA and the possibility of collusion, the decision problem of the regulator, who maximizes the social value of rating, is given by[39]:

$$\max_{\tilde{q},e} \tilde{V}(\tilde{q}) = \tilde{q}(1-p)m + \Delta\rho - c(\tilde{q}) - e \tag{11}$$

The rating standard in the presence of possible collusion is denoted by $\tilde{q}$. The new incentive compatibility constraint requires the CRAs profit from rating and compliance with the rating standard, set by the regulator, to be larger or equal the CRAs profit in the case of joint provision of services and acceptance of the bribe, given by equation (10'):

$$\theta(\tilde{q}) - c(\tilde{q}) \geq \theta(\tilde{q}) + \Delta\rho - h(e)\hat{\eta}$$

In the case of a direct bribe, $\Delta\rho$ in the incentive compatibility constraint has to

[38] If any collective action restrictions would be absent, investors could make the debt financing dependend on the requirement, that consulting and rating by the same firm is impossible.

[39] The efficiency gain is integrated into the social value function in the most easiest way by simply adding $\Delta\rho$. In the case of a direct bribe β the positive effect on social welfare would be absent and the objective function of the regulator is the same as equation (5) in section 3.3.

be replaced by β. The optimal rating standard has to be chosen such that it is implementable by the CRA and collusion does not happen. According to section 3.3, the incentive compatibility constraint can be reformulated as the optimal effort, employed in regulation, as a function of the optimal rating standard, which assures the constraint being binding:

$$e\left(\tilde{q}\right) = h^{-1}\left(\frac{c\left(\tilde{q}\right) + \Delta\rho}{\hat{\eta}}\right) \tag{12}$$

As equation (9) in section 3.3.3, the optimal effort is increasing and convex in the rating standard. But in contrast to equation (9), the optimal effort, given a certain rating standard is now higher, since the numerator increases by $\Delta\rho$ in equation (12).[40] In that case, more costly effort has to be employed by the regulator to make a given rating standard incentive compatible. Using equation (12) in equation (11), maximizing with respect to $\tilde{q}$ leads to the following first order condition:

$$\left(1-p\right)m = c'\left(\tilde{q}\right) + e'\left(\tilde{q}\right)$$

Proposition 3 describes the properties of the new optimal rating standard:

Proposition 3 *If the rent from the joint provision of services is $\Delta\rho > 0$ or if there is the possibility of a direct bribe $\beta > 0$, the optimal rating standard in the presence of potential collusion between CRA and IB is lower than the optimal rating standard without the possibility of collusion: $\tilde{q} < \hat{q}$. The optimal rating standard is decreasing, if the rent of the joint provision of services $\Delta\rho$ or the direct bribe β increase.*■

[40] Analogously, in the case of a direct bribe the optimal effort, which assures the incentive compatibility constraint being binding, can be rewritten as: $e\left(\tilde{q}\right) = h^{-1}\left(\frac{c(\tilde{q})+\beta}{\hat{\eta}}\right)$.

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If there were no efficiency gains from the joint provision of services, the bribe would be zero: $\Delta\rho = 0$. In that case the optimal rating standard is the same as in section 3.3., where rating service only is considered: $\tilde{q} = \hat{q}$. Accordingly, the optimal rating standard is the same ($\tilde{q} = \hat{q}$), if the regulator would forbid the joint provision of services by the CRA or the possibility of a direct bribe, since the possibility of collusion would then be eliminated. The intuition of why $\tilde{q} < \hat{q}$ is straightforward, if $\Delta\rho > 0$ or $\beta > 0$. The corresponding effort that has to be employed by the regulator for a given rating standard is now higher as shown in equation (12). Since an increase of costly regulatory effort decreases the social value, the regulator chooses a lower rating standard. If the rent $\Delta\rho$ or the direct bribe β increase, also the incentive for the CRA to accept the bribe and collude with the IB increases. Therefore it is optimal for the regulator to set a lower rating standard, since that would reduce the CRA's cost in the case of compliance with the standard. In principle, one of the two sources of potential collusion can be prevented by the regulator by simply forbidding the joint provision of rating and consulting services. That issue has also been discussed by the SEC and the European Commission in reaction to the inglorious role of CRAs in the subprime loan crisis in 2007 and been addressed in the "Credit Rating Agency Reform Act 2006" in the US. While collusion through the joint provision of services cannot be presumed ex ante by the regulator, the intention for corruption is obvious for the case of a direct bribe. For the remainder of the paper is assumed that direct bribes, for example in the form of extra payments or rating fees above the market level, would easily be detectable by the regulator and the analysis concentrates on the more sophisticated form of collusion - namely conflicts of interest via the joint provision of services. Whether the joint provision of services should be prohibited by regulation from a welfare perspective, will be analyzed in the next section.

3.4.2 Regulatory Intervention and Social Value

The model showed that the consulting fee can be used by the client to bribe the CRA to issue an inaccurate higher credit rating, if a CRA offers both ratings and consulting services. As already mentioned above, the role of CRAs in the past years changed from a passive to a more active part particularly in the rating process of structured debt products, such as collateralized debt obligations. In an iterative process, CRAs are involved in advising their clients in designing products that receive the desired high credit rating to be attractive for the investors community. CRAs have been heavily criticized for this behavior in the recent past, as they were under suspicion of being exposed to conflicts of interest, therefore being jointly responsible for the financial market crisis in 2007 by issuing inaccurate credit ratings. The model's answer to a situation with existing conflicts of interest is that the regulator should either simply choose a lower rating standard or forbid the joint provision of services and eliminate the potential conflict of interest at its root. In the latter case the regulator chooses optimally a higher rating standard, as shown in the previous section. But what has not been analyzed so far, is the question, whether the regulator should allow of forbid the joint provision of services, if the decision criterion is the social value.[41] The objective function of the regulator in the presence of conflicts of interest was given by:

$$\max_{\tilde{q}} \tilde{V}(\tilde{q}) = \tilde{q}(1-p)m + \Delta\rho - c(\tilde{q}) - h^{-1}\left(\frac{c(\tilde{q}) + \Delta\rho}{\hat{\eta}}\right) \tag{13}$$

As we have shown above, the CRA - if it is hired for creating a credit rating - can provide consulting services more efficiently in comparison to external competitors

[41] In the case of a direct bribe (β) without joint provision of services, the implication for regulation is very easy: "forbidding" to accept the direct bribe increases the social value of rating, because there is no potential efficiency gain and no trade-off from allowing the possibility of collusion in that case.

by being able to provide the same service at lower costs. This efficiency gain $\Delta\rho$, that can be used by the rated IB to bribe the CRA, on the one hand increases the social value. This positive effect would be lost, if the regulator would forbid the joint provision of services. On the other hand, the joint provision of services makes collusion possible and the financing of bad portfolios more likely, which decreases the social value. As the efficiency gain has one negative and one positive effect on the social value, the answer is now, under which circumstances the regulator optimally should allow or forbid the joint provision of activities. If the regulator forbids the bundling of services, the social welfare of the credit rating is $\hat{V}(\hat{q})$, as defined in section 3.3.3. In the following, we compare the social value in the case of joint provision of services (case 1: $\tilde{V}(\tilde{q})$), with the social value, if CRAs are allowed to offer ratings only (case 2: $\hat{V}(\hat{q})$)[42]. The partial effect of an increase of $\Delta\rho$ on the social value in case 2 is zero ($\partial\hat{V}/\partial\Delta\rho = 0$), while in case 1 is given by

$$\frac{\partial\tilde{V}}{\partial\Delta\rho} = 1 - h^{-1\prime}(...)\frac{1}{\hat{\eta}} \tag{14}$$

Depending on the size of equation (14), i.e. whether $1 \gtrless h^{-1\prime}(...)\frac{1}{\hat{\eta}}$, the social value can either increase or decrease as $\Delta\rho$ increases. Therefore, obviously one criterion for the regulator's decision is the size of $\Delta\rho$, as the effect on the social value could be positive or negative for differing values. The previous section has shown that the necessary effort for a given rating quality increases as $\Delta\rho$ becomes larger. From this follows that $h^{-1\prime}(...)$ in equation (14) is a positive and increasing function of $\Delta\rho$. If equation (14) is negative at $\Delta\rho = 0$, it remains negative for any $\Delta\rho > 0$. In that case, despite of the efficiency gain, it is optimal for the regulator to prohibit the joint provision of services, because $\tilde{V} < \hat{V}$ for all $\Delta\rho > 0$. If equation (14) is

[42] The objective function if the CRA offers the service of rating only was given by $\hat{V}(\hat{q}) = \hat{q}(1-p)m - c(\hat{q}) - h^{-1}\left(\frac{c(\hat{q})}{\hat{\eta}}\right)$ (see section 3.3).

positive at $\Delta\rho = 0$, it becomes negative, if $\Delta\rho$ becomes sufficiently large. In that case, there exists a threshold value for the size of $\Delta\rho = \Delta\rho^*$, below which it is optimal for the regulator to allow the joint provision of services (case 1), since the positive effects on the social value overweigh ($\tilde{V} \geq \hat{V}$ for $0 \leq \Delta\rho \leq \Delta\rho^*$). On the other side for $\Delta\rho > \Delta\rho^*$ it is optimal to forbid the joint provision of ratings and consulting services, since the adverse effects of conflicts of interest dominate ($\tilde{V} < \hat{V}$ for $\Delta\rho > \Delta\rho^*$). To analyze the determinants for the decision of the regulator, besides the size of the efficiency gain (which works in our model as a bribe) further, equation (14) can be rewritten as follows[43]:

$$\frac{\partial \tilde{V}}{\partial \Delta\rho} = \frac{1}{c'(\tilde{q})} \left(c'(\tilde{q}) - e'(\tilde{q})\right) \tag{15}$$

Equation (15) is negative for any positive value of $\Delta\rho$, if $c'(\tilde{q}) < e'(\tilde{q})$ at $\Delta\rho = 0$. While $c'(\tilde{q})$ can be interpreted as the marginal costs of rating, and therefore as the cost efficiency of CRAs, $e'(\tilde{q})$ can be interpreted as the efficiency of the regulation technology. Above, the regulation technology was characterized by the probability to detect deviation from a certain rating standard by employing costly effort e. A more efficient regulation technology would require less effort to enforce a given rating standard and henceforth a lower increase of effort if the rating standard increases ($e'_{high}(\tilde{q}) < e'_{low}(\tilde{q})$). If the efficiency of the rating technology is sufficiently low, such that $c'(\tilde{q}) < e'(\tilde{q})$ at $\Delta\rho = 0$, it is optimal for the regulator to forbid the joint provision of services for any positive value of $\Delta\rho$, since the social value in case of the joint provision of services is always smaller, compared to case 2 ($\tilde{V}(\tilde{q}) < \hat{V}(\hat{q})$). Proposition 4 describes the optimal decision of the regulator, if the regulation technology is too inefficient.

[43] The derivation of this equation is in the appendix 3.C.

Proposition 4 *If the regulation technology is sufficiently inefficient, such that* $c'(\tilde{q}) < e'(\tilde{q})$ *at* $\Delta\rho = 0$*, the optimal strategy for the regulator is to forbid the joint provision of services and to set the optimal rating standard* $q = \hat{q}$*. Otherwise the social value of rating would be inefficiently low for any* $\Delta\rho > 0$*:* $\tilde{V}(\tilde{q}) < \hat{V}(\hat{q})$*.*■

While the decision between case 1 and case 2 is clear and independent of the size of $\Delta\rho$, if $c'(\tilde{q}) < e'(\tilde{q})$ at $\Delta\rho = 0$, the decision problem looks different, if the efficiency of the regulation technology is sufficiently high. If the regulation technology is such that $c'(\tilde{q}) > e'(\tilde{q})$ at $\Delta\rho = 0$, equation (15) is positive as $\Delta\rho$ increases and becomes negative, if $\Delta\rho$ becomes sufficiently large. This is true, because $c'(\tilde{q})$ becomes smaller and $e'(\tilde{q})$ becomes larger as $\Delta\rho$ increases.[44] From this follows that for $c'(\tilde{q}) > e'(\tilde{q})$ at $\Delta\rho = 0$ the optimal decision of the regulator for one of the two alternatives depends on the size of the efficiency gain $\Delta\rho$. Proposition 5 describes the optimal decision of the regulator.

Proposition 5 *If the regulation technology is sufficiently efficient such that* $c'(\hat{q}) > e'(\hat{q})$ *at* $\Delta\rho = 0$*, and the size of the efficiency gain is below its critical value,* $\Delta\rho < \Delta\rho^*$*, the optimal strategy for the regulator is to allow the joint provision of services and to set the optimal rating standard* $\tilde{q} < \hat{q}$*, since* $\tilde{V}(\tilde{q}) > \hat{V}(\hat{q})$ *for* $\Delta\rho < \Delta\rho^*$*. If the efficiency gain is larger than its critical value,* $\Delta\rho > \Delta\rho^*$*, the optimal strategy is to forbid the joint provision of services and to set the optimal rating standard* $\hat{q}$*, since* $\tilde{V}(\tilde{q}) < \hat{V}(\hat{q})$ *for* $\Delta\rho > \Delta\rho^*$*.*■

The model shows that the joint provision of services - for example expressed by the deep involvement of CRAs in the rating process of structured finance products, such as collateralized debt obligations - is not necessarily a root of inefficiency for

[44] Proposition 3 in the previous section has shown that $\frac{\partial\tilde{q}}{\partial\Delta\rho} < 0$. Because of the convexity of $c(.)$ follows that $\frac{\partial c'(.)}{\partial\Delta\rho} < 0$. For the derivation of $\frac{\partial e'(.)}{\partial\Delta\rho}$, see the proof of proposition 4 in the appendix.

which regulatory intervention could be justified. If the criterion for the regulator is social welfare, the decision of the regulator on the optimal rating standard and possible restrictions of activities depends on the surrounding conditions. If the potential bribe is large enough, it is optimal to restrict the activities of CRAs, as the negative effects of collusion dominate. But it could be optimal to allow the joint provision of services, if the bribe is low enough, since the positive effects of the efficiency gain dominate in that case. Additionally, the model shows that the basic requirement for the strategy of allowing the joint provision of services lies in the hand of the regulator, meaning that the efficiency of the regulation technology has to be sufficiently high.

3.5 Conclusion

The discussion on the role and power of CRAs in financial markets is an ongoing debate among academics, practitioners, and institutions of financial supervision.[45] Many times, CRAs were suspected for having issued inaccurate credit ratings or having updated already issued credit ratings too late. Furthermore, CRAs were suspected to be exposed to various conflicts of interest. Jochen Sanio, the chairman of the German federal financial supervision authority (Bafin), once blamed CRAs to be the "largest uncontrolled power in the global financial system".[46] On the role of CRAs in the subprime loan crisis, Keneth Rogoff presumed that ""[...] rating agencies cooperated too closely with the banks and received a much too high payment for their ratings." and "I could imagine that Moody's will become the Arthur Andersen of this decade"(see Zeit, 2007).

[45] See for example IOSCO (2004, 2007) and CRA Reform Act (2006).

[46] Own translation from German to English. This quote is from a public hearing of the financial committe of the German Bundestag at June 4th 2003.

The applied model in chapter 3, which is based on Pagano & Immordino (2007), has shown that intransparency of how credit ratings are generated by CRAs, could be a rationale for regulation. Without regulation, the quality of the credit ratings would be inefficiently low and misallocation of investment inefficiently high. Minimum rating standards, which can be enforced by costly regulation, would increase the social value of credit ratings in the applied model. The adverse effects of conflicts of interest were analyzed in the model, too. By the joint provision of credit ratings and consulting services, we have shown that on the one hand there is the threat of collusion, which may lead to inaccurate credit ratings, but on the other hand that potential efficiency gains are present, too. In the presented theory, the potential conflict of interest can be prevented by simply constraining the activities of CRAs. It has also been discussed that this regulatory intervention may or may not be optimal from a welfare perspective.

The results of that paper on the one hand gives a contribution to the theoretical academic literature on CRAs, by modelling the optimal regulation of CRAs in the presence of unobservable rating quality and conflicts of interest. On the other hand, the analysis, presented in this paper, also contributes to the discussion about the possibility and necessity to regulate activities of CRAs that is consistently present among institutions of financial market regulation as well as observers and practitioners of financial markets, especially in the aftermath of the subprime loan crisis in 2007. A frequent argument against regulation of CRAs in the past was that CRAs have a strong incentive to issue accurate credit ratings, because otherwise they would lose their reputation, which is regarded to be the most important asset of CRAs.[47] Therefore it was argued that self-regulation among CRAs works well and no further regulation would be necessary.

[47] see for example Schwarcz (2001).

However, a necessary requirement for self-regulation is competition and the possibility of market entry for competitors. Due to the market power of some few CRAs and the heavy criticism, CRAs were confronted with in the past, it is disputable whether the threat of losing reputation is enough to prevent CRAs from issuing inaccurate credit ratings and colluding with debt issuers. Regarding this limited competition, Partnoy (1999) argues that markets may become inattentive as to the CRAs' reputation as soon as some few CRAs have received recognition status by the regulator. As soon as self-regulation of CRAs fails, the results of our paper provide insights for the optimal regulation of CRAs.

