Banking Regulation, Public Interventions, and their Effects on Economic Growth

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Abstract

This thesis investigates whether public interventions and new regulatory requirements have significant growth effects. It contains three separate analyses and is organized into five chapters. In Chapter 2, the thesis provides a general equilibrium analysis of potential consequences from the introduction of a binding leverage ratio, as proposed in Basel III. If banks differ in their monitoring skills and their ability to successfully complete a risky investment project, a tighter leverage ratio does not only mitigate moral hazard arising from limited liability, but also carries an unintended consequence: Banks are not allowed to absorb the entire supply of debt if they cannot raise new equity, which induces agents with a lower monitoring skill to open a bank. This decreases the average ability of operating banks. The thesis further shows that rising heterogeneity in the banking sector increases this negative effect and that additional instruments of the regulator and additional outside options of agents cannot overcome this unintended allocation effect. In Chapter 3, using industry data from Eurostat and applying the Rajan-Zingales methodology, the thesis investigates the real growth effects of banking sector integration in the European Union over the phase of rapid financial integration before the global financial crisis as well as the following phase of financial fragmentation and bank deleveraging. The thesis finds evidence that banking sector integration had a more than four times stronger growth effect during the crisis than in normal times. Growth effects are also stronger in times of domestic bank deleveraging. The chapter concludes that concerns of European policy makers about fragmentation in the European banking sector are justified and that future reintegration is an important building block of future growth perspectives in the European Union. In Chapter 4, the thesis investigates short-run and medium-run growth effects of banking sector state aid in the European Union during the financial and sovereign debt crisis. The study is based on European industry data for the sample period from 2008 to 2013 on which the Rajan-Zingales-methodology is applied. It distinguishes between direct recapitalizations, impaired asset relief programs, guarantees, and other liquidity support based on detailed annual data by the European Commission. The thesis finds positive medium-run, but negative short-run growth effects of capital related measures. Liquidity support, however, had positive short-run, but no medium-run effects. Therefore, the analysis provides guidance that banking sector state aid should, in first instance, restore long-term viability by providing capital support and use liquidity measures to buffer its negative short-term consequences. The results of the three analyses indicate that interventions in the banking sector as well as corresponding regulatory reforms have significant real economic effects. A balanced approach is necessary to obtain positive influence on economic growth.

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Abstract

Diese Dissertation untersucht, ob staatliche Interventionen und neue regulatorische Anforderungen signifikante Wachstumseffekte hervorrufen. Sie enthält drei separate Analysen und ist in fünf Kapitel unterteilt. Kapitel 2 beinhaltet die Analyse eines allgemeinen Gleichgewichtsmodells zu den potenziellen Konsequenzen der Einführung einer, wie in Basel III vorgeschlagenen, Leverage Ratio. Wenn sich Banken in ihren Fähigkeiten der Überwachung und der Durchführung von risikoreichen Investitionsprojekten unterscheiden, ruft die Leverage Ratio nicht nur eine Reduzierung des Verhaltensrisikos aus beschränkter Haftung hervor, sondern zusätzlich auch einen unerwünschten Effekt: Durch die Einschränkung der Eigenkapitalaufnahme können Banken nicht das gesamte Angebot an Depositen aufnehmen. Individuen mit geringeren Fähigkeiten erhalten Anreize eine Bank zu eröffnen. Dies reduziert somit die durchschnittliche Fähigkeit aller Banken. Die Arbeit zeigt ferner, dass steigende Heterogenität im Bankensektor diesen negativen Effekt verstärkt und zusätzliche regulatorische Instrumente und Investitionsmöglichkeiten für Individuen diesen unerwünschten Allokationseffekt nicht eliminieren können. In Kapitel 3 untersucht diese Dissertation unter Zuhilfenahme von Industriedaten von Eurostat und der Rajan-Zingales-Methode reale Wachstumseffekte von Bankensektorintegration in Europa. Dies umfasst zum einen die Phase der Finanzintegration vor der globalen Finanzkrise sowie die anschließende Phase der Fragmentierung und des Schuldenabbaus bei Banken. Die Arbeit zeigt, dass im Vergleich zu normalen Zeiten Bankensektorintegration einen mehr als viermal so starken Wachstumseffekt während der Krise hatte. Diese Effekte treten ebenfalls verstärkt in Zeiten des Schuldenabbaus bei heimischen Banken auf. Die Schlußfolgerung dieses Kapitels ist, dass die Bedenken von europäischen Politikern hinsichtlich der Fragmentierung im europäischen Bankensektor gerechtfertigt sind und dass eine zukünftige Reintegration einen wichtigen Baustein für zukünftige Wachstumsperspektiven in der EU darstellt. In Kapitel 4 untersucht diese Dissertation kurz- und mittelfristige Wachstumseffekte von Bankenrettungsmaßnahmen in der EU während der Finanz- und Staatsschuldenkrise. Die Studie basiert auf europäischen Industriedaten von 2008 bis 2013 und der Anwendung der Rajan-Zingales-Methode. Sie unterscheidet zwischen direkten Rekapitalisierungen, dem Kauf notleidender Aktiva, Garantien sowie sonstigen Liquiditätsmaßnahmen basierend auf detaillierten jährlichen Daten der Europäischen Kommission. Die Arbeit findet positive mittel-, aber negative kurzfristige Wachstumseffekte von Kapitalmaßnahmen. Liquiditätshilfen allerdings hatte positive kurz-, aber keine mittelfristigen Effekte. Die Analyse legt daher nahe, in erster Linie die langfristige Überlebensfähigkeit des Bankensektors durch Kapitalunterstützung zu sichern und kurzfristige negative Effekte durch Liquiditätsmaßnahmen abzupuffern. Die Resultate der drei Analysen deuten darauf hin, dass Interventionen im Bankensektor und regulatorische Reformen signifikante realökonomische Effekte haben. Ein austarierter Ansatz ist notwendig um eine positive Wirkung auf das Wirtschaftswachstum zu erzielen.