3.A Proofs of Propositions

Proof of proposition 1. The optimal rating quality $q^* \in [0,1]$ is derived by the first order condition:

$$(1-p)\,m = c'(q^*) \tag{A1.}$$

Effect of p: As p increases, the left hand side of A1. becomes smaller. To keep equality, the right hand side has to become smaller, too. Due to the characteristics of the cost function $c(.)$, the optimal rating quality q^* has to decrease.

Effect of m: m increases, if d increases and/or Ψ_b decreases. The left hand side increases, therefore the optimal rating quality q^* has to increase, too.

Effect of $c'(q^*)$: A more efficient rating technology is expressed with lower costs for a given rating standard. If rating quality increases, the rise of costs is lower for a more efficient technology: $c'_{high}(\bar{q}) < c'_{low}(\bar{q})$. The marginal rating costs for a given rating quality is lower, if cost efficiency becomes higher. The value of left hand side is exogenous and constant. If cost efficiency increases q^*, the rating standard has to rise in order to keep the right hand side constant.■

Proof of proposition 2. The optimal rating standard if rating quality $\hat{q}$ is unobservable and with costly regulation is derived by the first order condition:

$$(1-p)\,m = c'(\hat{q}) + e'(\hat{q}) \tag{A2.}$$

As the left hand side of (A2.) is the same as the left hand side of (A1.), we have:

$$c'(q^*) = c'(\hat{q}) + e'(\hat{q}) \tag{A.2'}$$

Since $c(.)$ and $e(.)$ are increasing and convex in q, therefore q^* has to be larger than $\hat{q}$: $q^* > \hat{q}$.

For the proof of parts (i) to (iii) of proposition 2 see the proof of proposition 1. Part (iv) claims that the optimal rating standard is higher, if optimal penalty $\hat{\eta}$ increases. An example for a rise in $\hat{\eta}$ is an increase in the profits per rating due to market power in the CRA sector. The necessary effort that has to be employed in order to enforce a given rating standard, is given by:

$$e\left(\hat{q}\right) = h^{-1}\left(\frac{c\left(\hat{q}\right)}{\hat{\eta}}\right) \tag{A3.}$$

If $\hat{\eta}$ increases, the optimal effort corresponding to a given rating standard decreases. From this follows that the marginal effort $e'(.)$ decreases either. The right hand side therefore becomes smaller for a given rating standard. Due to the characteristics of the functions $c(.)$ and $e(.)$, the optimal rating standard $\hat{q}$ must increase to ensure equality of equation (A.3).■

Proof of proposition 3. Why the optimal rating standard in the presence of joint provision of services ($\tilde{q}$) and analogously in the case of a direct bribe, is lower than the optimal rating standard in 3.3 ($\hat{q}$), can be shown as follows: The first-order condition of the regulator's decision problem is given by

$$(1-p)\, m = c'\left(\tilde{q}\right) + e'\left(\tilde{q}\right) \tag{A.4}$$

The left hand side of A4. the same as in equation A.2, therefore it must be true that:

$$c'\left(\hat{q}\right) + e'\left(\hat{q}\right) = c'\left(\tilde{q}\right) + e'\left(\tilde{q}\right) \tag{A.4'}$$

Since the effects are analog for the direct (β) and the indirect bribe ($\Delta\rho$), the proof is presented for $\Delta\rho > 0$ only. Taking into account the potential bribe $\Delta\rho$, the necessary effort to enforce a given rating standard $\bar{q}$ is larger in the case of joint provision of services:

$$e\left(\bar{q}\right) = h^{-1}\left(\frac{c\left(\bar{q}\right)}{\hat{\eta}}\right) < e\left(\bar{q}\right) = h^{-1}\left(\frac{c\left(\bar{q}\right) + \Delta\rho}{\hat{\eta}}\right)$$

The marginal effort with bribe is therefore larger than the marginal effort without bribe for a given rating quality. Therefore the optimal rating standard has to be lower in the case of joint provision of services, to ensure equality of equation (A.4'), given the characteristics of $c(.)$ and $e(.)$: $\tilde{q} < \hat{q}$.

That the optimal rating standard is decreasing as the rent of the joint provision of services increases can be shown by total differentiating equation (A.4) and using $e'\left(\tilde{q}\right) = h'^{-1}\left(\frac{c(\tilde{q})+\Delta\rho}{\hat{\eta}}\right)\frac{c'(\tilde{q})}{\hat{\eta}}$:

$$\underbrace{d\left(1-p\right)m}_{=0} = c''\left(\tilde{q}\right)d\tilde{q} + e''\left(\tilde{q}\right)d\tilde{q} + h''^{-1}\left(\frac{c\left(\tilde{q}\right)+\Delta\rho}{\hat{\eta}}\right)\frac{c'\left(\tilde{q}\right)}{\hat{\eta}^2}d\Delta\rho$$

$$\longrightarrow \quad \frac{d\tilde{q}}{d\Delta\rho} = -\frac{h''^{-1}\left(\frac{c(\tilde{q})+\Delta\rho}{\hat{\eta}}\right)\frac{c'(\tilde{q})}{\hat{\eta}^2}}{c''\left(\tilde{q}\right)+e''\left(\tilde{q}\right)} < 0 \tag{A.5}$$

Equation is smaller than zero, because of the convexity of $e(.)$, $c(.)$, and $h^{-1}()$. ■

Proof of proposition 4. The social value with joint provision of services is given by $\tilde{V}$, whereas the social value with rating only is given by $\hat{V}$. If $\Delta\rho = 0$, then $\tilde{V} = \hat{V}$. Equation (A.5) showed that $\frac{d\tilde{q}}{d\Delta\rho} < 0$. Therefore, given the characteristics of $c(.)$, it must be true that $\frac{\partial c'(\tilde{q})}{\partial\Delta\rho} < 0$. Above, we have shown that $e'\left(\tilde{q}\right) = h'^{-1}\left(\frac{c(\tilde{q})+\Delta\rho}{\hat{\eta}}\right)\frac{c'(\tilde{q})}{\hat{\eta}}$. Differentiating with respect to $\Delta\rho$ yields $\frac{\partial e'(\tilde{q})}{\partial\Delta\rho} = h''^{-1}\left(\frac{c(\tilde{q})+\Delta\rho}{\hat{\eta}}\right)\frac{c'(\tilde{q})}{\hat{\eta}^2} > 0$. The

partial derivative of the social value $\tilde{V}$ and $\hat{V}$ with respect to $\Delta\rho$ is given by: $\frac{\partial \tilde{V}}{\partial \Delta\rho} = \frac{1}{c'(\tilde{q})}\left(c'\left(\tilde{q}\right) - e'\left(\tilde{q}\right)\right)$ and $\frac{\partial \hat{V}}{\partial \Delta\rho} = 0$. As $\Delta\rho$ increases, the difference $\left(c'\left(\tilde{q}\right) - e'\left(\tilde{q}\right)\right)$ decreases, since c' decreases and e' increases. If $\frac{\partial \tilde{V}}{\partial \Delta\rho} < 0$ at $\Delta\rho = 0$, which is the case if $c'\left(\tilde{q}\right) < e'\left(\tilde{q}\right)$, the social value $\tilde{V}$ decreases further as $\Delta\rho$ increases. Therefore, it is optimal to prevent the joint provision of services for any $\Delta\rho > 0$, since $\tilde{V} < \hat{V}$. ■

Proof of proposition 5. If $\frac{\partial \tilde{V}}{\partial \Delta\rho} > 0$ at $\Delta\rho = 0$, then we must have $c'\left(\tilde{q}\right) > e'\left(\tilde{q}\right)$. From this follows that $\tilde{V}$ increases, if $\Delta\rho$ becomes larger, as long as $\Delta\rho$ is relatively small. Given the characteristics of $\frac{\partial c'(\tilde{q})}{\partial \Delta\rho}$ and $\frac{\partial e'(\tilde{q})}{\partial \Delta\rho}$, $\tilde{V}$ decreases, for relatively large values of $\Delta\rho$. Therefore, at some critical level $\Delta\rho = \Delta\rho^*$, we have $\tilde{V} = \hat{V}$. For values $\Delta\rho < \Delta\rho^*$, we have $\tilde{V} > \hat{V}$, and therefore allowing the joint provision of services is optimal. For values $\Delta\rho > \pi\Delta\rho^*$, we have $\tilde{V} < \hat{V}$, and therefore forbidding the joint provision of services is optimal.■

3.B Derivation of Equation (15)

The necessary regulation effort for a given rating standard is given by: $e\left(\tilde{q}\right) = h^{-1}\left(\frac{c(\tilde{q})+\Delta\rho}{\hat{\eta}}\right)$. Differentiating with respect to $\tilde{q}$ leads to $e'\left(\tilde{q}\right) = h'^{-1}\left(\frac{c(\tilde{q})+\Delta\rho}{\hat{\eta}}\right)\frac{c'(\tilde{q})}{\hat{\eta}}$ and after rearranging:

$$\frac{e'\left(\tilde{q}\right)}{c'\left(\tilde{q}\right)} = h'^{-1}\left(\frac{c\left(\tilde{q}\right)+\Delta\rho}{\hat{\eta}}\right)\frac{1}{\hat{\eta}} \tag{A.6}$$

Inserting equation (A.6) into equation (14): $\frac{\partial \tilde{V}}{\partial \Delta\rho} = 1 - h'^{-1}\left(\frac{c(\tilde{q})+\Delta\rho}{\hat{\eta}}\right)\frac{1}{\hat{\eta}}$ leads to equation (15):

$$\frac{\partial \tilde{V}}{\partial \Delta\rho} = 1 - \frac{e'\left(\tilde{q}\right)}{c'\left(\tilde{q}\right)} \longleftrightarrow \frac{\partial \tilde{V}}{\partial \Delta\rho} = \frac{1}{c'\left(\tilde{q}\right)}\left(c'\left(\tilde{q}\right) - e'\left(\tilde{q}\right)\right)$$

4 Credit Rating Agencies and Financial Market Stability

4.1 Introduction

Credit ratings, which are published by credit rating agencies (CRAs), reflect the opinion of the CRA on the likelihood that an issuer of a debt instrument will default on the interest or principal due on its bonds. Whether a firm or a debt instrument is rated investment-grade or speculative-grade, influences the conditions at which the issuer of a debt instrument can borrow. With increasing complexity of financial markets, the reliance of both investors and regulators on credit ratings has grown rapidly in the last decades. Nevertheless, the role, CRAs play in financial markets, is not unambiguous. On the one hand, in consideration of the fact that the amount of rated debt instruments increased dramatically over the last decades, credit ratings seem to be very important and valuable for financial markets. Therefore, CRAs seem to have enormous market influence and informative value, because otherwise there would be no need for debt issuers to spend money for costly credit ratings. On the other hand, CRAs faced heavy criticism in the recent past for issuing inaccurate credit ratings and for not revealing additional important information. Examples for presumably inaccurate behavior of CRAs are the defaults of Enron or Parmalat and the Asian crisis.[48] Another example is the dubious role of CRAs in relationship with the financial market crisis in 2007, set off by the debacle in subprime lending in the USA. CRAs rated structured financial products with the highest rating, which were worth less than junk bonds after the start of the crisis. A closer look at the market

[48] In the latter case, the CRAs gave Thailand an investment-grade rating until five months after the start of the crisis. In the case of Enron, CRAs adhered an investment-grade rating until days before the firm went bankrupt.

structure of CRAs shows that the market is dominated by three big global firms (Moody's Investors Services, Standard & Poor's and Fitch Ratings). Those three CRAs together have a market share of 96%, whereat Standard & Poor's (40%) and Moody's (39%) are about equal in size. It has been criticized several times that there is obviously a lack of competition and limited market entry. That there is obviously not much price competition[49] among the two largest CRAs shows a look at their quasi-monopoly profits.[50] While CRAs themselves remained largely unregulated, credit ratings are extensively used in financial market regulation. For examples, many institutional investors are restricted to invest only in instruments with a certain credit rating and in the context of Basel II, capital adequacy ratios are determined according to the rating of a debtor.[51]

The main goal of that paper is to analyze the role of CRAs and credit ratings in the context of financial market stability. Three questions will be analyzed in a theoretical framework. The first question is, in how far the valuable role of credit ratings is influenced by the size of the rating fee. By analyzing that question, the paper emphasizes the role of market power of some few CRAs, which obviously have the possibility to set higher rating fees compared to the competitive level. The second question is, in how far the valuable role of credit ratings is influenced, if credit ratings are voluntary instead of mandatory. The third questions asks, whether the way CRAs exactly generate their revenues - charging the rating fee from debt issuers or investors - has consequences for the stabilizing role of credit ratings.

The theoretical framework in this paper is an extension of the approach in Boot

[49] See Economist (2005).

[50] The operating margin of Moody's in 2006 was 61.8% and in 2005 54.3%. The operating margin of Standard & Poor's in 2006 was 43% and 42.5%. See Moody's (2007) and Standard & Poor's (2007).

[51] For an overview about the use of credit ratings in financial market regulation, see for example BIS (2000) or Rosenbaum (2004).

et al. (2006). The valuable and stabilizing role of credit ratings is motivated as a solution in situations, where multiple equilibria exist. Therefore, the use of credit ratings may increase stability in financial markets. It is assumed that an investment bank has the possibility to invest in a portfolio with either high or low risk. In order to finance its operations, the investment bank issues a debt contract and offers it to external investors. It will be shown that under certain conditions, the decision of the investment bank depends on the expectations of external investors - and will thus become self-fulfilling. In those cases, multiple equilibria are present and the desired good equilibrium may be established by the use of credit ratings. The coordination mechanism relies on one important regulatory feature: a part of the investor community - institutional investors - is restricted to invest only in products with a certain credit rating.

By introducing rating fees it will come clear that the ability of credit ratings to improve financial market stability depends on the size of the rating fee. A reduction of the rating fee always improves the utility of credit ratings, irrespective whether investors or the rated issuer has to pay for the rating service. With the inclusion of rating fees, we directly take a stand on the debate whether the obvious limited competition in the market of CRAs, which presumably leads to inefficiently high rating fees, has negative effects on financial market stability. The model concludes that in the presence of inefficiently high rating fees credit ratings may be more valuable, if it is mandatory to request a credit rating. It may also have an impact on the utility of credit ratings, if investors instead of debt issuers are charged to pay the rating fee. The presented model abstracts from the possibility of opportunistic behavior of CRAs. Moral hazard aspects between the rated issuer of a debt instrument and the CRAs, which were central in the analysis in chapter 3, are excluded from the analysis. Therefore, the aim is not to analyze the effects of potential conflicts of

interest between the CRAs and the rated entity in the applied model, but rather to concentrate on the role of credit ratings as a coordination mechanism that increases financial market stability.

The remainder of this chapter is structured as follows. Section 4.2 provides a review on the related literature. In section 4.3, we introduce the model framework and analyze the role of rating fees for the ability of credit ratings to increase financial market stability. Finally, section 4.4 concludes.

4.2 Related Literature

The literature on the role of CRAs in financial markets has largely an empirical focus. The empirical literature analyzes for example the performance of CRAs (see Galil, 2003), their impact on capital flows (see Dodd & Setty, 2003) or the influence of the business cycle on credit ratings (see Amato & Furfine, 2004). While CRAs have been extensively analyzed empirically, there is a lack of theory in the literature (Cantor, 2004).

On the one hand, credit ratings seem to play an important role in financial markets, as nearly all issued debt products receive a credit rating. On the other hand, financial economics literature partially considers the importance of credit ratings with scepticism. There is an essential disagreement, on whether credit ratings play a meaningful economic role and whether credit ratings have real informational content. For example Partnoy (1999) claims that credit ratings are only important, because they are used in the regulation of financial market participants. Other authors have the opinion that the importance of credit ratings is exaggerated, since credit ratings changes often lag the market and the markets often anticipates ratings changes (see Brealey & Myers, 2002). The largest part of the existing theoretical

literature, such as Millon & Thakor (1984), Boom (2001) or Mukhopadhyay (2004) analyze the role of CRAs under the assumption that the CRA has a technology to generate new information for market participants. In those contributions, the authors do not take into account the criticism that CRAs might not be able to provide new information. Implications regarding the concentrated market structure in the CRA sector provide Lizzeri (1999) and Doherty et al. (2007). Lizzeri (1999) shows that more competition can lead to full information revelation and Doherty et al. (2007) provide empirical evidence that competition improves rating quality.

In contrast to the existing theoretical literature, Boot et al. (2006) motivate the useful role of credit ratings as a coordination mechanism in situations, where multiple equilibria exist. The key assumption in their approach is that a certain fraction of the investor community is restricted by regulation to invest only in instruments with a credit rating that reflects at least investment-grade. In the presence of multiple equilibria, those investors, which rely their investment decision and their required debt repayment on the observed credit rating, can lead to the desired "good" equilibrium and therefore reduce financial market fragility. Boot et al. (2006) show that a CRA not necessarily has to provide new information to the market in order to play a useful role in increasing financial market stability. Using the framework of Boot et al. (2006), we analyze the effects of revenue creation of CRAs on financial market stability and derive implications referring to competition in the CRA sector.

4.3 The Model

This section introduces a model to analyze the stabilizing role of CRAs in financial markets, especially concentrating on the role of rating fees. Part 4.3.1 introduces the assumptions and the framework of the model, which is based on the approach in Boot et al. (2006). What follows in part 4.3.2 is the illustration of the stabilizing mechanism of credit ratings by coordinating the beliefs of external investors. The model then focuses on the consequences of an increase of the rating fee, which has to be paid by the issuer of a debt instrument in part 4.3.3 and then distinguishes between voluntary and mandatory credit ratings in part 4.3.4. Part 4.3.5 analyzes the robustness of the implications on financial market stability by charging external investors instead of the issuer of the debt instrument for the rating fee.

4.3.1 Framework and Assumptions

A representative, risk neutral investment bank (IB) has the choice to invest either in a portfolio with low risk (LR) or in a portfolio with high risk (HR). Portfolio LR generates a payoff $\Psi^{LR} > 0$ in the case of success with probability $p_{LR} \in [0;1]$ and a payoff of zero in the case of failure with probability $(1 - p_{LR})$. Hence, portfolio LR yields an expected payoff $p_{LR}\Psi^{LR}$. The high-risk portfolio (HR) generates a higher payoff Ψ^{HR} $(> \Psi^{LR})$ in the case of success with a probability $p_{HR} \in [0;1]$ which is smaller than p_{LR} of portfolio LR $(p_{HR} < p_{LR})$. In the case of failure with probability $(1 - p_{HR})$, project HR generates a payoff of zero. The success probability of the two portfolios can also be considered as the quality of the portfolio, whereat a higher quality is equivalent to a higher success probability. The expected payoff of portfolio

LR is assumed to be larger than the expected payoff of portfolio HR:

$$p_{LR}\Psi^{LR} > p_{HR}\Psi^{HR}$$

Therefore, investment of the representative IB in portfolio LR is first-best efficient. For being able to invest in one of the two portfolios, the investment bank needs to raise debt finance of an amount $d > 0$ from external investors. The IB is assumed to have no own funds initially, therefore investment of the IB relies entirely on debt finance.

External investors, which provide debt finance for the investment bank, are assumed to be risk neutral, too.[52] The qualities of the two possible portfolios LR and HR, the IB can invest in, are assumed to be public observable. Nevertheless, external investors cannot contract the investment bank to invest in a specific portfolio. Instead, external investors require a debt repayment $D^i > 0$ with $i \in [LR; HR]$ according to the type of portfolio which they expect the IB will choose. We assume a perfectly competitive credit market and for simplification reasons a risk-free interest rate of zero. If external investors expect that the IB will invest in portfolio HR, they require a high repayment $D^{HR} > 0$. Instead, if they expect that the IB will choose portfolio LR they require a low repayment $D^{LR} < D^{HR}$. Since in the case of failure, both portfolios yield a payoff of zero, external investors then get a repayment of zero and the investment bank defaults. Since we assume risk neutrality and a risk free interest rate of zero, the expected repayment is equal to the amount of debt d. If external investors expect the choice of portfolio LR, we have:

$$p_{LR}D^{LR} + (1 - p_{LR})\,0 = d \longrightarrow D^{LR} = \frac{d}{p_{LR}} \tag{16}$$

[52] External investors can be regarded as for example banks, investment funds or pension funds for which risk neutrality can be justified.

and if external investors expect the choice of portfolio HR, we have:

$$p_{HR}D^{HR} + (1 - p_{HR})\,0 = d \longrightarrow D^{HR} = \frac{d}{p_{HR}} \tag{17}$$

It is obvious, that the required debt repayment in both cases is decreasing in the quality of each portfolio: $\frac{\partial D^i}{\partial p_i} < 0$. The objective of the IB is to maximize its profits by investing in one of the two portfolios, given the expectations of external investors, which are reflected in the amount of required debt repayment. Depending on the parameters in the model introduced so far, it can be shown that for p_{LR} sufficiently large ($p_{LR} \geq \bar{p}_{LR}$), it is optimal for the IB to select portfolio LR, irrespective which project external investors expect - even if all external investors would anticipate investment in the high-risk portfolio and require the corresponding high debt repayment D^{HR}. If the quality of portfolio LR is high enough, the first-best investment decision will always be established. Therefore, if $p_{LR} \geq \bar{p}_{LR}$, it is rational for external investors to expect the choice of portfolio LR and to require a debt repayment of D^{LR}. We define cases, where $p_{LR} \geq \bar{p}_{LR}$ as region 'C'. The optimal decision of the IB is again independent of the external investors' expectations, if the quality of portfolio LR is sufficiently low ($p_{LR} < \underline{p}_{LR}$). If the quality of the first-best portfolio is below a lower bound $\underline{p}_{LR}$, it is optimal for the IB to invest in the high-risk portfolio HR, even if all external investors would require a low debt repayment D^{LR}. Henceforth, external investors will rationally require a high debt repayment, if the quality of portfolio LR is sufficiently small. We define cases, where $p_{LR} < \underline{p}_{LR}$ as region 'A'. While the decision of the investment bank is clear, if the quality of project LR lies in either region A or region C, the decision of the IB looks different, if portfolio LR has intermediate quality ($\underline{p}_{LR} \leq p_{LR} < \bar{p}_{LR}$), which is defined as region 'B'. For qualities of portfolio LR in region B, the choice of the investment bank depends on

the expectations of external investors. The IB will choose the first-best portfolio LR, if external investors expect the choice of portfolio LR and accordingly require a low debt repayment D^{LR}. Contrary, the IB will optimally decide to choose the high-risk portfolio HR, if external investors expect the choice of portfolio HR and accordingly require a high repayment D^{HR}. Since the choice of the IB depends on the expectations of external investors, multiple equilibria are present, if the low-risk portfolio has intermediate quality. Proposition 6 provides a summary of the optimal decision of the IB for different qualities of portfolio LR.[53]

Proposition 6 *Region A: If $p_{LR} <\underline{p}_{LR}$, the IB optimally chooses portfolio HR, independent of the expectations and the required debt repayment of external investors.*

Region B: If $\underline{p}_{LR} \leq p_{LR} < \bar{p}_{LR}$, the choice of the IB depends on the required debt repayment of external investors. If external investors expect portfolio LR and require D^{LR}, the IB optimally chooses portfolio LR, and vice versa. In region B, multiple equilibria are present.

Region C: If $p_{LR} \geq \bar{p}_{LR}$, the IB optimally chooses the first-best portfolio LR, independent of the expectations and the required debt repayment of external investors.■

The results of proposition 6 for region B can be further generalized, as will be shown in the next section: The IB can be induced to optimally choose portfolio LR, if the fraction of external investors, which require a low debt repayment, is sufficiently large. The investment possibilities of the IB and the expectations of external investors therefore have an impact on financial market stability. Since we assume, that the expected payoff of the low-risk portfolio LR is larger than the expected payoff of the high-risk portfolio HR, financial market stability will be increased, if the IB decides to invest in portfolio LR instead of portfolio HR (see

[53]The proofs of proposition 6 and of all following propositions are located in the appendix.

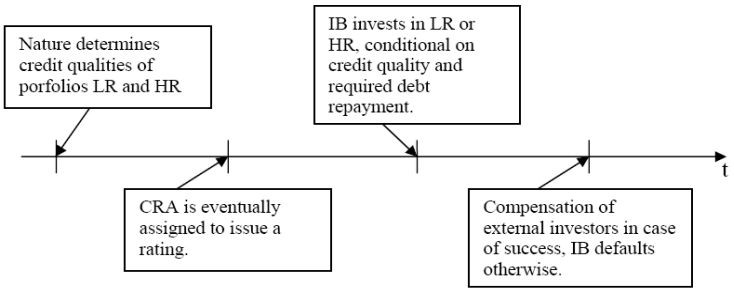

Figure 4.1: Sequence of events.

definition 1).

Definition 1 *Financial market stability in the economy is higher, if the IB decides to invest in the low-risk portfolio LR ("good" equilibrium) instead of the high-risk portfolio HR ("bad" equilibrium), because* $p_{LR}\Psi^{LR} > p_{HR}\Psi^{HR}$.

The framework of the model is completed by the introduction of a representative, profit maximizing credit rating agency (CRA), which may issue a credit rating, if it is hired by the IB or external investors. The credit rating reflects the type of the portfolio, the IB is going to invest. If the CRA is hired, it receives a rating fee θ for its services and issues a credit rating $r \in \{g; b\}$, that is public observable. Depending on the public observable credit qualities of the two possible portfolios LR and HR, the CRA issues a good credit rating $r(p_{LR}, p_{HR}) = g$, if the CRA anticipates that the IB will invest in portfolio LR. A good credit rating can therefore be interpreted as an investment-grade rating, because it reflects investment in a low-risk portfolio. The CRA issues a bad credit rating $r(p_{LR}, p_{HR}) = b$, that can be interpreted as a speculative-grade rating, if it anticipates, that the IB will decide to invest in portfolio HR. The sequence of events in the model is illustrated in figure 4.1. At first, nature determines the credit qualities of the two portfolios LR and HR. In the next step, the investment bank or external investors assign a CRA to issue a credit rating r

and pay in exchange the rating fee θ. After then, the IB chooses portfolio LR or HR, conditional on the credit qualities and required debt repayment, which may depend on the observed credit rating. Finally, the return of the chosen portfolio materializes. The IB pays back the required debt repayment to external investors, if the portfolio succeeds and defaults in the case of failure. For credit qualities, which lie in region A or C, credit ratings do not play any important role. Neither improves a credit rating financial market stability nor does it provide additional information to the market. The reason for that is very straightforward. As proposition 6 shows, the decision of the IB in which portfolio to invest, is independent of external investors' expectations and the required debt repayment for credit qualities in regions A and C. Therefore, a CRA would issue a bad credit rating $r = b$, if $p_{LR} < \underline{p}_{LR}$, and a good credit rating $r = g$, if $p_{LR} \geq \bar{p}_{LR}$ respectively. Since the decision of the IB is already clear and anticipated by external investors as well, a credit rating does not provide any new information to the market. The IB or external investors would in that case only be willing to pay a rating fee θ for a credit rating, if it is mandatory by regulation to receive a credit rating. If receiving a credit rating would be voluntary, neither external investors, nor the IB would have an incentive to acquire a credit rating and pay the rating fee θ. However, credit ratings are able to play a useful role concerning financial market stability, if the credit quality of portfolio LR lies in region B, where multiple equilibria exist. The next section will take a closer look on that issue and especially on the role of the rating fee.

4.3.2 Credit Ratings and Multiple Equilibria

This section concentrates on intermediate credit qualities of portfolio LR. As defined above, for credit qualities in region B multiple equilibria are present, since the investment decision of the IB depends on the expectations of external investors.

4. CRAS AND FINANCIAL MARKET STABILITY

So far, we assumed a homogenous mass of external investors, which provide debt finance for the IB, and whereat each single external investor forms her expectations independently. Now, we assume that a public observable fraction $\lambda \in [0,1]$ of external investors is restricted by regulation to invest only in products with a certain quality. Examples for those investors can be banks, insurance companies or pension funds. In the following, as in Boot et al. (2006), we label those external investors as "institutional investors". In the framework, institutional investors are restricted to invest only in products with investment-grade rating ($r = g$), which reflects, that the investment bank chooses the low-risk portfolio. Therefore, institutional investors are allowed to invest, if credit quality lies in region A, whereat the IB always chooses the low-risk portfolio, and are prohibited to invest, if the credit quality of portfolio LR lies in region C, whereat it is optimal for the IB to invest in the high-risk portfolio.

If the quality of the low-risk product lies in region B, institutional investors are only allowed to invest, if the "good" equilibrium will be established - meaning that the IB decides to invest in portfolio LR. If the CRA issues a good credit rating $r = g$, institutional investors are allowed to invest and require a low debt repayment D_{LR}. All other investors - fraction $(1 - \lambda)$ - form their expectations irrespective of the issued credit rating, but those investors are assumed to be aware of the repayment decision of institutional investors. If institutional investors require the low debt repayment and the other investors the high repayment, the investment bank will be confronted with a total debt repayment D^{λ}, given by:

$$D^{\lambda} = \lambda D_{LR} + (1 - \lambda) D_{HR} \tag{18}$$

Facing a required debt repayment of D^{λ}, for which $D_{LR} \leq D^{\lambda} \leq D_{HR}$, the investment bank makes its decision to choose either the low-risk or the high-risk project.

The fraction of institutional investors is assumed to be public observable. Therefore, D^{λ} is known by the investment bank as well as by all external investors. Facing a total debt repayment D^{λ}, the IB chooses project LR, if D^{λ} is sufficiently low and project HR, if D^{λ} is sufficiently large. Because the size of D^{λ} depends on λ, $\frac{\partial D^{\lambda}}{\partial \lambda} < 0$, the possibility to induce the IB to establish the good equilibrium, depends on the fraction of institutional investors. The next two sections analyze in detail the decision of the investment bank and the influence of the rating fee θ^{i} with $i \in \{IB; II\}$ that has to be paid by the investment bank ($i = IB$), if credit ratings are either mandatory by regulation or the decision, to obtain a credit rating is voluntary. Additionally, we analyze the influence of the rating fee, if institutional investors ($i = II$) are charged to pay for the credit rating.

4.3.3 Rating Fee and Financial Market Stability

Again, a situation is considered, in which the IB and external investors are confronted with a credit quality of the low-risk project in the multiple equilibria region B. For the moment, we assume that receiving a credit rating is mandatory, and that the IB has to pay for a costly credit rating that is issued by a credit rating agency (CRA). Since we assume that the IB has no own funds, it has to raise total debt finance D from external investors that covers the amount that is invested in the portfolio d plus the rating fee θ^{IB}: $D = d + \theta^{IB}$. As mentioned above, we assume that there exists a fraction λ of institutional investors that is only allowed to invest, if the IB chooses the low-risk portfolio. If the CRA issues a credit rating $r = g$, which reflects the choice of the low-risk project, institutional investors require a debt repayment $\hat{D}_{LR}$, which is given by

$$d + \theta^{IB} = p_{LR}\hat{D}_{LR} \longleftrightarrow \hat{D}_{LR} = D_{LR} + \frac{\theta^{IB}}{p_{LR}} \tag{19}$$

with $D_{LR} = \frac{d}{p_{LR}}$. The other part of investors $(1-\lambda)$ forms its own expectations, irrespective of an observed credit rating. If they anticipate that the IB will choose the high-risk portfolio, they require a high debt repayment $\hat{D}_{HR}$, which is given by

$$d + \theta^{IB} = p_{HR}\hat{D}_{HR} \longleftrightarrow \hat{D}_{HR} = D_{HR} + \frac{\theta^{IB}}{p_{HR}} \tag{20}$$

with $D_{HR} = \frac{d}{p_{HR}}$. Confronted with a debt repayment as defined in equation (18) with $\hat{D}^{\lambda} = \lambda\hat{D}_{LR} + (1-\lambda)\,\hat{D}_{HR}$, the expected profit of the IB, if it chooses portfolio LR and taking into account the rating fee θ^{IB}, is given by:

$$E\left(\Pi_{LR}\right) = p_{LR}\left(\Psi_{LR} - \hat{D}^{\lambda}\right) + (1-p_{LR})\,0$$

$$\longleftrightarrow E\left(\Pi_{LR}\right) = p_{LR}\left[\Psi_{LR} - \lambda\hat{D}_{LR} - (1-\lambda)\,\hat{D}_{HR}\right] \tag{21}$$

If the investment fails - with probability $(1-p_{LR})$ - the profit of the IB is zero and cannot be negative, since we assume limited liability. If the investment was successful - with probability p_{LR} - the IB receives the portfolio's payoff Ψ_{LR} and pays back the required debt repayment $\hat{D}^{\lambda}$ to external investors. In contrast, the expected profit of investing in portfolio HR, is accordingly given by:

$$E\left(\Pi_{HR}\right) = p_{HR}\left[\Psi_{HR} - \lambda\hat{D}_{LR} - (1-\lambda)\,\hat{D}_{HR}\right] \tag{22}$$

The IB would optimally invest in portfolio LR and establish the good equilibrium, if the expected profit of choosing portfolio LR is larger than the expected profit of choosing portfolio HR. The IB is indifferent, if the expected profits of both portfolios are equal:

$$E\left(\Pi_{LR}\right) = E\left(\Pi_{HR}\right)$$

$$\longleftrightarrow p_{LR}\left[\Psi_{LR}-\hat{D}^{\lambda}\right]=p_{HR}\left[\Psi_{HR}-\hat{D}^{\lambda}\right] \tag{23}$$

Equation (23) can now be solved for the proportion of institutional investors $\hat{\lambda}$ that is necessary to assure that the IB is indifferent between the two portfolios, by using (19)-(22) and given the values of p_{LR}, p_{HR}, θ^{IB}, Ψ_{LR}, and Ψ_{HR}:

$$\hat{\lambda}=\frac{\left(p_{LR}-p_{HR}\right)D_{HR}-\left(p_{LR}\Psi_{LR}-p_{HR}\Psi_{HR}\right)+\left(\frac{p_{LR}-p_{HR}}{p_{HR}}\right)\theta^{IB}}{\left(p_{LR}-p_{HR}\right)\left(D_{HR}-D_{LR}\right)+\left(\frac{p_{LR}-p_{HR}}{p_{HR}}\right)\left(\frac{p_{LR}-p_{HR}}{p_{LR}}\right)\theta^{IB}}>0 \tag{24}$$

As shown above, the total debt repayment $\hat{D}^{\lambda}$ is decreasing, if the fraction of institutional investors increases ($\frac{\partial\hat{D}^{\lambda}}{\partial\lambda}<0$). Therefore, the IB would optimally choose portfolio LR, which leads to the good equilibrium, if the proportion of institutional investors is larger than the critical value $\hat{\lambda}$ in equation (24), because for $\lambda\geq\hat{\lambda}$ the expected profit of investing in portfolio LR is larger, compared to portfolio HR: $E\left(\Pi_{LR}\right)\geq E\left(\Pi_{HR}\right)$. In the case of $\lambda\geq\hat{\lambda}$, the CRA issues a credit rating $r=g$ and the other part of the investor community $(1-\lambda)$, which is aware of the required debt repayment of institutional investors λ and the implicit portfolio choice of the investment bank, also anticipates that the good equilibrium will be established and optimally sets the required debt repayment equal D_{LR}. From this follows that the IB is confronted with the total debt repayment of $D^{\lambda}=D_{LR}$.