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Chapter 1

Introduction

Banks play an important role in the economy due to the special services they provide. In their core business of taking deposits and providing credit, they conduct the functions of maturity-, lot-size-, and liquidity-transformation. Via banks, agents with short-term liquidity surplus are able to finance large-volume long-term investment projects that generate positive cash-flows only in the long run. In this regard, by taking the risk of significant maturity incongruency of their assets and liabilities, banks contribute significantly to economic growth, but at the cost of particular fragility. The nature of this business typically leads to high leverages, which further increases the risk of severe crises. With this trade-off, banks and regulators have to balance on the one hand preserving economic gains and on the other hand reducing fragility.

As probably any financial crisis before, the crisis of 2008/2009 denotes a break in the world of banking. Since then, the business model of banks is undertaking massive changes along many dimensions. Prior to the crisis, perspectives of banking sectors were seen enthusiastically by many commentators. Low interest rates, new information technology, and increasing globalization led to an optimistic sentiment, and banks increased leverage by enlarging their balance sheet much stronger than real economic activity did. This was further accompanied by new financial instruments and highly sophisticated risk management techniques. At the same time, the interconnectedness increased and financial markets integrated towards a more global system. Particularly in the European Union, traditionally more bank-based than the United States, banks' became huge relative to their home countries' GDP. As the crisis evolved, however, significant parts of many banking sectors experienced capital and liquidity shortfalls and required state aid in order to survive. In some cases, the burden of bank rescue became too large and the domestic countries itself went into severe distress. This pattern appeared strongly pronounced in the European Union and fueled the sovereign debt crisis in several countries.

In the light of the financial crisis, interventions in the banking sector were substantial. At the peak of distress, governments implemented large bailout programs to prohibit a complete meltdown of the financial system. After having obtained some stabilization, political pressure emerged to significantly change the regulatory system and banks' business models. With the evolution to Basel III, the introduction of a new regulatory framework forces banks to fulfill stricter and additional requirements and sets incentives to restructure or wind down specific business segments and to refocus on domestic markets as well. Significant stock holdings by governments due to recapitalizations additionally fosters this behavior. Banks are redefining their business models and have to manage capital allocation as well as maturity and liquidity incongruencies more conservatively, but also more efficiently. Banks react by a reduction of highly internationalized investment banking activities and a refocusing on corporate financing and private banking in domestic markets. Furthermore, with the experience of the financial crisis, specific products and services will be reduced while others will gain more relevance. These interventions and the associated adjustments in the supply of services will affect the corporates and individuals that depend on banking services. E. g., firms that try to expand in foreign markets often do no longer have access to foreign branches, and the corresponding local expertise, of their main bank. Hence, real economic activity is affected. This thesis investigates whether public interventions during the crisis and new regulatory requirements in its aftermath have significant growth effects. It is motivated by the large impact of the financial crisis on the financial sector as well as the economic disastrous consequences. First, this dissertation investigates stricter capital requirements that were implemented in response to the crisis and their effects on the allocation of funds within the banking sector. Second, it reflects the growth effects stemming from increased financial fragmentation since 2008. Finally, we examine the role of bank bailouts in reducing output costs during times of distress. In general, this dissertation points out that it is necessary to carefully disentangle the consequences of crises and interventions to provide appropriate reactions in the future.

Chapter 2, which is joint work with Andreas Barth, investigates effects of regulatory changes on the allocation of funds within the banking sector and potential consequences for real economic activity. In particular, it focuses on the introduction of the leverage ratio and provides a theoretical investigation of how this regulatory measure affects the allocation of funds within the banking sector. It concentrates on situations in which regulation of banks gets stricter, as it is the case since the financial crisis. Our results suggest that changes in the regulatory framework lead to adjustments in the banking sector, which potentially affect the quality and quantity of services to the real sector. Prior to the financial crisis, the core concept of banking regulation contained an evaluation of banks'

assets and the requirement to finance investments with equity capital according to the associated risk. However, during the crisis, in many cases, capital buffers turned out to be very weak and the measurements of portfolio risk appeared inappropriate in times of financial distress. After the crisis, politics decided to adjust the regulatory framework towards a more balanced approach, called Basel III, to strengthen resilience of the banking sector. It still measures regulatory capital requirements by risk-weighted assets, but, inter alia, requires higher capital ratios and applies stricter definitions of eligible core capital. In addition, it introduces a leverage ratio, i. e., a minimum share of equity as of total unweighted assets. By focusing on the pure volume of assets and equity, it complements the risk-weighted approach by a risk-insensitive measure that ensures that banks have a minimum level of equity irrespective of their asset risk. This dissertation reflects the introduction of this regulatory tool. We reduce our analysis to the minimum of necessary assumptions and show that a leverage ratio may have unintended consequences for the stability of the banking sector. Individuals are heterogeneous with respect to their ability of monitoring and screening investment projects. However, they may rather deposit their equity with individuals that are better able to manage their investment project and want to increase their investment volume, instead of investing into a long-term investment project on their own. The allocation of funding is provided via the deposit rate that serves as a market clearing price and, therefore, balances demand and supply of deposits. Obviously, the whole endowment in the economy will be allocated to individuals with the highest ability. They invest in the risky projects with own funds as well as deposits. We call this positive effect on the average ability of banks the 'allocation effect'. It generates gains of specialization that are shared with depositors via an appropriate deposit rate. At the same time, however, leveraging up banks' balance sheet generates incentives for banks to invest into riskier projects, i. e., a moral hazard behavior arising from limited liabilities. We demonstrate that these two effects are countervailing. By introducing the cap on the debt-to-equity ratio, the regulator is able to reduce moral hazard. However, she also restricts the selection among individuals that invest into the long-term projects. In this regard, the leverage ratio helps to improve resilience of the banking sector by pushing banks to manage less risky projects. At the same time, it has the unintended consequence of mitigating the allocation effect by prohibiting a superior allocation of funds to a pool of individuals with a higher average ability. An appropriate leverage ratio balances these two effects. Intuitively, gains of specialization cannot emerge if individuals are homogeneous. This implies that the optimal leverage ratio is increasing in the degree of heterogeneity.