If the proportion λ is instead lower than $\hat{\lambda}$, it is optimal for the IB to invest in portfolio HR and the bad equilibrium will be established, because for $\lambda<\hat{\lambda}$ we have $E\left(\Pi_{LR}\right)<E\left(\Pi_{HR}\right)$. In that case, the CRA issues a bad credit rating $r=b$ and the institutional investors are prohibited to invest. If institutional investors are excluded from investing, the entire debt financing will be provided by the other investors. In that case the other external investors form their expectations independent from the observed credit rating. Therefore, the portfolio choice of the IB still depends on the

expectations of external investors and multiple equilibria are still present.

As in Boot et al. (2006), the credit rating acts as a coordination mechanism, because a part of the investor community sets the required debt repayment according to the observed credit rating. Equation (24) shows that the possibility of a credit rating to play a useful role, strictly depends on the fraction of investors, which bases its expectations on the observed credit rating. The useful role of a credit rating is derived by the possibility to solve the problem of multiple equilibria that is present for intermediate credit qualities of portfolio LR in region B. With obtaining a credit rating, it is possible to establish the good equilibrium with certainty for credit qualities in region B, while without a credit rating, the investment decision depends on the uncoordinated expectations of external investors, and the possibility of a resulting bad equilibrium cannot be eliminated in advance, like it is possible with a credit rating for $\lambda \geq \hat{\lambda}$. Proposition 7 summarizes the coordinating function of credit ratings.

Proposition 7 *If the proportion of institutional investors λ exceeds the critical level $\hat{\lambda}$, the investment bank optimally chooses portfolio LR, the CRA issues a corresponding credit rating $r = g$, signalling the good equilibrium, and all investors optimally set the required debt repayment to D_{LR}.*

If the proportion of institutional investors λ is lower than the critical level $\hat{\lambda}$, the CRA issues a corresponding low credit rating $r = b$, institutional investors are not allowed to invest. Multiple equilibria are still possible.■

Furthermore, from equation (24) follows that the critical proportion of institutional investors $\hat{\lambda}$ is decreasing for better credit qualities of the low risk portfolio p_{LR}. Let D^* be the debt repayment for which the IB is indifferent between portfolio LR and portfolio HR. Then, from equation (23) follows that D^* can be formulated

as:

$$D^* = \frac{p_{LR}\Psi_{LR} - p_{HR}\Psi_{HR}}{p_{LR} - p_{HR}}$$

Using that expression in equation (24), the critical proportion of institutional investors can be reformulated as:

$$\hat{\lambda} = \frac{D_{HR} - D^* + \frac{1}{p_{HR}}\theta^{IB}}{D_{HR} - D_{LR} + \frac{1}{p_{LR}}\left(\frac{p_{LR}-p_{HR}}{p_{LR}}\right)\theta^{IB}} \tag{24'}$$

Because $\frac{\partial D_{LR}}{\partial p_{LR}} < 0$ and $\frac{\partial D^*}{\partial p_{LR}} > 0$, if follows from equation (24') that $\frac{\partial \hat{\lambda}}{\partial p_{LR}} < 0$. Therefore, a lower proportion of institutional investors is necessary to establish the good equilibrium, if the credit quality of portfolio LR increases. The intuition for that result is that an increase in the credit quality of portfolio LR decreases the required debt repayment of institutional investors. Therefore, the IB is already with a lower fraction of institutional investors indifferent between portfolio LR and HR and the good equilibrium can be established more easily with better credit qualities of the good portfolio LR. Furthermore, it can be shown that $\hat{\lambda}$ depends on the amount of debt d that is needed to invest in one of the two portfolios. The required debt repayment of external investors is increasing, if the amount of provided debt increases: $\frac{\partial D_i}{\partial d} = \frac{1}{p_i} > 0$ with $i \in [LR; HR]$. From this follows that the critical share of institutional investors is increasing with the amount of debt finance: $\frac{\partial \hat{\lambda}}{\partial d} > 0$. The intuition is, again, straightforward. As the amount of debt finance increases, the required debt repayment increases, irrespective whether external investors expect the choice of portfolio LR or HR. In order to keep the total amount of debt repayment constant, such that the IB remains indifferent between portfolio LR and HR, the share of institutional investors, which require a low debt repayment, has to increase. Proposition 8 summarizes the properties of $\hat{\lambda}$.

Proposition 8 *The critical share of institutional investors $\hat{\lambda}$ increases and therefore financial market stability decreases, if*

- the credit quality of the low-risk portfolio p_{LR} deteriorates,

- the amount of debt finance d increases.■

The CRA, which produces the credit rating, is assumed to require the rating fee θ^{IB} for its services. The rating fee increases the amount of debt, the IB has to raise from external investors, and therefore increases the required debt repayment, which is lower in the case, when external investors expect the choice of portfolio LR. The influence of the rating fee on the critical fraction of institutional investors can be analyzed by looking at the partial derivative of (24') with respect to θ^{IB}. Because $\frac{1}{p_{LR}} < \frac{1}{p_{HR}}$ and $0 < \frac{p_{LR}-p_{HR}}{p_{LR}} < 1$, it follows that

$$\frac{\partial \hat{\lambda}}{\partial \theta^{IB}} > 0 \tag{25}$$

Equation (25) shows that the critical share of institutional investors must be higher, if the rating fee increases. As already mentioned, the amount of debt increases, when the rating fee becomes larger. Institutional investors require a lower debt repayment, if they observe a good credit rating, in contrast to investors, who probably expect the choice of the high-risk portfolio. Therefore, the fraction of institutional investors has to increase, too, because only as $\hat{\lambda}$ increases, the total required debt repayment is low enough to induce the IB to choose the low-risk portfolio and to establish the good equilibrium. It is obvious that the size of the rating fee has consequences for financial market stability in the applied framework. Financial market stability can be increased, if the rating fee will be reduced. The reason for this is that less investors, who follow the observed credit rating are necessary to establish the good

equilibrium.

One policy implication that can be derived from this result is to analyze whether the market price of a credit rating is too high and eventually to take actions to decrease the market rating fees. A market rating fee could be inefficiently high, if for example the rating technology is inefficiently costly or if there is a lack of competition in the sector of CRAs. According to standard microeconomics theory, the rating fee would be higher than the competitive rating fee, if some few CRAs have market power and the possibility to set prices. Taking a closer look at the current state in financial markets reveals that the rating market is dominated by three big CRAs, which earn very high, quasi-monopoly profits.[54] Therefore, more intensive competition in the rating sector, which would lead to lower rating fees, would be desirable, since in the presence of multiple equilibria, the good equilibrium could then be established more easily according to the presented theory.

Very often, institutions of financial supervision themselves limit market entry for competitors. For being eligible to the use for certain regulatory purposes in the U.S., a CRA hat to be recognized by the U.S. security and exchange commission (SEC). Until 2005 only three CRAs received the status of being nationally recognized statistical ratings organizations (NRSRO).[55] In 2007, the SEC adopted rules to implement provisions of the Credit Rating Agency Reform Act 2006, among others that the NRSRO status has to be renewed regularly and that the recognition process should be simplified (see SEC, 2007). Today, already seven CRAs received NRSRO status and the SEC reacted on the public pressure for more competition among CRAs by enlarging the number of recognized CRAs. The theoretical approach in

[54] For example Moody's realized an operating margin of 61.8% in 2006, and comparably Standard & Poor's 43% (see Moody's, 2007 and Standard & Poor's, 2007). Although both CRAs operate in the same market, there is obviously not much competition regarding rating fees.

[55] Those agencies were Standard&Poor's, Moody's and Fitch. For more information on SEC requirements for recognizing a CRA, see for example BIS (2000).

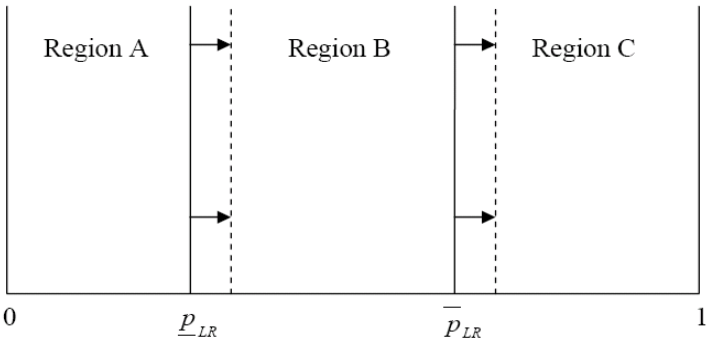

Figure 4.2: Increase of the rating fee θ^{IB}.

this paper supports the efforts to promote competition by showing that a resulting reduction in rating fees would be valuable for financial market stability.[56]

Apart from the influence of the rating fee on the critical fraction of institutional investors, a second implication can be derived. Proposition 6 showed that multiple equilibria are possible and therefore credit ratings are most valuable, if the low-risk portfolio has an intermediate credit quality ($\underline{p}_{LR} \leq p_{LR} < \bar{p}_{LR}$). As has been shown above, for credit qualities in region B the decision of the IB to invest in one of the two possible portfolios depends on the required debt repayment. If the rating fee would be increased, the total required debt repayment would increase, too. Therefore, the good equilibrium only can be established for better credit qualities of the low-risk portfolio than before. From this follows that an increase in the rating fee leads to an increase of the threshold values $\underline{p}_{LR}$ and $\bar{p}_{LR}$ as well. Figure 4.2 shows that for higher rating fees, region B moves to the right, which means that region A becomes larger and region C smaller. The raise of $\underline{p}_{LR}$ as θ^{IB} increases, implies that some portfolios with a credit quality in region B deteriorate to region A, in which the IB always optimally decides to choose the high-risk portfolio. Therefore, a higher rating

[56] Related to our result, Doherty et al. (2007) show empirically, that more competition among CRAs leads to higher rating qualities and lower rating fees. Lizzeri (1999) shows that competition among certification intermediaries improves information revelation.

fee increases financial market fragility independent of the fraction of institutional investors, since a credit rating is no more able to play a potential valuable role for those credit qualities of the low-risk portfolio, which are lower than the new lower bound of credit qualities $\underline{p}'_{LR}$ (with $\underline{p}_{LR} < \underline{p}'_{LR}$). Related, a raise of $\bar{p}_{LR}$ as θ^{IB} increases, implies that some credit qualities that were in region C before, are now located in the multiple equilibria region B. Again, this implies a reduction in financial market stability, because for credit qualities in region C, always the good equilibrium occurs, while for credit qualities in region B, the possibility to establish the good equilibrium depends on the fraction of institutional investors. Proposition 9 summarizes the implications of lower rating fees for financial market stability.

Proposition 9 *A reduction of the rating fee θ^{IB} increases financial market stability, because (i) the critical fraction of institutional investors decreases for given intermediate credit qualities (region B), and (ii) the range of credit qualities, for which the good equilibrium can be established, will be increased (region A decreases, region C increases).*■

4.3.4 Mandatory versus Voluntary Credit Ratings

Proposition 6 showed that it is optimal for the IB to choose portfolio LR and rational for the investors to require the low debt repayment, if the credit quality of LR lies in region C. A CRA that is assigned and paid by the IB would issue a good credit rating $r = g$ in that case. If getting rated would be voluntary, the IB would in that case decide not to obtain a costly credit rating, because its expected profit would be higher without a credit rating, since the rating fee would increase the debt repayment. Hence, regarding financial market stability, it is irrelevant, whether a credit rating is assigned or not in that case. Similarly, an IB would not be willing to

pay for a costly credit rating, if the credit quality of portfolio LR is located in region A. Irrespective of a credit rating and the required debt repayment, it is optimal for the IB to choose portfolio HR and hence optimal not to obtain a costly credit rating, which would reduce the IB's expected profit. Again, it has no influence on financial market stability, whether a credit rating would be mandatory or voluntary.

As was shown above, for credit qualities of portfolio LR in region B, a credit rating can help to guarantee the good equilibrium and henceforth to improve financial market stability, if the fraction of institutional investors, which follow the observed credit rating is large enough. In that case, a credit rating, which in that case would be $r = g$, would be assigned by the IB only, if the expected profit of the IB with credit rating would be larger than the expected profit without a credit rating. The expected profit with credit rating $E(\Pi^r)$ and for $\lambda \geq \hat{\lambda}$, as shown above in section 4.3.3, is given by $E(\Pi^r) = p_{LR}\left(\Psi_{LR} - D_{LR} - \frac{\theta^{IB}}{p_{LR}}\right)$. Without a credit rating, institutional investors are prohibited from investing, and debt finance will be supplied by other uncoordinated external investors. Depending on the share of external investors, that requires the low debt repayment, the IB would then select optimally portfolio LR or HR. Let the expected profit without a credit rating be denoted as $E(\Pi^n)$. The IB is then willing to obtain a costly credit rating, if $E(\Pi^r) \geq E(\Pi^n)$. This is satisfied for a rating fee $\theta^{IB} \leq \phi$, where ϕ is the expected value of a credit rating: $\phi = p_{LR}(\Psi_{LR} - D_{LR}) - E(\Pi^n)$. The IB would not be willing to request a credit rating, if the rating fee exceeds the individual expected value of a credit rating ϕ, and hence, multiple equilibria would still be present. From this finding directly follows that too high rating fees, possibly resulting from market power of some few CRAs, are even more harmful for financial market stability, if credit ratings are voluntary. The reason is that in cases, where $\theta^{IB} > \phi$, the IB would entirely abstain from buying a credit rating, even if a credit rating could play a useful coordinating

role (i.e. $\lambda \geq \hat{\lambda}$) to fix the "good" equilibrium. On the other hand, if credit ratings are mandatory and the fraction of institutional investors is lower than the critical value ($\lambda < \hat{\lambda}$), a CRA would issue a bad credit rating $r = b$ and multiple equilibria would still be present. For the case of voluntary credit ratings, an IB would not be willing to assign a costly credit rating if $\lambda < \hat{\lambda}$. No credit rating would be issued in that case and, again, multiple equilibria would still be possible. Again, regarding financial market stability, it is irrelevant whether credit ratings are mandatory or voluntary for credit qualities in region B and $\lambda < \hat{\lambda}$.

Another insight of the last section, which is illustrated in figure 4.2, implied that the decision of an IB to request a credit rating, increases region A and reduces region C. If the credit quality of portfolio LR would fall in region A with a credit rating and then receive a bad rating $r = b$, it would be preferable not to buy a credit rating and thus to remain in region B, with at least having the possibility to realize the good equilibrium. The same is true for marginal credit qualities, which deteriorate from region C to region B. In that case, it is again preferable to forgo a costly credit rating, because the IB would maximize its profits, if the credit quality of portfolio LR remains in region C. Altogether, the model predicts that credit ratings are most valuable, if credit ratings are voluntary and if the rating fee is sufficiently low ($\theta^{IB} \leq \phi$). If the rating fee is instead inefficiently high ($\theta^{IB} > \phi$), credit ratings only play a valuable role for credit qualities in region B, when credit ratings are mandatory and the fraction of institutional investors is sufficiently large.

Todays financial markets not only show rating fees that are presumably above the competitive level, but also quasi-mandatory credit ratings. Actually every debt product that is issued in capital markets is rated and therefore it seems that credit ratings can be regarded as quasi-mandatory. The model in that chapter would pre-

dict that the negative effect of inefficiently high rating fees on financial market stability is to some degree dampened by the obviously unwritten law of quasi-mandatory credit ratings. Even though rating fees are high, the model predicts that credit ratings help to establish the good equilibrium for intermediate credit qualities, if issuers are forced to obtain a credit rating and the fraction of the investor community that follows the observed credit rating is large enough.

4.3.5 Robustness: Institutional Investors pay Rating Fee

So far, it has been assumed that the IB, or generally speaking, the issuer of a debt instrument has to pay the rating fee. This assumption coincides widely with reality, as today all big CRAs charge the issuer for the rating fee. In contrast, the big CRAs earned their revenues until the early 1970s by charging the investors for the provided information. Nowadays, smaller CRAs sometimes charge investors, not issuers, to pay for their credit ratings. BIS (2000) argues that this difference in charging rating fees "probably arises from global reputation, regulatory certification, and general availability of rating information". White (2001) explains the dominance of charging the issuer of a debt instruments with the need to reassure nervous investors and the difficulties in preventing free-riding by investors on credit ratings, once they are published. Moody's argues on its website[57] that the rationale for charging issuers is "[...] that issuers should pay for the substantial value objective ratings provide in terms of market access. In addition, it was recognized that the increasing scope and complexity of the capital markets demanded staffing at higher levels of compensation than could be received from publication subscriptions alone." Besides those arguments in favour of issuer fees, it has frequently been criticized that issuer fees would be one source of conflicts of interest. That is because a CRA would be

[57] see www.moodys.com

willing to provide the rated issuer that pays for the service with favourable credit ratings.

In that section, we check the robustness of the results regarding financial market stability by assuming that institutional investors, instead of the IB, now are charged to pay the rating fee. The aim of this exercise is to discriminate between the two possible payment schemes as to financial market stability, even if potential conflicts of interest and opportunistic behavior are excluded from the analysis. The rating fee that is charged from institutional investors is defined as $\theta^{II} > 0$. Institutional investors, which are allowed to invest, if a good credit rating would be issued, will now require a debt repayment, such that the expected repayment covers their expenses, which consists of the amount of debt d plus the rating fee.

$$d + \theta^{II} = p_{LR}\tilde{D}_{LR} \longleftrightarrow \tilde{D}_{LR} = \frac{d + \theta^{II}}{p_{LR}} \tag{26}$$

Since the entire rating fee is now financed by institutional investors, the required debt repayment of all other external investors is given by equations (16) or (17) respectively. Analog to the analysis above[58], facing a required debt repayment $\tilde{D}_{LR}$ of a fraction λ of institutional investors and for credit qualities of portfolio LR in region B, the IB compares the expected profits of investing in portfolio LR with those of portfolio HR. The total debt repayment is now given by $\tilde{D}^{\lambda} = \lambda\tilde{D}_{LR} + (1-\lambda)\, D_{HR}$:

$$p_{LR}\left[\Psi_{LR} - \tilde{D}^{\lambda}\right] = p_{HR}\left[\Psi_{HR} - \tilde{D}^{\lambda}\right] \tag{27}$$

Solving equation (27) for λ leads to the critical share of institutional investors $\tilde{\lambda}$, for

[58] see equations (23) and (24).

which the IB is indifferent between portfolio LR and HR:

$$\tilde{\lambda} = \frac{(p_{LR} - p_{HR})\, D_{HR} - (p_{LR}\Psi_{LR} - p_{HR}\Psi_{HR})}{(p_{LR} - p_{HR})\,(D_{HR} - D_{LR}) - \left(\frac{p_{LR}-p_{HR}}{p_{LR}}\right)\theta^{II}} \tag{28}$$

If $\lambda \geq \tilde{\lambda}$, the IB optimally chooses portfolio LR. In that case, the CRA would issue a good credit rating $r = g$ and institutional investors would be allowed to invest. Since λ is assumed to be observable, institutional investors would only be willing to pay for a credit rating if $\lambda \geq \tilde{\lambda}$, because only then they are allowed to invest.[59] From equation (28) follows directly that the critical fraction of institutional investors increases for higher rating fees:

$$\frac{\partial \tilde{\lambda}}{\partial \theta^{II}} > 0$$

The rating fee has again a negative effect on financial market stability, since a higher fraction of institutional investors is necessary to establish the good equilibrium as the rating fee increases. This result confirms that the rating fee has the same robust influence on financial market stability, irrespective which party has to pay the rating fee. Again, this result implies that more competition among CRAs, which would lead to lower rating fees, would be desirable, since the good equilibrium could be established more easily. To investigate, which compensation scheme should be preferred for given rating fees, the critical fraction of institutional investors in the two considered cases has to be compared. Given the same costs of a credit rating and assuming the same demand price elasticity of the IB and institutional investors, the CRA would set the rating fee for institutional investors such that the total revenues

[59] If $\lambda < \tilde{\lambda}$, institutional investors cannot induce the IB to choose portfolio LR (see above). In that case, institutional investors do not invest and the complete debt is provided by other external investors, which form their expectations and repayment requirements independently. Multiple equilibria are still present for $\lambda < \tilde{\lambda}$.

of the CRA are the same as if the IB would be charged to pay the rating fee:

$$\theta \equiv \theta^{IB} = \lambda\theta^{II} \longleftrightarrow \theta^{II} = \frac{\theta}{\lambda} \tag{29}$$

Using equation (29) in equation (28), the critical fraction of institutional investors, when the rating fee is charged from institutional investors $\tilde{\lambda}$ can now be compared with the case, when the rating fee is charged from the IB $\hat{\lambda}$, in equation (24). $\tilde{\lambda}$ is equal $\hat{\lambda}$, if

$$\theta = \theta^* = \frac{p_{LR}}{p_{LR} - p_{HR}} \left[p_{LR}\left(\Psi_{LR} - D_{LR}\right) - p_{HR}\left(\Psi_{HR} - D_{LR}\right)\right] \tag{30}$$

For $\theta < \theta^*$ follows from equation (30) that $\tilde{\lambda} < \hat{\lambda}$, and for $\theta \geq \theta^*$ that $\tilde{\lambda} \geq \hat{\lambda}$. Proposition 10 summarizes the implications for financial market stability, if the rating fee is charged from institutional investors.

Proposition 10 *If the rating fee is charged from institutional investors, (i) the critical proportion of institutional investors that is necessary to establish the good equilibrium increases as the rating fee increases ($\frac{\partial\tilde{\lambda}}{\partial\theta^{II}} > 0$), (ii) for $\theta < \theta^*$ the good equilibrium can be established more easily compared to charging the fee from the IB ($\tilde{\lambda} < \hat{\lambda}$).*■

For rating fees lower than θ^* and if the CRA charges the rating fee from institutional investors, a lower fraction of institutional investors would be needed to establish the good equilibrium. On the other hand, the good equilibrium can be reached more easily, if the issuer of a debt instrument (in our setup the IB) pays the fee, when the fee is larger than θ^*. Using equation (30) in equation (24) or (28), it can be shown that $\lim_{\theta\to\theta^*} \tilde{\lambda} = 1$ and $\lim_{\theta\to\theta^*} \hat{\lambda} = 1$. Since $\lambda \in [0; 1]$, it follows directly that credit ratings are no more able to act as a coordination mechanism for $\theta > \theta^*$,

because the critical proportion of institutional investors would in that case be $\lambda > 1$, irrespective which party pays the rating fee. The intuition why $\tilde{\lambda} < \hat{\lambda}$ for $\theta < \theta^*$ is as follows: If the IB has to pay the rating fee, the IB is confronted with an additional debt repayment for the credit rating given by $\lambda\frac{\theta}{p_{LR}} + (1-\lambda)\frac{\theta}{p_{HR}}$. If instead institutional investors have to pay the rating fee, the additional debt repayment is given by $\frac{\theta}{p_{LR}}$. Since $p_{LR} > p_{HR}$, for all $\lambda \in [0;1]$ follows that $\frac{\theta}{p_{LR}} \leq \lambda\frac{\theta}{p_{LR}} + (1-\lambda)\frac{\theta}{p_{HR}}$. Because the IB is confronted with a lower additional debt repayment, that originates from the credit rating, if the rating fee is charged from institutional investors, a lower fraction λ is necessary to establish the good equilibrium.

Irrespective which side - the issuer of a debt instrument or investors - has to pay the rating fee, the model predicts that a reduction of the rating fee would help to increase financial market stability in situations, where multiple equilibria are present. Additionally, the model shows that credit ratings would lose entirely their capacity to act as a stabilizing coordination mechanism, if the rating fee would be $\theta > \theta^*$. As to regulation, the model recommends to charge the rating fee from institutional investors, because the "good" equilibrium could be established more easily as was shown above. A side-effect of this payment scheme would be the elimination of the potential conflict of interest between CRA and the debt issuer.[60] However, this recommendation assumes the same willingness of both parties to pay a certain rating fee and does not take into account potential efficiency gains of charging the fee from debt issuers rather from a dispersed investor community, as for example the public good character of information and free-riding of other investors, once the rating is published.

[60] For the analysis of conflicts of interest see chapter 3.

4.4 Conclusion

Credit ratings do not only influence the finance costs of a debt issuer, but also the possibility to reach a wide investor base, as very often, investors are regulated to invest only in instruments with a certain credit rating. That paper contributes to the understanding of the role, CRAs and their credit ratings play in financial markets. Boot et al. (2006) motivate credit ratings as a coordination instrument in environments, where multiple equilibria exist. The ability of credit ratings to increase financial market stability relies on the assumption that a sufficiently large part of the investor community uses the observed credit rating for its investment decision. That paper extends the model of Boot et al. (2006) by the introduction of rating fees. With that extension, we were able to analyze implicitly, whether the frequent argued criticism on the concentrated market structure in the CRA sector, which may have led to inefficiently high rating fees, has negative implications regarding financial market stability and whether there is a need for regulatory intervention. We showed that the rating fee negatively influences the ability of credit ratings to improve financial market stability, because the necessary fraction of institutional investors, which relies its investment decision on the observed credit rating, has to increase. This result implies that more competition in the rating sector that would lead to lower rating fees is desirable. Furthermore, we showed that an inefficient high rating fee is even more harmful, when getting a credit rating is voluntary. The intuition is that a rating fee that is too high, might keep off the issuer of a debt instrument to obtain a credit rating. The model concludes that in the presence of inefficiently high rating fees, credit ratings only can play a stabilizing role, if credit ratings are mandatory. CRAs may not necessarily charge the rating fee from issuers of debt instruments, but they also in principle have the possibility to charge the fee

from investors. Extending the model by charging the rating fee from institutional investors that rely their investment decision on the observed credit rating, confirmed the robustness of the results. Additionally, the model concludes that credit ratings may be even more valuable, if the rating fee is charged from investors rather from debt issuers.

One policy implication of the model, that was presented in this paper, is that more competition in the CRA sector is positive for financial market stability. If more intensive competition would reduce rating fees, the stabilizing effect of credit ratings as a coordination instrument would be facilitated. The relevance of the results are largely reflected in recent changes in the regulatory supervision of CRAs in the United States. The SEC recently reacted on the frequent criticism that there is a lack of competition in the CRA sector, by granting NRSRO status to more CRAs. Until 2005, only three CRAs were recognized by the SEC, today the number increased up to seven. One goal of the "Credit Rating Agency Reform Act 2006", which passed legislation in September 2006, among others, is the promotion of competition and facilitation of market entry.

However, it has to be mentioned that some questions are not answered by the model. First, it was assumed that all parameters about portfolio quality, payoffs and structure of the investment community were public observable. It remains to be analyzed, in how far the stabilizing role of credit ratings is influenced by uncertainty about those parameters, especially the fraction of institutional investors. Second, the presented model excluded moral hazard aspects which may influence the reliability of credit ratings. Related, it remains to be investigated what is the optimal number of recognized CRAs in financial markets and whether there is a trade-off between the degree of competition among CRAs (and therefore the level of the rating fee) and the reliability of credit ratings.

4.A Proofs of Propositions

Proof of proposition 6. The total debt repayment D^*, for which the IB is indifferent between portfolio LR and HR, is given by:

$$p_{LR}\left(\Psi_{LR} - D^*\right) = p_{HR}\left(\Psi_{HR} - D^*\right)$$

$$\longrightarrow D^* = \frac{p_{LR}\Psi_{LR} - p_{HR}\Psi_{HR}}{p_{LR} - p_{HR}},$$

and $\frac{\partial D^*}{\partial p_{LR}} > 0$, and $\frac{\partial D^*}{\partial p_{HR}} < 0$. Let $\underline{p}_{LR}$ be the credit quality for which $D^* = D_{LR}$. Then, the IB strictly prefers to choose portfolio HR independent from investors' required debt repayment, if $p_{LR}\left(\Psi_{LR} - D_{LR}\right) < p_{HR}\left(\Psi_{HR} - D_{LR}\right)$, which is the case for $D_{LR} > D^*$ and $p_{LR} < \underline{p}_{LR}$ (Region A). Next, let $\bar{p}_{LR}$ be the credit quality ($\bar{p}_{LR} > \underline{p}_{LR}$) for which $D^* = D_{HR}$. Then, it is optimal for the IB to choose portfolio LR, independent from investors' required debt repayment, if $p_{LR}\left(\Psi_{LR} - D_{HR}\right) \geq p_{HR}\left(\Psi_{HR} - D_{HR}\right)$. That is the case, if $D_{HR} \leq D^*$ and $p_{LR} \geq \bar{p}_{LR}$ (Region C). Region C is nonempty ($\bar{p}_{LR} < 1$), if $\frac{1}{p_{HR}} < \left(\Psi_{LR} - p_{HR}\Psi_{HR}\right) / \left(1 - p_{HR}\right)$; this condition is satisfied, if p_{HR} is not too small. If portfolio LR has intermediate quality, $\underline{p}_{LR} \leq p_{LR} < \bar{p}_{LR}$ (Region B), then $D_{LR} \leq D^*$ and $D_{HR} > D^*$. In region B, the IB optimally chooses the portfolio that is anticipated by external investors (multiple equilibria). Region B is nonempty ($\underline{p}_{LR} < 1$), if $\left(\Psi_{LR} - p_{HR}\Psi_{HR}\right) / \left(1 - p_{HR}\right) > 1$. This condition is satisfied, if p_{HR} is not too large. ■

Proof of proposition 7. For $E\left(\Psi_{LR} - \hat{D}^{\lambda}\right) = E\left(\Psi_{HR} - \hat{D}^{\lambda}\right)$, the critical proportion of institutional investors is given by

$$\hat{\lambda} = \frac{\left(p_{LR} - p_{HR}\right)\hat{D}_{HR} - \left(p_{LR}\Psi_{LR} - p_{HR}\Psi_{HR}\right)}{\left(p_{LR} - p_{HR}\right)\left(\hat{D}_{HR} - \hat{D}_{LR}\right)},$$

with $\hat{D}_{HR} = D_{HR} + \frac{\theta^{IB}}{p_{HR}}$ and $\hat{D}_{LR} = D_{LR} + \frac{\theta^{IB}}{p_{LR}}$. $\hat{\lambda}$ can be reformulated as $\hat{\lambda} = \frac{\hat{D}_{HR} - \left(\frac{p_{LR}\Psi_{LR} - p_{HR}\Psi_{HR}}{p_{LR} - p_{HR}}\right)}{\hat{D}_{HR} - \hat{D}_{LR}}$. The total debt repayment D^*, for which the IB is indifferent between portfolio LR and HR, is given by: $p_{LR}(\Psi_{LR} - D^*) = p_{HR}(\Psi_{HR} - D^*) \longrightarrow D^* = \frac{p_{LR}\Psi_{LR} - p_{HR}\Psi_{HR}}{p_{LR} - p_{HR}}$. Using that formulation for D^* in $\hat{\lambda}$, it follows that: $\hat{\lambda} = \frac{\hat{D}_{HR} - D^*}{\hat{D}_{HR} - \hat{D}_{LR}}$. By assumption in region B, we have $\hat{D}_{HR} > \hat{D}_{LR}$ and $\hat{D}_{LR} < D^* < \hat{D}_{HR}$, and therefore follows that $0 < \hat{\lambda} < 1$. If $\lambda > \hat{\lambda}$, then the total debt repayment $\hat{D}^{\lambda}$ decreases, because $\frac{\partial \hat{D}^{\lambda}}{\partial \lambda} < 0$. Therefore, we have $E(\Pi_{LR}) \geq E(\Pi_{HR})$ for $\lambda \geq \hat{\lambda}$, and the IB chooses optimally portfolio LR. In that case the CRA issues a credit rating $r = g$. Institutional investors are allowed to invest. Other external investors, proportion $(1 - \lambda)$, anticipate that the IB chooses portfolio LR, and therefore rationally require $\hat{D}_{LR}$. The total debt repayment is therefore given by $\hat{D}^{\lambda} = \hat{D}_{LR}$ and the expected profit of the IB is given by $E(\Pi_{LR}) = p_{LR}\left(\Psi_{LR} - \hat{D}_{LR}\right)$. If $\lambda < \hat{\lambda}$, then the proportion of institutional investors is too small to induce the IB to choose portfolio LR. The decision of the IB depends on the expectations of the other external investors, proportion $(1 - \lambda)$. Multiple equilibria are still possible. In that case, the CRA issues a bad credit rating $r = b$, institutional investors therefore are not allowed to invest. In that case, the total debt is provided by other external investor, which form their expectations independent from a credit rating. Multiple equilibria are still possible.■

Proof of proposition 8. The critical proportion of institutional investors is given by $\hat{\lambda} = \frac{\hat{D}_{HR} - D^*}{\hat{D}_{HR} - \hat{D}_{LR}}$, with $\hat{D}_{HR} = D_{HR} + \frac{\theta^{IB}}{p_{HR}}$, $\hat{D}_{LR} = D_{LR} + \frac{\theta^{IB}}{p_{LR}}$ and $D^* = \frac{p_{LR}\Psi_{LR} - p_{HR}\Psi_{HR}}{p_{LR} - p_{HR}}$. An increase in the credit quality p_{LR} of portfolio LR leaves $\hat{D}_{HR}$ unchanged: $\frac{\partial \hat{D}_{HR}}{\partial p_{LR}} = 0$. For $\hat{D}_{LR}$ follows that $\frac{\partial \hat{D}_{LR}}{\partial p_{LR}} < 0$, since $\hat{D}_{LR} = \frac{d}{p_{LR}} + \frac{\theta^{IB}}{p_{LR}}$

and $\frac{\partial \hat{D}_{LR}}{\partial p_{LR}} = -\frac{1}{p_{LR}^2}\left(d + \theta^{IB}\right) < 0$. For D^*, we have

$$\frac{\partial D^*}{\partial p_{LR}} = \frac{(1 - p_{LR})\,\Psi_{LR} + p_{HR}\Psi_{HR}}{(p_{LR} - p_{HR})^2} > 0.$$