Chapter 3, which is joint work with Isabel Schnabel, investigates real growth effects with respect to financial disintegration during the financial crisis. European banking sec-

tors experienced a strong course of integration since year 2000. Due to the political framework of the single market and the introduction of the Euro, banks increased foreign presence significantly. As a result, more strongly interwoven banking sectors led to more homogeneous lending and deposit rates and better absorption of country-individual shocks. With the beginning of the crisis, however, banks started to re-concentrate on domestic markets. They started to wind down foreign branches and subsidiaries or sold them to competitors. Political considerations fostered this behavior. On the one hand, national governments required failing banks to increase lending to domestic enterprises in exchange for support measures. In addition, the European Commission, which had to approve national rescue packages, put much emphasis on potential distortions in the single market. According to their premise, banks had to contribute significantly to the burden of the bailout, which in their view made a substantial restructuring necessary. On the other hand, by increasing capital requirements, banks have strong incentives to reduce their assets. These aspects reinforce a trend, triggered by the financial crisis, in which a strong re-nationalization of banking sectors took place in the European Union. Banks focus more strongly on their domestic markets by reducing foreign presence and cross-border-lending, leading to more pronounced fragmentation of the European banking sector. This raises concerns of officials in banking supervision and monetary politics about negative consequences for the single market, which is based on a long-lasting debate on the merits of financial integration. So far, clear evidence is not obtained. In Europe, however, significant growth gains were identified. Our work adds to this discussion by investigating differences of the growth effect of banking sector integration, particularly between times of boom and bust before and after the crisis and phases of leveraging and deleveraging. We use data on industrial production growth and exploit the different characteristics of industries with respect to their need for external financing of investment activities. Effects are identified by measuring short run deviations of industry growth rates from their medium run averages. Under the premise of holding constant domestically provided financing, our results show that foreign bank presence had an economically significant and positive growth effect during times of crisis and phases of domestic balance sheet reductions. Moreover, this effect is much stronger during these times than during normal times and phases of increasing balance sheets, respectively. Our results indicate that banks have to be present in foreign countries via branches and subsidiaries rather than providing cross-border credit, probably since physical presence is necessary to obtain relevant information.

Chapter 4 investigates the growth effects associated with banking sector state aid in the European Union during the crisis. Troubling banks had to be supported by capital injections and liquidity aid. Their implementation aimed to provide a backstop against

an uncontrolled meltdown with potentially disastrous consequences for the real economy. This chapter empirically investigates the growth effects of bank bailout programs in the European Union during the crisis. Our results suggest that this policy could successfully reduce the negative real effects stemming from troubling banks. Each individual case may provide a unique story, but the degree of interconnectedness with the global financial system as well as the dependency on short-term funding significantly determined their vulnerability to the shock of the Lehman Brothers collapse and the bursting of the US housing price bubble. Hence, many large and systemically relevant banks went into distress. Their bailout appeared necessary to avoid further negative effects on real economic activity. If necessary, governments provided the necessary backstop by capital injections and liquidity support in all countries of the European Union. However, bank rescue policies were heterogeneous. First, they differed in the measures used. The implementation of direct recapitalizations as well as asset relief programs focused on restoring banks' capital position. With respect to liquidity, banking sector support mainly concentrated on guarantees on newly issued debt and guarantees on deposits. Second, the way of implementation differed significantly. Some countries used schemes with strict rules and conditions to participate. Nevertheless, in general, all banks could apply for participation. Examples are the recapitalizations schemes in France and Denmark. Other countries, however, provided aid on an ad-hoc basis and in a very discretionary way (Belgium and Netherlands decided on a case-by-case basis about if, how, and how much aid to inject into a specific institution). We use detailed data about bailout policies on an annual basis and apply the approach used in Chapter 3, which hypothesizes that frictions in the banking sector affect industries differently, according to the degree to which they depend on external financing. Our times series allows to distinguish between short run and medium run growth effects. Short run effects are identified by annual deviations of industry growth rates from medium run averages as in Chapter 3, whereas medium run effects are based on averages of growth rates over the sample period. We show that banking sector support during the crisis was beneficial in terms of buffering the negative consequences of troubling banks. Capital-related aid to the banking sector had a significant and positive effect on industry growth rates in the medium run. Guarantees, however, were particular effective in the short run. The results, therefore, suggest that a favorable structure of bank bailout policies implies capital injections that are backed by guarantees. This can restore long-term viability, but reduce negative short-term consequences of the implementation of recapitalization measures.