Therefore, the denominator of $\hat{\lambda}$ decreases, whereas the nominator increases. From this follows that $\frac{\partial \hat{\lambda}}{\partial p_{LR}} < 0$. An increase of the credit quality p_{LR} leads to a reduction of $\hat{\lambda}$ and a reduction of p_{LR} to an increase of $\hat{\lambda}$. An increase in the amount of debt finance leads to an increase of $\hat{D}_{LR}$ and $\hat{D}_{HR}$: $\frac{\partial \hat{D}_{LR}}{\partial d} = \frac{1}{p_{LR}} > 0$ and $\frac{\partial \hat{D}_{HR}}{\partial d} = \frac{1}{p_{HR}} > 0$. Therefore, we have for $\hat{\lambda}$:

$$\frac{\partial \hat{\lambda}}{\partial d} = \frac{\frac{1}{p_{HR}}\left(\hat{D}_{HR} - \hat{D}_{LR}\right) - \left(\hat{D}_{HR} - D^*\right)\left(\frac{1}{p_{HR}} - \frac{1}{p_{LR}}\right)}{\left(\hat{D}_{HR} - \hat{D}_{LR}\right)^2}.$$

Rearranging leads to $\frac{\partial \hat{\lambda}}{\partial d} = \frac{D^*\left(\frac{1}{p_{HR}} - \frac{1}{p_{LR}}\right)}{\left(\hat{D}_{HR} - \hat{D}_{LR}\right)^2}$. We assume that $p_{LR} > p_{HR}$, and therefore follows that $\frac{\partial \hat{\lambda}}{\partial d} > 0$.■

Proof of proposition 9. (i) The critical fraction of institutional investors is given by equation (24'):

$$\hat{\lambda} = \frac{D_{HR} - D^* + \frac{1}{p_{HR}}\theta^{IB}}{D_{HR} - D_{LR} + \frac{1}{p_{LR}}\left(\frac{p_{LR} - p_{HR}}{p_{LR}}\right)\theta^{IB}}.$$

The partial derivative with respect to the rating fee θ^{IB} is given by: $\frac{\partial \hat{\lambda}}{\partial \theta^{IB}} = \frac{\frac{1}{p_{HR}}\left[D_{HR} - D_{LR} + \frac{1}{p_{LR}}\left(\frac{p_{LR} - p_{HR}}{p_{LR}}\right)\right] - \left(D_{HR} - D^* + \frac{1}{p_{HR}}\theta^{IB}\right)\left[\frac{1}{p_{LR}}\left(\frac{p_{LR} - p_{HR}}{p_{LR}}\right)\right]}{\left(D_{HR} - D_{LR} + \frac{1}{p_{LR}}\left(\frac{p_{LR} - p_{HR}}{p_{LR}}\right)\theta^{IB}\right)^2}$, rearranging leads to

$$\frac{\partial \hat{\lambda}}{\partial \theta^{IB}} = \frac{\frac{1}{p_{HR}}\left(D_{HR} - D_{LR}\right) - \frac{1}{p_{LR}}\left(D_{HR} - D^*\right)}{\left(D_{HR} - D_{LR} + \frac{1}{p_{LR}}\left(\frac{p_{LR} - p_{HR}}{p_{LR}}\right)\theta^{IB}\right)^2}.$$

Because $\frac{1}{p_{HR}} > \frac{1}{p_{LR}}$ and $D_{HR} > D^* > D_{LR}$, it is obvious that $\frac{1}{p_{HR}}(D_{HR} - D_{LR}) > \frac{1}{p_{LR}}(D_{HR} - D^*)$, and therefore, $\frac{\partial \hat{\lambda}}{\partial \theta^{IB}} > 0$.

(ii) In region A, the IB would always choose portfolio HR, if $p_{LR}\left(\Psi_{LR} - \hat{D}_{LR}\right) < p_{HR}\left(\Psi_{HR} - \hat{D}_{LR}\right)$, which is the case, if p_{LR} is sufficiently small: $p_{LR} < \underline{p}_{LR}$. An increase of the rating fee θ^{IB} leads to an increase of debt repayment $\hat{D}_{LR}$: $\frac{\partial \hat{D}_{LR}}{\partial \theta^{IB}} > 0$. Therefore, the condition for region A is already satisfied for larger credit qualities $p_{LR} < \underline{p}'_{LR}$ with $\underline{p}_{LR} < \underline{p}'_{LR}$. In region C, the IB would always choose portfolio LR, if $p_{LR}\left(\Psi_{LR} - \hat{D}_{HR}\right) \geq p_{HR}\left(\Psi_{HR} - \hat{D}_{HR}\right)$, which is the case, if p_{LR} is sufficiently large: $p_{LR} > \bar{p}_{LR}$. Again, an increase of the rating fee θ^{IB} leads to an increase of debt repayment $\hat{D}_{HR}$: $\frac{\partial \hat{D}_{HR}}{\partial \theta^{IB}} > 0$. Therefore, the condition for region C is after an increase of the rating fee only satisfied for higher credit qualities than before: $p_{LR} > \bar{p}'_{LR}$, with $\bar{p}_{LR} < \bar{p}'_{LR}$. From this follows that the range of region A increases, while the range of region C decreases (see figure 4.2).■

Proof of proposition 10. If the rating fee is charged from institutional investors, the critical proportion of institutional investors is given by

$$\tilde{\lambda} = \frac{(p_{LR} - p_{HR}) D_{HR} - (p_{LR}\Psi_{LR} - p_{HR}\Psi_{HR})}{(p_{LR} - p_{HR})(D_{HR} - D_{LR}) - \left(\frac{p_{LR} - p_{HR}}{p_{LR}}\right)\theta^{II}}.$$

Since the rating fee shows up in the nominator, if follows directly that $\frac{\partial \tilde{\lambda}}{\partial \theta^{II}} > 0$. If instead the rating fee is charged from the IB (see also equation (24)), the critical λ is given by:

$$\hat{\lambda} = \frac{(p_{LR} - p_{HR}) D_{HR} - (p_{LR}\Psi_{LR} - p_{HR}\Psi_{HR}) + \left(\frac{p_{LR} - p_{HR}}{p_{HR}}\right)\theta^{IB}}{(p_{LR} - p_{HR})(D_{HR} - D_{LR}) + \left(\frac{p_{LR} - p_{HR}}{p_{HR}}\right)\left(\frac{p_{LR} - p_{HR}}{p_{LR}}\right)\theta^{IB}}.$$

The critical λ is equal in both cases, if $\tilde{\lambda} = \hat{\lambda}$. Using $\theta \equiv \theta^{IB}$ and $\theta^{IB} = \lambda\theta^{II}$, it follows that equality of the LHS and the RHS is satisfied for the critical rating fee $\theta^* = \frac{p_{LR}}{p_{LR}-p_{HR}} [p_{LR}(\Psi_{LR} - D_{LR}) - p_{HR}(\Psi_{HR} - D_{LR})]$. In region B, it is assumed that $p_{LR}(\Psi_{LR} - D_{LR}) > p_{HR}(\Psi_{HR} - D_{LR})$, and therefore $\theta^* > 0$. Case 1: For $\theta < \theta^*$ follows that $\tilde{\lambda} < \hat{\lambda}$; in that case the rating fee should optimally be charged from institutional investors, because a lower proportion of institutional investors is needed to fix the good equilibrium. Case 2: For $\theta > \theta^*$ follows that $\tilde{\lambda} > \hat{\lambda}$. Only case 1 is relevant, because for using $\theta = \theta^*$ in the equation for $\tilde{\lambda}$ or $\hat{\lambda}$ follows that $\lambda = 1$. If $\theta > \theta^*$ credit ratings no more are able to act as a coordination mechanism since in that case we would have $\lambda > 1$. ■

5 Concluding Remarks to Chapters 3 and 4

The last two chapters emphasized that CRAs and their credit ratings are able to play an important role in financial markets and that their prominent role in todays financial markets is therefore justified. The models in both chapters focused on the interaction between a representative issuer of a debt instrument, a representative CRA, and external investors. The model, presented in chapter 3, motivated the useful role of credit ratings by reducing misallocated investment. Credit ratings were assumed play an active role by providing additional information to market participants, which led to an increase in social welfare. The model, presented in chapter 4, motivated the valuable effect of credit ratings by showing that they may act as a coordination mechanism in the presence of multiple equilibria and thus increase financial market stability. In that chapter, the CRA played a beliefs coordinating, but rather passive role.

Besides the valuable positive effects for financial markets CRAs are able to create, both chapters addressed different points of criticism CRAs were repeatedly confronted with over the last years, namely: inaccurate credit ratings, conflicts of interest and the market dominating position of some few CRAs. The rationale for regulatory intervention in chapter 3 was derived by moral hazard aspects due to unobservable rating quality and conflicts of interest, while adverse consequences of the market structure in the CRA market were largely excluded. Chapter 4 concludes that inefficiently high rating fees over the competitive level restrict the valuable role of credit ratings for financial market stability, while the model excludes moral hazard aspects and conflicts of interest.

Although the chapters 3 and 4 concentrate on different aspects concerning which role CRAs actually play and concerning regulation, the policy implications that

could be derived by both approaches are highly relevant and complementary. Anecdotal evidence shows that the CRA industry is very concentrated (three CRAs possess about 96% market share) and the possibilities of market entry for new competitors are limited. While reputation is one entry barrier for competitors, market entry is also limited by regulatory recognition. As already mentioned in chapter 1 the world's leading CRAs earn very high, quasi-monopoly profits. Additionally, CRAs very often have been criticized in the past for issuing inaccurate credit ratings - presumably because of too low rating quality and conflicts of interest. Combining the results of the models in both papers, one recommendation for regulatory authorities (from chapter 4) should be to simplify market entry in order to promote competition, which would lead to lower rating fees and possibly to higher rating quality. Additionally, chapter 3 concludes that regulatory minimum rating standards and a monitoring of potential conflicts of interest should be introduced. This would help to amplify the accuracy and reliability of credit ratings and therefore increase the social value of credit ratings. Since both chapters concentrated on the interaction between the rated debt issuer, the CRA, and external investors, strategic interactions in the CRA sectors were excluded from the analysis. Interesting questions regarding future research would be for example the market entry and exit of CRAs, collusion between CRAs, or the optimal size of the CRA sector, and their implications for regulation.

Some steps in the direction towards the policy recommendations of the last two chapters was recently made in the USA by the "CRA Reform Act 2006" with the goal to promote competition and to simplify market entry for competitors (see CRA Reform Act, 2006). The international organization of security commissions[61] (IOSCO) released in 2004 a code of conduct fundamentals for CRAs with the purpose

[61] Financial regulators of over one hundret countries are affiliated with the IOSCO.

to "promote investor protection by safeguarding the integrity of the rating process" (see IOSCO, 2004). A review of the functional implementation in IOSCO (2007) showed that the big CRAs largely follow the provisions of the code of conduct, but unfortunately partially deviate from provisions as to the reduction of conflicts of interest.[62] After the subprime loan crisis in 2007 the IOSCO recently modified the code of conduct by including the prohibition of the joint provision of advice on the design of structured products and rating of the same product (see IOSCO, 2008). It remains to be seen whether the voluntary adoption of a code of conducts and the self-healing of the CRA industry is sufficient to restore and strengthen the trust in credit ratings or whether national regulators will have to intensify and enlarge regulations and laws for CRAs.

[62] For example some CRAs do not disclose their compensation arrangements with rated entity with regards the proportion of non-rating fees and rating fees. This provision of the IOSCO code of conduct was meant to help investors to determine whether non-rating fees, such as consulting fees, are high enough to call into question the analytical independence of the CRA. Other CRAs deviate from the provision to prevent that employes are involved in the rating process and in negotiations regarding payment and fees - especially in structured finance products. (see IOSCO, 2007)

Part III

Economics of Banking

6 Costly Bank Capital - Demand and Supply Side Considerations[63]

6.1 Introduction

The real-life observation of costly bank capital has inspired economic theorists to develop models where the cost arises from the specific liquidity creation function of the bank. Very often, these modelling approaches result in the corner solution of the regulatory capital requirement, which collides with the actual amount of capital held in banks[64]. As a consequence, a lot of theoretical literature concentrates on the optimal capital adequacy regulation, as well as on the ability of regulators to enforce the rules. However, banks seem to hold more capital than required, in particular in less developed countries. This raises the question of a possible trade-off in the bank's capital decision.

This chapter asks what drives the capital decision of a bank and, in particular, whether supply side restrictions play a determinant role. In doing so, we directly take a stand in the theoretical debate on bank capital determination. Whereas Diamond & Rajan (2000, 2001) stress the asset side, Gorton & Winton (1995, 2000) derive a relation between the cost of capital and the heterogenous liquidity needs of consumers that buy bank shares. On the other hand, Milne & Whalley (2001) and

[63] This chapter is based on joint work with Katri Mikkonen.
[64] See e.g. Bolton & Freixas (2000) and Hellman & al. (2000).

Milne (2002) argue that the penalty of breaching the regulatory minimum capital level induces banks to hold buffers above the requirement, implying that regulation drives the bank capital decision after all.

Earlier empirical literature has almost entirely concentrated on the demand side factors in determining bank capital. In contrast, we investigate whether supply side restrictions may play a role in a given market, using both balance sheet data of multinational banks and market data. As the market of operation of the foreign units usually differs from the market where the multinational bank acquires its capital, we use multinational banks as a means to separate the supply side factors from those of the demand side.

We test the determinants of bank capital in the eight Central and Eastern European and Baltic countries (CEB) that have recently joined the EU. Due to the high presence of multinational banks, these markets serve as a good testing environment. Summary statistics first show that there is a robust difference between the capital ratios in domestic and foreign banks in those countries, indicating that the supply side may matter. We then limit our sample to multinational banks and run panel regressions on their capital. Explanatory variables include both bank- and market-specific factors. We find evidence that factors related to the country of origin play a role in bank capital determination in the CEB countries.

Finally, we are able to give some tentative policy conclusions. Multinational banking, even in the form of subsidiaries, may improve stability in markets with strong capital supply restrictions. However, the motives driving foreign direct investment may change as soon as the difference between the home and host capital markets becomes smaller. Therefore, our conclusion shall not be taken as a universal, one-size-fit-it-all rule, but as applying for specific types of markets.

This chapter is organized as follows: First, section 6.2 gives an overview of the related empirical literature. Section 6.3 then presents the different implications of the theories of liquidity provision. Section 6.4 describes the banking sector in the CEB region and the data used, and section 6.5 presents some descriptive statistics. Section 6.6 introduces the model specification used in the regressions. The regression results are summarized in section 6.7. Finally, section 6.8 concludes.

6.2 Related Literature

Earlier empirical literature has almost entirely concentrated on the demand side factors in determining bank capital. For example, Altunbas et al. (2000) and Barrios & Blanco (2003) find empirical evidence on the significance of bank specific, solvency related factors for Spain, Yu (2000) for Taiwan, and De Bondt & Prast (1999) for five European Union (EU) countries and for the US. In addition, the first two papers show that regulatory pressure seems to matter in Spain. However, none of the above mentioned contributions control for factors linked with the shareholder characteristics. As to the US, Marcus (1983), and Benston et al. (2003) later on, find evidence that the tax treatment of capital items and deposits has had a significant effect on the amount of bank capital; but again, the institutional environment in their study affects the demand of capital by the banks, not the supply by the shareholders. Finally, Saunders & Wilson (1999) find indirect evidence for the existence of heterogenous investors, and therefore, for the importance of the distribution of shareholders and depositors. In particular, the overall risk seems to have remained stable during the long decline in bank capital and the introduction of safety nets over the past century, whereas the distribution of risk has strongly shifted towards equity. This implies that the agents holding equity and deposits have strongly differ-

ent preferences, and that it may matter how these preferences are distributed across economies. A recent study by the European Central Bank (see ECB, 2007) analyzes the determinants of bank capital in publicly traded banks in Europe and the US. The authors find evidence that standard determinants of firm leverage are also able to explain capital ratios of large banks in the EU and the US. In particular, the capital decision of banks seems not to be driven by regulatory capital requirements, but rather result from an optimizing behavior similar to that of non-financial firms. But again, the study concentrates on the demand side and does not directly control for factors linked with the supply side of bank capital**.** Flannery & Rangan (2004) find evidence that the increase in capital holdings of US banks can be explained by greater risk exposures of banks and the increased demand of the market that the default risk of large banks to be priced.

Theoretical literature on multinational banks has not so far profoundly investigated the bank capital question. Indeed, most contributions either ignore capital, or impose a binding minimum capital requirement. This is understandable due to the quickly increasing complexity of multinational banking models. Repullo (2001) considers the determinants of international takeovers and finds out that a takeover is more likely the smaller is the target bank and the riskier its investments are relative to the parent bank. Moreover, a takeover is almost always welfare improving. However, as there is no bank capital in the model, liquidity aspects cannot play any role. Loranth & Morrison (2003) model minimum bank capital requirements in a multinational setting and show how they can lead to underinvestment due to their impact on the value of deposit insurance. However, they as well assume that banks cannot draw any utility from bank capital. Finally, in a rare effort to endogenously model capital of a multinational bank, Mikkonen (2006) shows that with restrictions on the supply side, multinational banks in general have more capital

than domestic ones, and that they may appoint more capital to the subsidiary than it had before the takeover, if the difference between the financial market conditions is large enough. The conclusion serves as an inspiration for the empirical work of this paper.