Finally, Chapter 5 summarizes the most important policy conclusions of our analysis in more detail and relates our findings to current regulatory developments. Our results pro-

vide useful suggestions for policymakers. The results of our three analyses indicate that political actions with respect to the financial sector have countervailing effects. These implications have to be balanced in order to achieve an optimal approach. The implementation of a leverage ratio may increase stability, but potentially prohibits a more favorable allocation of funds in the financial system. Giving banks incentives to focus more strongly on domestic markets is associated with negative effects for real economic growth. Finally, bailouts for banks in times of crisis have positive growth effects. Nevertheless, the associated increase in sovereign debt may also have negative implications.

Chapter 2

Capital Regulation with Heterogeneous Banks - Unintended Consequences of a Too Strict Leverage Ratio -

This chapter is based on joint work with Andreas Barth.[1]

2.1 Introduction

In the most recent years, hardly any issue has been discussed as intensively as the appropriate amount of bank equity. Addressing excessive credit growth and leverage, the European Systemic Risk Board (2014a), for example, issued a handbook on operationalizing macro-prudential policy in the banking sector with one key instrument being the leverage ratio as a non-risk-weighted capital requirement. As part of Basel III, this concept gained a lot of attention and is foreseen to be implemented as a regulatory tool in addition to traditional risk-sensitive minimum capital requirements from 2018 onwards. Most arguments in the public as well as in the academic literature regarding tighter cap-

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ital requirements refer to a quantitative effect,[2] and only little is said about potential qualitative effects.

We provide, with an allocation effect, a novel mechanism of how the financial sector could be adversely affected by a binding leverage ratio. Within a world of heterogeneous banks, higher capital requirements, while mitigating moral hazard and improving the quality of bank lending decisions, reduce the average quality of the banking sector: Individuals who are best able to run banks are not allowed to absorb the entire supply of debt when they cannot immediately raise new equity, which introduces qualitatively worse agents to become banks.

More precisely, we develop a theoretical setup closely related to the work of Morrison and White (2005) with a continuum of individuals, which are heterogeneous with respect to an unobservable ability to successfully complete investment projects, drawn from the unit interval. These agents can invest their initial endowment into a risky project, or deposit it with another individual.[3] It turns out that agents with a high success probability decide endogenously to invest into a risky investment project, and individuals with a low success probability prefer to lend their funds to 'better' individuals. The deposit market with an endogenously determined interest rate serves as an instrument to transfer the funding resources and thus tries to balance demand and supply. In order to illustrate the impact of various levels of capital requirements on the size and the riskiness of the banking sector, we assume an exogenous regulator who implements a leverage ratio for banks.[4] We show that an increase in the regulatory capital adequacy implies three effects: First, as we assume that the established banks cannot raise new equity, the decrease in the demand for debt and the excess supply ceteris paribus lowers the deposit rate, which implies a lower value of the investment opportunity *depositing*. Due to the decrease in the deposit rate, some former depositors find it now more profitable to run a bank by themselves. Since these agents unambiguously have a lower ability than the already existing banks, the average quality in the banking sector deteriorates, which, ceteris paribus, increases

[2]For example, in 2009, Josef Ackermann, former CEO of Deutsche Bank, stated in an interview that "more equity might increase the stability of banks. At the same time however, it would restrict their ability to provide loans to the rest of the economy", see Ackermann (2009). On the other hand, Admati, DeMarzo, Hellwig, and Pfleiderer (2011) point out that the common arguments against too much equity are either fallacies, irrelevant facts, or even myths. In particular, they argue that higher capital requirements do not force banks to reduce lending activities since higher regulatory equity does not require to set capital aside or to hold additional reserves.

[3]We call borrowing agents who take deposits and invest into the risky project *banks*, and lending agents *depositors*.

[4]One could endogenize the role of the regulator, e. g ., by giving him the goal to maximize aggregate payoff of the economy and at the same time minimize the potential negative spillover effects to depositors. Weighting these goals differently, one would obtain different levels of capital requirements.

average riskiness of banks. Second, there is a decrease in moral hazard in the sense of Jensen and Meckling (1976) as a direct effect. Banks have more 'skin in the game' and therefore, choose a lower project risk. Finally, the drop in the interest rate on debt weakens further moral hazard for banks as it incentivizes banks again to choose a lower project risk. Hence, the overall effect of regulatory changes on aggregate project risk is ambiguous.

Our model allows for a discussion of the allocation problem regarding the heterogeneity in the banking system and regarding an auditing technology as a second instrument of the regulator. Regarding the first issue, it can be shown that the degree of heterogeneity plays a crucial role in determining the strength of the allocation effect. More precisely, the positive effects of specialization can be exploited to a greater degree with a large leverage than under tighter regulation, such that the average ability of banks gets the more deteriorated the larger the dispersion in the individuals' ability. We further discuss the role that an auditing technology as a second instrument of the regulator's toolbox might have on our allocation effect. The allocation effect will appear (although possibly somewhat weaker) as long as the screening technology is imperfect in the sense that the regulator will only identify the true ability of some applicants. Moreover, even if the regulator is equipped with a perfect auditing technology, the allocation effect may still be present under certain circumstances.

This chapter adds to the literature on the impact of banking regulation on bank behavior. There is a large list of theoretical papers describing partial equilibrium effects of whether tighter capital requirements incentivize banks to increase their asset risk. This literature, however, is largely inconclusive, and the direction of the effect depends strongly on the assumptions.[5]

Interestingly, the empirical literature, too, provides conflicting answers on the question how capital regulation works on risk-taking: Shrieves and Dahl (1992), Aggarwal and Jacques (2001), and Rime (2001) find that asset risk is the higher the tighter banking regulation is, while Jacques and Nigro (1997) obtain lower risk levels in response to an increase in banks' capital requirements. This chapter features this mixed evidence as the proposed allocation effect works countervailing to the well-known moral hazard effect. It remains a future exercise to re-investigate empirically the relation between capital

[5]See, for example, the work of Koehn and Santomero (1980), Kim and Santomero (1988), Rochet (1992), Gennotte and Pyle (1991), Blum (1999), Hakenes and Schnabel (2011) for different channels of how stricter capital requirements may increase banks' risk-taking, and, inter alia, the studies by Furlong and Keeley (1989) and Hellmann, Murdock, and Stiglitz (2000) for the opposing result that stricter regulation results in lower asset risk. See also VanHoose (2007) for a detailed review of the literature on bank capital regulation.

regulation and bank risk in the light of differences in the relative strengths of both effects for various degrees of heterogeneity within the banking sector and a distinctive auditing ability of the regulator.

This chapter differs from the theoretical work above as we do not focus on partial equilibrium but put our emphasis on general equilibrium and fit in with a lengthy but still ongoing debate. Bernanke and Gertler (1985), for example, suggest that banking regulation in terms of interest ceilings on deposits are not justified while regulation in terms of capital requirements is useful. While both implications are also part of our model, we argue that the usage of the useful instrument of capital adequacies could feed back on deposit rates and thus induce an unintended effect corresponding to the one of interest rate ceilings. Not only interest ceilings on deposits generate our novel allocation effect, but capital requirements are enough to introduce this effect.

Similar to Gorton and Winton (1995), the model in this chapter features the result that a social welfare maximizing regulator should allow risky banks to operate. The reason for obtaining this result, however, differs substantially: While in our model the regulator must balance moral hazard and a proper allocation of capital, her trade-off in Gorton and Winton (1995) is to use capital requirements in order to balance the riskiness of banks and the exit of banks out of the market which involves the loss of their charter value. Therefore, our allocation effect serves as an additional explanation to the charter value argument in Gorton and Winton (1995) why too restrictive capital requirements might be harmful for the economy.

With an emphasis on systemic risk, the analysis by Feess and Hege (2012) concludes that the optimal system of capital requirements may adopt differentiated requirements for banks. If the regulator cannot observe the true portfolio risk, sophisticated banks will suffer from a similar moral hazard problem as banks in our model do. However, as long as the regulator can perfectly verify the true portfolio risk, sophisticated banks are allowed to grow larger by demanding lower capital requirements, while unsophisticated banks remain small and should concentrate the risky assets in their portfolio. Morrison and White (2009) investigate the issue of heterogeneous capital requirements on an international level. If regulators have different abilities in auditing banks, an international level playing field in capital requirements does not yield an optimal solution if bank capital is immobile. Regulators with a lower auditing quality have to implement stricter capital requirements than regulators with high auditing ability.

Also referring to systemic risk, Martinez-Miera and Suarez (2014) describe in a dynamic general equilibrium model both an intended and an unintended consequence of capital regulation. On the one hand, capital requirements can reduce incentives to take systemic risk due to a 'last bank standing' effect, but it comes on the other hand at the cost of reducing credit and output in calm times. We thus provide a different channel for both the intended and unintended effect of capital regulation as Martinez-Miera and Suarez (2014).

Similar to Bernanke and Gertler (1985) who use their model to describe the disintermediation process caused by a restriction of bank deposit rates "as it occurs in the U.S. in 1966, 1973, etc"(Bernanke and Gertler (1985)), our allocation effect can serve as an illustration for the rise of the shadow banking system.[6] Although we do not explicitly model intermediation outside the regulated sector and therefore abstract from a discussion on regulatory arbitrage, the reduction of the (good) banking sector in favor of agents with a lower ability to run successfully investment projects can be interpreted in terms of a substitution effect between banks and shadow banks. Therefore, our model can be seen as a complement to current contributions focusing on the relation between shadow banking and capital regulation, as for example Plantin (2015) or Harris, Opp, and Opp (2014).

Our allocation effect also points towards the empirical finding in Aiyar, Calomiris, and Wieladek (2014) who obtain a sizable impact of capital regulation on the loan supply side by making use of the "UK policy experiment" in which regulators have imposed time-varying, bank-specific minimum capital requirements. More precisely, showing that higher capital requirements for UK banks led to more investments by branches of foreign banks, they demonstrate that changes in capital requirements lead to 'allocation effects' within the banking sector, which might be in the sense of our work that restricting banks by capital requirements may incentive agents with lower ability to step in.[7]

The policy implication of the present model adds interesting insights to the discussion on the usage of leverage ratios. The literature on this topic focuses mainly on the complementary use of risk-based capital requirements and non-risk based leverage ratios.

[6]In distinction from Bernanke and Gertler (1985), the allocation effect in our model additionally provides an explanation for a reduction of the (good) banking sector in favor of a bad banking sector (or the shadow banking sector) even if the regulator does not put an exogenous restriction on the deposit rate, but only strengthens the capital requirements. Thus, the 'disintermediation process' can be explained for a much broader set of countries.

[7]Following the argumentation that distance matters in banking, and especially the result on cultural differences between contract parties in Giannetti and Yafeh (2012), it is consecutive to argue that foreign branches have a lower ability in evaluating borrowers' creditworthiness than domestic banks, as our allocation effect would predict.