6.3 Capital Costs, Demand, and Supply

Besides the exogenously motivated capital buffer explanation of Milne & Whalley (2001) and Milne (2002), two complementary theories of endogenous bank capital formation have recently emerged from the liquidity creation function of banks. Whereas the Diamond & Rajan (2000, 2001) line of thought emphasizes the information problems in the market for bank loans, Gorton & Pennacchi (1990) and Gorton & Winton (1995) derive the cost of bank capital from information problems and heterogenous investors in the bank capital market. Since each framework produces distinguishable predictions as to our empirical results, they are explained more in detail in this section.

Diamond & Rajan (2000, 2001) show that a bank as an institution can solve the double hold-up problem related to the investment decision of the agent. The first hold-up is caused by the borrowing firm that has specific skills and can therefore threaten to withdraw from the project. This can be alleviated through relationship lending, namely by delegating monitoring of the firm to an experienced lender, the bank. However, since the bank, the so-called relationship lender, gains specific loan collection skills, it can extract rents from its shareholders through renegotiation, which gives rise to the second hold-up problem. This in turn can be prevented via the introduction of a collective action problem of non-insured, uncoordinated depositors that face a sequential service clause.

6. COSTLY BANK CAPITAL - DEMAND AND SUPPLY

The basic trade-off between bank capital and deposits in Diamond & Rajan (2000) can be expressed as follows: More capital increases the rents extracted by the bank and therefore decreases the amount the bank is able to raise and invest. Deposits, for their part, alleviate the rent extraction problem, on the one hand, but increase the probability of inefficient liquidation of the bank in presence of uncertainty on asset values, on the other[65]. The theory predicts higher bank capital levels in bank credit markets that are less developed, less transparent, and small in size. In particular, Diamond and Rajan (2000) assume that there is no aggregate shortage of liquidity or capital, and that the distribution of investors' endowments is not critical. Therefore, the supply side does not play a role here.

In contrast, the Gorton & Winton (1995) general equilibrium model derives the cost of capital from the bank capital markets. As in Gorton & Pennacchi (1990), capital is informationally sensitive, and because information is costly, there are both informed and non-informed traders in the market. The coexistence of risk and private information results in a lemons cost of capital, and there is a trade-off between this cost, on the one hand, and the risk of bank failure, on the other.

Unlike in Diamond & Rajan (2000), the distribution of shares matters in Gorton & Winton (1995). In particular, as consumers have heterogenous needs for liquidity, the magnitude and distribution of these needs now determine the cost of capital. For example, a wealthier shareholder population may have less compelling liquidity needs than a poorer one. As a consequence, the characteristics of the shareholders make a difference as to at which price the bank is able to raise capital, in addition to the characteristics of the market where the bank operates. The theory predicts higher bank capital levels in bank capital markets where liquidity needs of shareholders are

[65] Please note that the mechanism presumes that at least some deposits remain outside the deposit insurance.

low and uncertainty is high.

It is now clear why the comparison of the two sources of capital costs becomes particularly interesting in the case of multinational banks. If the factors related to the demand side dominate, the conditions in the market of operation determine the cost of capital. However, if the supply side shows some influence, the conditions in the market of origin shall play a role. Furthermore, the influence of the supply side factors may raise some interesting stability conclusions, as shown in Mikkonen (2006). The model studies the bank capital of multinational banks and finds out that multinational banks have more capital than domestic banks when the differences in capital market conditions are the most pronounced. Interestingly, this coincides with the case where the presence of multinational banks tends to be stability improving for the host country. In the following, we therefore ask two related questions: First, in the sample of multinational banks, do home rather than host market characteristics matter? This would help us find evidence for the two distinguishable aspects of bank capital formation mentioned above. And second, in the sample of all banks, do multinational banks have more capital than domestic ones? This would lead to stability conclusions.

6.4 CEB Banking Sector and the Dataset

The bank panel consists of the balance sheet data of 37 domestic banks and 44 subsidiaries of multinational banks in the five Central and Eastern European countries[66] and the Baltic states[67] (those are abbreviated by the term CEB countries in the following), for the time period of 2001 to 2005[68]. By limiting the time period, we

[66] Poland, Czech Republic, Slovak Republic, Hungary, Slovenia.

[67] Latvia, Lithuania, and Estonia.

[68] For some banks, the database misses some observations, and we thus have an unbalanced panel. Please note, however, that this is simply due to inaccurancies and difficulties in data collection and

wish to avoid transitional effects that were still prevalent in the 1990s. The selected banks comprise at least 80 per cent of total bank assets in each country. Most of the multinational banks in the sample originate from the 15 old EU member countries (EU-15)[69]. Multinational banks not only operate in a subsidiary but also in a branch structure in the CEB countries, whereby the subsidiary structure by far dominates.[70] Since the bank assets are pooled in the branch case and separated in the subsidiary case, we included only multinational bank subsidiaries in our dataset for reasons of data availability. Compared to the EU-15 countries, the banking sectors in the CEB countries are relatively small and the degree of intermediation rather low (see ECB, 2005). After several bank failures and systemic crises in the mid-1990s, a period of restructuring and privatization of the banking sector followed, and foreign banks entered the market. By the start of our dataset in 2001, most banks were already privatized, with multinational bank subsidiaries dominating the banking sectors. Figure 6.1 shows the assets of multinational bank subsidiaries in per cent of total bank assets in the economy in the time period from 2001 to 2005. Apart from Slovenia and Latvia, foreign banks own over 70% of total bank assets. This ratio even exceeds 90% in Estonia, Lithuania and Slovakia. Until today, multinational banks only play a minor role in Slovenia. During the considered time period, the restructuring and privatization of the Slovenian banking sector was not yet as progressed as in the other countries in our dataset, and foreign bank entry was still heavily regulated. By the beginning of the period under consideration, CEB banking sectors had become broadly competitive. Regarding regulation of the banking sector, all countries in the dataset apply deposit insurance and capital adequacy

not due to bankruptcies or the like that would require further examination.

[69] Apart from multinational banks with their headquarters in the EU-15, the panel includes four subsidiaries originating from the US.

[70] For a compact overview on the banking structure in the EU see for example ECB (2005).

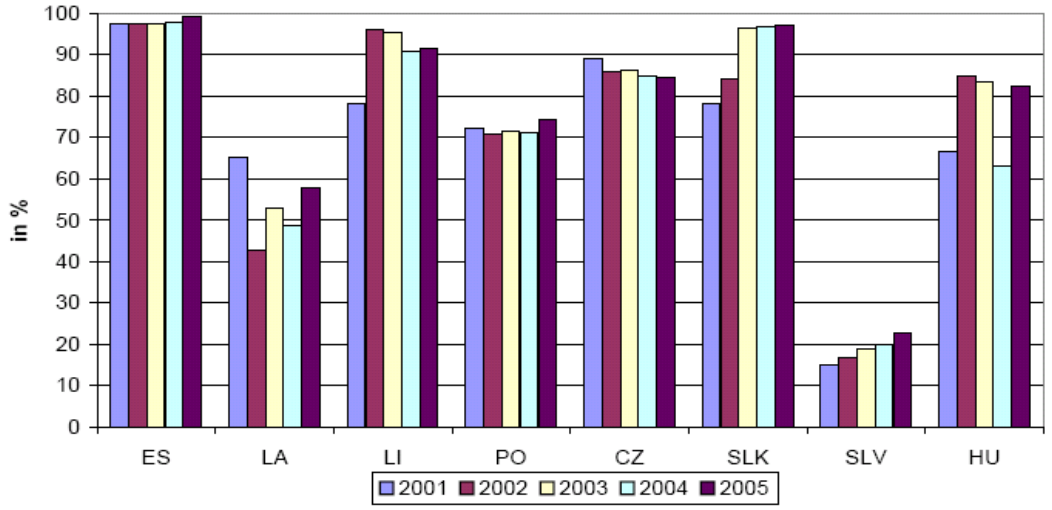

Figure 6.1: Ratio of foreign owned bank assets to total bank assets. Data source: EBRD (2006). (ES: Estonia, LA: Latvia, LI: Lithuania, PO: Poland, CZ: Czech Republic, SLK: Slovak Republic, SLV: Slovenia, HU: Hungary)

regulations.[71]

Our aim is to find determinants for the amount of capital a bank decides to hold. Especially, we are interested to discriminate between factors related to the demand and supply sides of bank capital. As already emphasized in the previous section, multinational banks serve as ideal testing candidates for that task. The reason behind this is straightforward. For multinational bank subsidiaries, the market of the source of bank capital, which is mainly the home country of their parent banks, is different from the market where those banks operate. Therefore, factors that affect the level of bank capital can be separated by using data referring to the demand (market of operation) and supply (market of origin) sides of bank capital. The variables with potential explanatory power in our dataset can be grouped into macro variables, on the one hand, and individual balance sheet items, on the other. To begin with, the macro variables include GDP per capita, different stock market measures, and the share of bad loans in host and home countries. GDP per capita

[71] see EBRD (2006).

and the different stock market measures are linked with the wealth and liquidity of the respective markets, and are therefore important determinants, when it comes to separating the effects of supply and demand side factors. The amount of bad loans in the economy approximates the informational asymmetries within the market in question, and a bank concentration variable captures the characteristics of the market structure in the CEB countries. Second, we use bank level data as to the origin of the bank, assets, loans, deposits, and returns. In particular, the market share of the bank approximates the charter value of the bank. These factors are to capture the effects of the bank specific business case, which are related to the demand side.

6.5 Descriptive Statistics

Figure 6.2 shows the distribution of the equity asset ratios (EAR) of the multinational bank subsidiaries and the domestic banks in our sample. For the calculation of the variable EAR, we use the ratio of book-equity to book-assets, which is taken from the balance sheets of the banks. Book-equity consists of equity capital plus disclosed reserves and retained earnings, and can be interpreted as the real economic capital of the bank. Our measure of capital complies henceforth with the classifications 'core capital' or 'Tier 1 capital', which are used in the Basel I and II guidelines (see BIS, 1998). The diagram covers 350 bank-year observations in our sample from 2001 to 2005. Even though a difference in the distributions of the capital ratios between the two groups is not obvious immediately, the distribution of EARs can already give some insights on the influence of capital regulation on the capital decision of banks. According to the Basel Capital Accord (Basel I), the

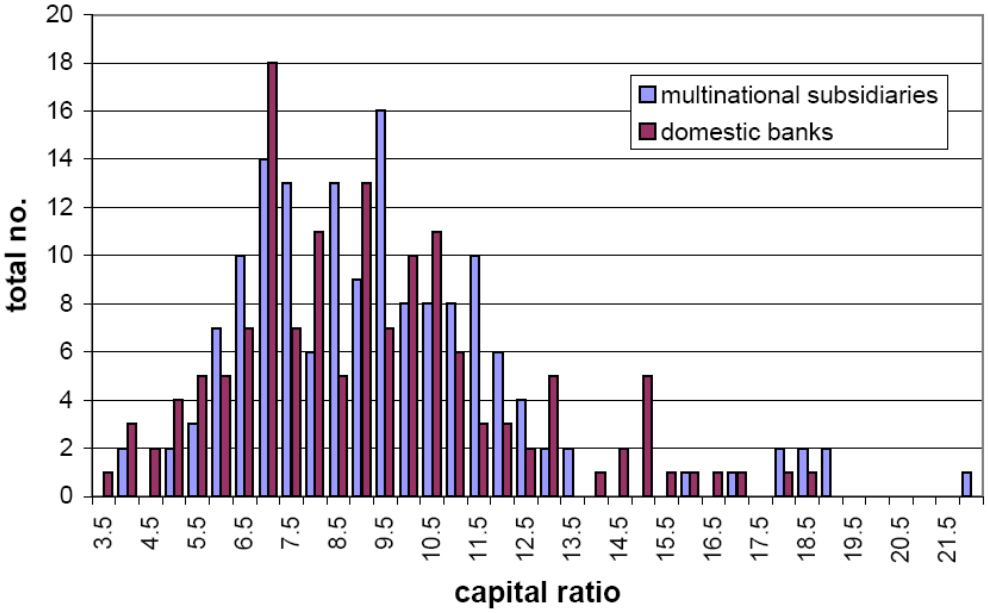

Figure 6.2: Distribution of capital ratios (EAR). Data source: Bank balance sheets from the banks' annual reports.

minimum regulatory capital ratio is 4%.[72] This regulatory minimum is calculated as Tier 1 capital divided by risk-weighted assets - whereas assets are split into three asset classes with weights of 0, 0.5 and 1. In the EARs, which are illustrated in figure 6.2, all book assets are weighted with 1. Therefore, our EAR is a more conservative measure compared to the Basel I minimum capital requirement. The mean EAR in our sample is 8.7% for domestic banks and 9.3% for multinational bank subsidiaries (see also table 6.1). Even with employing EAR as a measure of bank capital, the banks in our sample clearly hold substantially more capital than is required by regulation. Consequently, this finding contradicts the theoretical view that the capital decision of a bank is predominantly influenced by capital regulation.[73] Instead, the distribution of EAR points to a trade-off in the capital decision that depends on other influencing factors than regulation.

[72] The more commonly used minimum capital ratio of 8% is calculated under consideration of Tier 1 and Tier 2 capital (see BIS, 1998). All countries in our dataset, except Estonia (10%) and Slovenia (10.6%), require a minimum capital adequacy ratio of 8%.

[73] see for example Mishkin (2004).

Our first exercise is to analyze whether there is a difference between the amounts of capital that domestic banks and multinational subsidiaries hold. The reason for this is twofold: First, a possible difference between the two samples serves as an indicator that adding the supply side factors into the panel regressions may add some value vis-à-vis the existing empirical literature on bank capital. Second, as explained in Section 6.3, this will inform us on the stability properties of the multinational banks in a given market.

Group	Obs	Mean	Std. Dev.	min	max
Domestic	137	8.677	2.778	3.35	18.24
Multinational	213	9.315	3.504	2.08	28.02
Combined	350	9.065	3.250	2.08	28.02

Table 6.1: Summary statistics EAR groups.

Table 6.1 contains the summary statistics as to the EAR of the domestic and multinational banks in the pooled sample. Looking at the summary statistics, we see that the EAR seems to be systematically lower for the domestic than for the multinational banks in the sample. In order to investigate whether the difference in the EARs of multinational and domestic banks is significant, we perform a t-test on the equality of means and a two-sample Kolmogorov-Smirnov test on the equality of distributions of the two groups in our sample. The results are presented in Appendix 6.A . The t-test confirms the impression of differing means at a five per cent significance level. The result shows that subsidiaries of multinational banks tend to have a significantly higher equity-asset ratio than domestic banks in our sample. The Kolmogorov-Smirnov test result is not so clear-cut. Interestingly, excluding the banks in Slovenia from our sample improves the significance of the test result to a five per cent level, corroborating the result that the EAR for the group of multinational subsidiary banks contains larger values than the group of domestic banks in our sample. This might reflect the position of Slovenia as an outlier in our

sample: Until recently, international banks in Slovenia played rather a minor role, due to heavy regulation of entry.

The somewhat significant result is, nevertheless, the first indication towards acknowledging that the supply side might have some importance after all in the determination of bank capital. Indeed, if only factors related to the demand side mattered, there would be no reason for the amount of capital the bank holds to differ depending on whether the bank is multinational or domestic.

As in Mikkonen (2006), higher capital ratios of multinational banks may indicate large differences as to the supply of equity funding in the home and the host markets. Taking a closer look at the stock market total value traded to GDP ratio (SMG) and the GDP per capita ($GDPc$) in the home and host countries in the sample of multinational banks reveals a large difference between the two markets, in particular if we consider the situation in the beginning of the time span of the data set. Table 6.2 shows the summary statistics of 213 bank-year-observations of SMG and $GDPc$ for the host and home countries of the multinational banks in our sample. The

	Obs	Mean	Std. Dev.
$GDPc_{home}$	213	27158.03	5251.67
$GDPc_{host}$	213	6873.53	2411.01
SMG_{home}	213	0.689	0.613
SMG_{host}	213	0.064	0.068

Table 6.2: Summary statistics GDPc, SMG.

means of SMG and $GDPc$ are substantially higher for home than for host countries. In Mikkonen (2006), foreign subsidiaries of multinational banks have more capital than the domestic banks operating in the same market, if differences in capital market conditions are large enough. Taking SMG and $GDPc$ as a measure for capital market conditions, the difference in means of both SMG and $GDPc$ in the home and the host market as well as the difference in capital asset ratios (EAR)

of multinational subsidiaries and domestic banks in our sample speaks in favour of this conclusion.