Particularly, it has been argued that a leverage ratio affects banks' incentive to report truthfully their asset risk (Blum (2008) and Colliard (2014))[8] and may lead to more diversified bank portfolios (Kiema and Jokivuolle (2014)).[9] We add to the discussion on leverage ratios with our novel allocation effect: If the flat, non-risk-based capital requirement is a binding constraint, banks with the highest ability to screen investment projects cannot absorb the entire supply of deposits, and the resulting decrease in the interest rate on debt offers an incentive for less capable agents to enter into the bank business.[10]

The remainder of the chapter is organized as follows. In Section 2.2, we first introduce the basic setup of the theoretical model as well as the decision structure of all agents. Section 2.3 describes the payoffs and business opportunities, gives a first illustration of the allocation effect, and introduces the agents' participation constraints. We then present the equilibrium outcome in Section 2.4 and discuss the impact of capital requirements on the simultaneous problem of allocating resources among individuals and moral hazard in Section 2.5. We extent our model in Section 2.6 in several ways: We analyze the effect of different degrees of heterogeneity on the optimal level of minimum capital requirements, we discuss the impact that an auditing technology as a second regulatory instrument might have, and we allow for an additional investment opportunity. Section 2.7 concludes.

2.2 Model Setup

We follow Morrison and White (2005) with the basic setup of the model and consider a one period economy with a continuum of risk-neutral agents with mass 1, denoted by i. All individuals are heterogeneous with respect to an unobservable ability a_i, $a_i \sim U(0,1)$.[11] We interpret this competence as different levels of efficiency in monitoring and project screening. Each agent is endowed with capital C,[12] and this endowment can be transferred

[8] While Blum (2008) shows that a leverage ratio can introduce truthful risk reporting of banks by reducing the gains from understating their risk, the effect is reversed in the paper by Colliard (2014). Here, a binding leverage ratio increases loan rates due to the restriction in the supply of credit, which makes it more attractive for banks to use 'optimistic' models (i. e. to misreport).

[9] Kiema and Jokivuolle (2014) show that this diversification increases bank stability only in the absence of model risk. With model risk, however, the positive diversification effect of reshuffling low-risk loans to a larger number of banks is dominated by a "contamination effect", i. e. a larger number of banks hold an asset turned toxic.

[10] The work by Repullo and Suarez (2013) relates the discussion on risk-based capital requirements versus flat requirements in a dynamic equilibrium model on the supply of credit and banks' asset risk. It is shown that, while flat requirements reduce the pro-cyclicality of lending, risk-based requirements reduce banks' probability of default.

[11] In Section 2.6.1, we analyze different degrees of heterogeneity by generalizing the uniform distribution. Note that the results of our work qualitatively do not depend on the distribution of a_i.

[12] Since the continuum of agents is normalized to mass 1, the total endowment in the economy is C.

to the end of the period by running an investment project or by depositing at other agents. At the end of the period, all agents consume their profits from investing or depositing. The investment project is chosen from a whole set of projects, $y_i \in [0, 1]$ with a risk-return structure à la Allen and Gale (2004), i. e., the success probability is decreasing in the return of the project, $\left(\frac{\partial p(y_i,a_i)}{\partial y_i} \leq 0\right)$.[13] We assume the success probability to be increasing in the unobservable ability of the agent $\left(\frac{\partial p(y_i,a_i)}{\partial a_i} \geq 0\right)$. Particularly, we take the functional form $p(y_i, a_i) = (1 - y_i)a_i$. The investment pays a return $x \cdot y_i$ in case of success and zero otherwise, where x is a constant scaling factor.[14] Thus, individuals with different abilities have different expected returns from investing into the same risky projects.

The invested amount is not restricted to the own endowment, but agents are allowed to collect further funds from other agents. We call the agents collecting deposits banks. Thus, a second investment opportunity is to lend the own endowment to other agents.[15] This lending pays an interest r per unit of deposit, which is completely determined by supply and demand. However, deposits can only be repaid if banks have enough cash flow, i. e., only in case of a successful completion of the project. We assume that depositors can verify banks' investment and returns, which prevents banks from mimicking being insolvent. We further assume a zero correlation structure regarding the return of two different investment projects, $corr(xy_i, xy_j) = 0, \forall i, j \in I$, in order to rule out any hedging motive for lending agents. Moreover, we assume that depositors anticipate the moral hazard behavior of banks and price risks accordingly in the deposit rate.[16]

We introduce a regulator as an additional agent who has the power to put a minimum non-risk-weighted capital adequacy on banks. The regulator's adjustment screw implies a leverage ratio, which is defined as the ratio of equity C over total assets (= equity plus collected deposits of bank i), $\frac{C}{C+D_i}$. Since C is fixed, she has to define the maximum amount of funds banks can raise from other agents, D^{max}.

[13] In order to rule out any hedging motives, we restrict individuals to choose only one investment project.

[14] We assume x to be sufficiently large such that the expected return from investing into the risky project is high enough to ensure positive NPV projects. Assuming, e. g., $x = 8$ would ensure that half of the population has a non-negative NPV from investing only its endowment in the efficient project.

[15] We take the assumption that equity is expensive to the limit such that investors can only provide debt rather than additional equity. This situation could arise for example in the short run from a debt overhang problem.

[16] Note that with the existence of a deposit insurance, one could also interpret the banks' payments to depositors as the sum of payments to the depositors and a deposit insurance where depositors receive a fixed amount corresponding to the expected repayment without a deposit insurance.

The timing and sequence of events in the model are as follows: First, the regulator defines the minimum leverage ratio banks are obliged to fulfill. Second, individuals decide about investing into the risky project or depositing at a bank. If the risky project was selected, individuals decide simultaneously about becoming a bank, choose the volume of deposits they want to take, as well as the risk-return structure of the risky investment project. Finally, returns are realized and deposits are paid back.

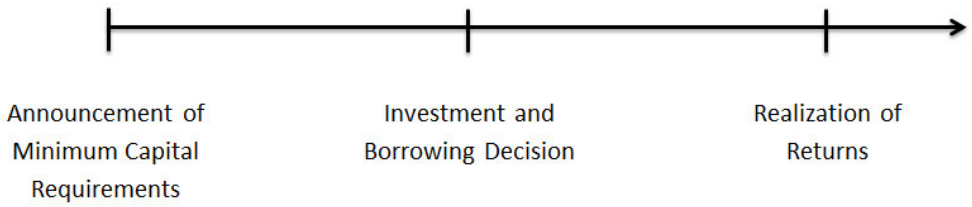

Figure 2.1: Timeline of the decision structure

2.3 Payoffs and Investment Choice

The expected profit of an agent that invests into the risky project consists of the return from the investment project and the costs from borrowing in the deposit market.[17] Thus, it is given by

$$E(\pi_i^{invest}) = (C + D_i)(1 - y_i)a_i x y_i - (1 - y_i)a_i r D_i - C.$$

Given agents choose to finance a risky investment project, they face the decision how many deposits they want to collect as well as about the risk-return structure of the project. Note that, since we consider a continuum of banks, they do not have the market power to influence the interest rate on the deposit market and take it therefore as given.

First, these agents' decision regarding the project risk features the well-known moral hazard behavior à la Jensen and Meckling (1976): All agents that decide to invest choose an inefficient high project risk y_i^*,

$$y_i^*(D_i, r) = \frac{1}{2} + \frac{rD_i}{2(C + D_i)x},$$

with $\frac{1}{2}$ being the efficient project, and the second term indicating the moral hazard effect due to limited liability.[18] Obviously, the project risk increases in the moral hazard effect.

[17] We will later show that there exists only a pooling equilibrium in the deposit market. Therefore, in order to simplify notation, we will never use a subscript i for the interest rate.

[18] See Appendix 2.A.1.

This distortion from the efficient project depends not only on the level of debt D_i, but also on the deposit rate r (see also Appendix 2.B).

Second, as it is shown in Appendix 2.A.1, all agents who decide to run the investment project want to take for a given deposit rate r either as much deposits as the regulator allows or they want to take no deposits at all.[19]

Both the decision about the project choice and the decision about the optimal debt level do not depend on the agent's unobservable ability. All individuals for whom it is beneficial to choose the investment project will decide for the same project $y_i^* = y^*$, independent of a_i. However, as agents' ability affects the success probability, they have different expected returns from investing into risky projects.

Regarding the expected profit of depositing agents, we assume that there will be no bailout of deposits. Individuals lending in the deposit market will only be repaid if the borrowing counterparts can generate enough positive cash flow, which is always the case when they succeed in the investment project. Thus, the individual's expected profit from lending his own endowment takes the expected ability of banks into account and reads

$$E(\pi_i^{deposit}) = \frac{1}{\int \mathbf{1}_{j^{bor}} dj} \int a_j(1-y_j)\mathbf{1}_{j^{bor}} djCr - C,$$

where $\frac{1}{\int \mathbf{1}_{j^{bor}} dj} \int a_j(1-y_j)\mathbf{1}_{j^{bor}} dj$ denotes the average expected success probability of the borrowing counterparts. Thus, $\frac{1}{\int \mathbf{1}_{j^{bor}} dj} \int a_j(1-y_j)\mathbf{1}_{j^{bor}} djCr$ describes the expected repayment from depositing the endowment.

Due to the linearity of the profit functions, agents will only choose one of the two opportunities, i. e. , they will either invest into the risky project (with a leverage ratio of one or the minimum required leverage ratio), or become a depositor:[20]

$$E(\pi_i) = \max \begin{cases} (C + D^{max})(1-y^*)a_i x y^* - (1-y^*)a_i r D^{max} - C \\ \frac{1}{\int \mathbf{1}_{j^{bor}} dj} \int a_j(1-y^*)\mathbf{1}_{j^{bor}} djCr - C \end{cases}$$

[19] One might think that the existence of a moral hazard problem results in an interior solution for the optimal amount of deposits for a sufficiently high value of D^{max}. The reason could be the deterioration of the expected return per unit invested for an increasing deposit volume, which could decrease expected profits large enough to incentivize banks not to collect as much deposits as possible. However, since banks take the deposit rate as given, the decline in expected return is not strong enough to outweigh the benefit from a larger investment volume.

[20] In the remainder, we consider the more interesting case of r being small enough relative to x to ensure that investing agents want to lever up. In Section 2.3.2, we explicitly show that depending of D^{max}, the equilibrium interest rate can satisfy all three cases of Appendix 2.A.1.

2.3.1 The Allocation of Funds

The intersection of both the expected return of the investment project and the expected return from depositing at a bank for various abilities a_i, depicted in Figure 2.2, ensures that there exists a critical level of ability a^*, above which agents decide not to deposit their endowment with a bank.[21] Ignoring any participation constraint, all agents whose ability exceeds a^* will open a bank and all remaining agents deposit their endowment with a bank. Thus, depositors and the regulator know the expected ability of banks to be $\frac{1}{2}(1 + a^*)$.