6.6 Model Specification

In order to analyze the influence of supply and demand side conditions on the capital choice of banks in a given market, we restrict our analysis by considering multinational bank subsidiaries only. The reason for that proceeding is the following. As already described in section 6.4, the market of the source of capital is often different from the market of operation for multinational bank subsidiaries, whereas the domestic banks operate and raise capital in the same market. As the explanatory market variables simultaneously influence the demand and supply of bank capital in the case of domestic banks, an identification problem is not present in the case of multinational bank subsidiaries arises. In the following, we regress the measure of bank capital in multinational bank subsidiaries on factors that are related with the subsidiary itself, with the parent bank, and with the macroeconomic conditions both in the home and host markets. Using the company fixed effects, our baseline panel regression has the following form:

$$(C - measure)_{it} = \alpha + \beta B_{it} + \gamma M_{it} + \upsilon_k + \upsilon_t + \varepsilon_{it}$$

The C-measure denotes the dependent bank capital variable of a multinational subsidiary i, which is owned by a certain parent bank k in period t.[74] As the dependent variable, we use the book-equity to book-assets ratio (EAR) of the multinational bank subsidiary. ECB (2007) analyzes the determinant of bank capital for

[74] In our dataset, there is no bank subsidiary with differing parent banks during the period of consideration. Therefore, it is not necessary to include an index k in the regression equation for the dependent variable and the explanatory variables B and M.

US and EU-15 banks by using book-equity to book-asset ratios (EAR) and market-equity to book-asset ratios for robustness reasons. Their results are robust for both variables. Because of lack of data availability, we restrict our analysis by considering EARs as the dependent variable only.

The explanatory variables are separated into two groups, where B_{it} denotes the bank specific variables of bank i in period t, and M_{it} variables related to the home and host markets for each bank i in period t. Again, these two groups can be separated into variables related to the market of origin (which refer to the supply side of bank capital) and variables related to the market of operation (which refer to the demand side of bank capital). Table 6.3 provides an overview of the explanatory

	demand side	supply side
bank level (B)	ROA, ROA_{-1} $mshare$, LAR	$PROA$, $PROA_{-1}$
market level (M)	$NPLhost$, $bcon$	$dGDPc$, $dSMT$, $dSMG$

Table 6.3: Explanatory variables.

variables and their classification. The bank specific factors, referring to the market of operation, include the return on assets after tax (ROA) and its lagged value (ROA_{-1}). According to the pecking-order theory (see Myers, 1984), more profitable banks should tend to hold more equity. The lagged return in particular is to control for the possible effect of internal financing in terms of accumulated wealth. As a supply side factor**,** we also control for the return on assets after tax of the parent bank ($PROA$) and its lagged value ($PROA_{-1}$), since the capital decision of a bank subsidiary may be influenced by the parent bank. The variable $mshare$ denotes the market share (single bank's total assets divided by total bank assets in the market) of a foreign subsidiary in the market of operation and is used as a measure of the bank size. In theory, the market share should be negatively related to the amount of

capital banks hold. The reason is on the one hand that due to diversification, larger firms should be safer and therefore prefer to hold more debt. On the other hand, larger banks could tend to hold less capital, if they believe they are "too-big-to-fail". Finally, we use the loans on assets ratio of the multinational subsidiary (LAR) in order to control for the influence of the bank's activities.

The market related factors, which refer to the supply side of bank capital, account for the difference in capital market conditions between the country of origin (i.e. the "home" country) and the market of operation (i.e. the "host" country). Those variables include the difference between the GDPs per capita in the home and host countries ($dGDPc$), the difference in the stock market turnover ratios in the home and host countries ($dSMT$) and the difference in "stock market total value traded to GDP" in the home and host countries ($dSMG$).[75] Those three variables serve as a measure of the supply side influence. Since we interpret the variables $GDPc$, SMT and SMG as proxies for the wealth and liquidity of the market for bank capital, the difference between those variables in the home country and in the host country gives a measure of the difference in capital market conditions between these two markets. Hence, the coefficient will give an idea of the importance of the supply side of bank capital. The three market variables will be used independently in the panel regression in order to check the robustness of the supply side influence on the banks' capital decision in our sample. As a market related factor, referring to the demand side of bank capital, we use the ratio of non-performing loans to total loans in the host market ($NPLhost$). The ratio of bad loans in the host market serves as a proxy for the level of uncertainty in the market of operation. The coefficient of this regressor would give information on a potential desire of the bank to insure itself against inefficient liquidations, as in Diamond & Rajan (2000). In order to control

[75] Data source of dSMT and dSMG is Beck et al. (2000) and the data source of dGDPc is Eurostat.

for specific characteristics of the banking sector in the market of operation (i.e. the individual CEB country), we employ the variable *bcon*. This variable contains information on the market structure of the banking sector, namely the concentration of banks.[76]

Finally, υ_t denotes time specific and υ_k group specific effects for all subsidiaries owned by the multinational bank k. To estimate the specified model, we use fixed effects panel estimation techniques in order to control for unobserved heterogeneity at the parent bank level and across time that may be correlated with the explanatory variables. The intuition of using fixed effects on the parent bank level is that a multinational bank as a whole consists of the parent bank, which operates in the home country, and of its subsidiaries, which operate in host countries. As it is the parent bank which has to resolve the profit maximization problem, it chooses how much capital to hold in the parent bank and in the subsidiaries as well, which may lead to company specific effects not observable to us.[77]

6.7 Results

The results of the panel regressions with $dGDPc$ as the measure for the influence of the supply side for five different specifications are summarized in table 6.4. The only significant coefficients emerging from the fixed effects regressions (1) - (5) are the difference between the GDPs per capita of the home and host markets ($dGDPc$), on the one hand, and the ratio of non-performing loans in the host country ($NPLhost$), on the other. In contrast, no banks specific regressors were significant, neither the

[76] The variable *bcon* contains the assets of the three largest banks as a share of all commercial banks in each CEB country (Data source: Beck et al. (2000)).

[77] Parent banks influence the operations of foreign subsidiaries in the CEB countries for example by providing financial support, setting growth targets or introducing information technology and monitoring systems. (see EBRD, 2006)

size measure $mshare$, the loans to assets ratio (LAR), nor the returns on assets and their lagged values of the subsidiary as well as of the parent bank. The coefficient of the proxy for the market structure ($bcon$) in the host market was insignificant, too. If we consider the GDP per capita as a proxy for the liquidity and wealth

Dep. Var.			EAR		
	(1)	(2)	(3)	(4)	(5)
$dGDPc$	0.00039	0.00041	0.00041	0.00037	0.00041
	(0.00016)**	(0.00015)***	(0.00015)***	(0.00014)***	(0.00015)***
$NPLhost$	0.189	0.190	0.191	0.232	0.189
	(0.060)***	(0.061)***	(0.056)***	(0.057)***	(0.056)***
$PROA$	−1.40	−1.41	−1.42	–	−1.22
	(0.921)	(0.925)	(0.913)		(0.890)
$PROA_{-1}$	0.242	0.331	0.326	–	0.416
	(0.641)	(0.627)	(0.626)		(0.618)
ROA	0.039	0.026	0.030	0.126	–
	(0.404)	(0.392)	(0.359)	(0.357)	
ROA_{-1}	0.074	0.043	0.044	0.125	–
	(0.181)	(0.181)	(0.176)	(0.356)	
$mshare$	−0.014	−0.001	–	–	–
	(0.052)	(0.043)			
$bcon$	2.407	2.541	–	–	–
	(1.833)	(1.836)			
LAR	−0.066	–	–	–	–
	(0.023)				
no. obs.	106	106	106	124	108
R^2	0.406	0.405	0.387	0.358	0.383

***, **, *: significantly different from zero at the 1, 5, 10% level resp., standard errors given in brackets; parent bank and time fixed effects included; robust standard errors.

Table 6.4: Results panel regression.

of the market for bank capital, its significance confirms the importance of home country conditions (i.e. the supply side) as to the capital decision of a multinational subsidiary. The positive coefficient of $dGDPc$ can be interpreted as the higher is the difference between the capital market conditions of the two markets, the more capital the subsidiary will hold after the takeover. The significance of the non-performing loans in the host market confirms the view that higher uncertainty in the market of operation may induce banks to increase capital as an insurance against

inefficient liquidation. The positive coefficient of $NPLhost$ reveals that banks hold more capital if there is higher uncertainty in the market. Therefore, demand side conditions play a role, too. Both observations reveal that banks face a trade-off between costly bank capital and the probability of being allowed to continue their operations and preserve their charter value. As to stability, the first observation reinforces the relation between the stability of a multinational bank and the capital market conditions, as in Mikkonen (2006). The second observation goes in the same direction: if the multinational banks tend to insure themselves against loss of operations in the host market, they are likely to increase stability.

In a next step, we check the robustness of the supply side influence by eliminating $dGDPc$ from the regression specification and instead including first $dSMT$ (difference between stock market turnover ratios in home and host country), and second $dSMG$ (difference between stock market total value traded-to-GDP ratio in home and host country). The results of the regressions (6) and (7) in table 6.5 show that the coefficient of the demand side measure $NPLhost$ remains highly significant with a positive sign. Additionally, the coefficients of the variables $mshare$ and $bcon$ become significant. The negative sign of $mshare$ now confirms the view that larger banks tend to hold less capital. The coefficient of the proxy for the difference in capital market conditions, which is expressed by $dSMT$ in regression (6), is again significant, however with a negative sign. The coefficient reflects that banks hold more capital, if the difference in capital market conditions becomes smaller. Even though the regressions reveal again a significant influence of the supply side, the sign of the coefficient has changed. Therefore, the influence of the supply side goes in the reverse direction. In regression (7), $dSMT$ has been replaced by the variable $dSMG$. Again, the coefficient of $NPLhost$ remains highly significant, confirming the relevance of demand side conditions. The coefficients of the variables $mshare$

Dep. Var.	EAR		
	(6)		(7)
$dSMT$	-3.313	$dSMG$	-4.729
	$(1.495)^{**}$		$(2.601)^{*}$
$NPLhost$	0.366	$NPLhost$	0.328
	$(0.061)^{***}$		$(0.053)^{***}$
$PROA$	-0.881	$PROA$	-1.099
	(1.134)		(1.146)
$PROA_{-1}$	0.211	$PROA_{-1}$	0.744
	(0.664)		(0.841)
ROA	0.192	ROA	0.179
	(0.444)		(0.447)
ROA_{-1}	0.186	ROA_{-1}	0.213
	(0.167)		(0.173)
$mshare$	-0.090	$mshare$	-0.0864
	$(0.044)^{**}$		$(0.043)^{**}$
$bcon$	4.201	$bcon$	3.259
	$(1.883)^{**}$		$(1.813)^{*}$
LAR	-0.025	LAR	-0.022
	(0.020)		(0.021)
no. obs.	106		106
R^2	0.388		0.376

***, **, *: significantly different from zero at the 1, 5, 10% level resp.; standard errors in brackets; parent bank and time fixed effects included; robust standard errors.

Table 6.5: Robutstness check of supply side influence.

and *bcon* remain significant, too. The coefficient of the supply side proxy $dSMG$ is, again, significant with a negative sign. As with $dSMT$, the estimation reveals that a reduction of the difference in capital market condition between home and host country - measured by $dSMG$ - leads to an increase in bank capital.

The opposite influence of our supply side measures with $dGDPc$ on the one side and $dSMT$ and $dSMG$ on the other raises the question which measure is better suitable to capture the influence of the supply side on the capital decision of banks in our sample. A closer look at the dataset reveals that banks with Austrian parent banks seem to be a special case, because the variables $dSMG$ and $dSMT$ for those banks have a negative sign in most cases. Taking $dSMG$ and $dSMT$ seriously as a

measure for the difference in wealth and liquidity between two certain markets, this would mean that wealth and liquidity for example in Slovenia and Slovakia is higher compared to Austria. As one would expect, looking at $dGDPc$ reveals exactly the opposite finding - therefore $GDPc$ seems to be a better measure to capture the wealth of the shareholders. Eliminating banks with Austrian parent banks from our dataset, the regressions with $dSMG$ and $dSMT$ as explanatory variables as to the supply side show positive coefficients, although they are insignificant (see table 6.6, regression (8) and (9)). Repeating the panel regression with $dGDPc$ as a measure for supply-side influence without banks with Austrian parent banks confirms the result of a significant and positive coefficient of the variable $dGDPc$ (see table 6.6, regression (10)). In all three regressions, the coefficient of $NPLhost$ remains highly significant with a positive sign.

Altogether, the empirical analysis shows a robust and significant influence of conditions in the market of operation, which are related with the demand side of bank capital. This finding confirms the view that banks obviously have the desire to insure themselves against inefficient liquidations, as emphasized in Diamond & Rajan (2000). Furthermore, we find partial evidence that conditions in the market of the source of bank capital, which are related to the supply side, also influence the capital decision of banks in our sample. However, the statistically significant influence of the supply side depends on the measure used to capture those effects.

Dep. Var.	EAR					
(8)		(9)		(10)		
$dSMT$	0.481	$dSMG$	1.225	$dGDPc$	0.00152
	(0.936)		(1.398)		(0.0006)**
$NPLhost$	0.204	$NPLhost$	0.214	$NPLhost$	0.196
	(0.053)***		(0.051)***		(0.048)***
$PROA$	−0.462	$PROA$	−0.472	$PROA$	−0.301
	(0.790)		(0.764)		(0.735)
$PROA_{-1}$	0.754	$PROA_{-1}$	0.535	$PROA_{-1}$	0.832
	(0.714)		(0.662)		(0.753)
ROA	0.326	ROA	0.254	ROA	0.173
	(0.459)		(0.476)		(0.493)
ROA_{-1}	0.149	ROA_{-1}	0.139	ROA_{-1}	0.117
	(0.213)		(0.210)		(0.205)
$mshare$	−0.016	$mshare$	−0.019	$mshare$	−0.018
	(0.041)		(0.042)		(0.039)
$bcon$	3.176	$bcon$	3.287	$bcon$	3.398
	(2.127)		(1.959)*		(1.803)
LAR	−0.008	LAR	−0.008	LAR	−0.007
	(0.023)		(0.024)		(0.222)
no. obs.	91		91		91
R^2	0.337		0.353		0.425

***, **, *: significantly different from zero at the 1, 5, 10% level resp.; standard errors in brackets; parent bank and time fixed effects included, robust standard errors.

Table 6.6: Regressions without banks with Austrian parent banks.

6.8 Conclusion

This chapter contributes to the empirical literature on the determination of bank capital by including supply side related factors to panel regressions for the first time to our knowledge. In so doing, we follow the theoretical models originating from the work of Gorton & Winton (1995). We use multinational bank subsidiaries, operating in the CEB countries, as a natural experiment for distinguishing the factors related to the market of origin from those related to the market of operation.

Our dataset shows a large dispersion in the capital ratios of domestic banks as well as multinational bank subsidiaries, which leads to the conjecture that banks face a trade-off in their capital decision. Tests on the means of bank capital ratios

in the CEB countries show that, in a given market, multinational banks may behave differently than the domestic ones. This gives support for the importance of the supply side. Besides the relevance of demand side conditions, panel regressions confirm partially - depending on the measure chosen as an explanatory variable - that the supply side related factors have a significant influence on the capital decision of multinational bank subsidiaries, operating in the banking markets of the CEB countries. What is more, in relation to the model in Mikkonen (2006), we are able to conclude that the multinational banks in the CEB countries may be stability increasing rather than stability decreasing. However, as the difference between the home and host capital markets becomes smaller, the motives driving internationalization may change. It may then be that the international banks are both more likely to go bankrupt and leave the market when bad times occur.

We managed to find a specific market where supply side factors obviously play a role in determining bank capital, and where the stability effect of multinational banking may be positive. It remains to be investigated whether other markets have different determinants. The ultimate aim would then be to develop a theory of banking where internationalization motives arise from the market characteristics and where those motives have stability consequences.

6.A Comparison of EAR Means and Distributions

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Domestic	137	8.677007	.2373747	2.7784	8.207584	9.14643
Multinational	213	9.314883	.2400889	3.503983	8.841615	9.78815
Combined	350	9.0652	.1737287	3.250167	8.723513	9.406887
Diff		-.6378753	.3376233		-1.302018	.0262678

Satterthwaite's degrees of freedom : 333.013

Ho : mean (Dom) - mean (Mul) = diff = 0

Ha : diff < 0	Ha : diff != 0	Ha : diff > 0
t = - 1.8893	t = - 1.8893	t = - 1.8893
P $<$ t = 0.0299	P $>$ | t | = 0.0597	P $>$ t = 0.9701

Table 6.7: Two-sample t-test with unequal variances on EAR of domestic and multinational banks.

(1) all eight countries included:			
Smaller Group	D	P-value	Corrected
Domestic :	0.1018	0.178	
Multinational :	-0.0135	0.970	
Combined K-S:	0.1018	0.353	0.306
(2) Slovenia excluded:			
Domestic :	0.1534	0.042	
Multinational :	-0.0360	0.840	
Combined K-S:	0.1534	0.083	0.063

Table 6.8: Two-sample Kolmogorov - Smirnov test on EAR of domestic and multinational banks.

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Curriculum Vitae

July 2008	Ph.D. in economics (Dr. oec. publ.) Ludwig-Maximilians-Universität München
2003 - 2008	Ph.D. program in economics Ludwig-Maximilians-Universität München
1998 - 2003	Diploma in economics (Dipl.-Volkswirt) Ludwig-Maximilians-Universität München
1997	Abitur Willibald-Gymnasium, Eichstätt
28 June 1978	Born in Eichstätt, Germany