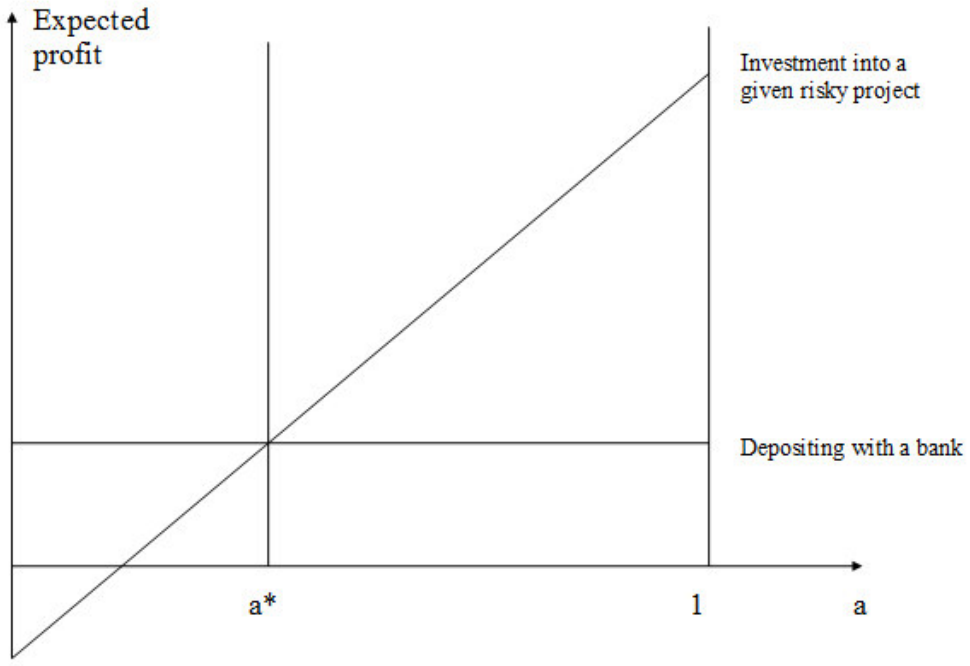

Figure 2.2: Expected profit for investing into a risky project or depositing at a bank for a given interest rate r, deposit volume D, and project return y_i.

For the market clearing condition in the deposit market, supply of deposits, which is defined for a given D^{max}, r,and y as

$$Supply = \int_0^{a^*} C di$$

has to equal the demand for deposits,

$$Demand = \int_{a^*}^{1} D^{max} di.$$

[21] Technically, $\frac{\partial E(\pi_i^{invest})}{\partial a_i} > 0$ and $\frac{\partial E(\pi_i^{deposit})}{\partial a_i} = 0$ as well as $E(\pi_i^{invest}|a_i = 0) < E(\pi_i^{deposit}|a_i = 0)$ ensures the intersection of both expected return functions.

This allows us to identify the critical ability a^*, at which the demand for and supply of deposits is cleared:

$$\int_0^{a^*} C di = \int_{a^*}^1 D^{max} di$$

$$\Leftrightarrow \qquad a^* = \frac{D^{max}}{C + D^{max}}. \tag{2.1}$$

Thus, the ability level, above which individuals decide to choose the risky investment project, depends positively on the regulatory maximum of debt D^{max}.[22]

Equation (2.1) and Figure 2.2 already provide a first illustrative intuition of the allocation problem we intend to highlight in our model. For a stricter regulation in the sense of a tighter leverage ratio (decrease of D^{max}), the critical ability a^* decreases, and the average ability of banks decreases.

2.3.2 Participation Constraints

So far, we have solved the individuals' maximization problem but neglected any participation constraints. In order to derive a necessary and sufficient condition for the existence of a debt market, we will now implement the natural constraints that agents are facing: All individuals have the possibility to use only their own endowment for investing into the risky project. This outside option pays the expected profit

$$E(\pi_i^{O1}) = C(1 - y_i)a_i x y_i - C,$$

being maximized for the project $y = \frac{1}{2}$.

Thus, in order to set up the constraints for participating in the banking sector for both opening a bank or depositing funds with a bank, we compare the outside option with the expected profit for individuals being a bank as well as with the expected profit for depositing the initial endowment.

Since all banks want to choose the maximum possible amount of deposits, $D_i = D^{max}$, and using the optimal project choice $y^* = \frac{1}{2} + \frac{rD^{max}}{2(C+D^{max})x}$, the expected profit for running a bank is given by

$$E(\pi_i | y_i = y^*, D_i = D^{max}) = (C + D^{max}) \left(\frac{1}{2} - \psi\right) a_i \left(\frac{1}{2} + \psi\right) x - \left(\frac{1}{2} - \psi\right) a_i r D^{max} - C$$

with $\psi = \frac{rD^{max}}{2(C+D^{max})x}$.

[22] $\frac{\partial a^*}{\partial D^{max}} = \frac{C}{(C+D^{max})^2} > 0$.

Thus, the participation constraint for agents to open a bank reads

$$(C + D^{max}) \left(\frac{1}{2} - \psi\right) a_i \left(\frac{1}{2} + \psi\right) x - \left(\frac{1}{2} - \psi\right) a_i r D^{max} - \frac{1}{4} C x a_i \geq 0. \qquad \text{(BOR1)}$$

Solving for r gives one boundary for investing agents to taking deposits, $r_1^{bor}(D^{max})$.[23] Since the expected profit from banking is decreasing in r, banks are willing to demand additional funding resources in the deposit market if the equilibrium interest rate is below the boundary.[24]

Contrary to the participation constraint for being a banker, the constraint for lending the endowment to a bank depends on the expected success probability of the depositing bank. Since the ability of a banker is not observable, depositors form expectations about their counterparts' ability[25] as well as their optimal project choice, taking into account that all banks choose the maximum amount of deposits, $D_i = D^{max}$. Thus, the participation constraints for depositors with respect to a risky investment of their endowment by their own reads

$$\frac{1}{2}(1 + a^*) \left(\frac{1}{2} - \psi\right) rC - \frac{1}{4} C x a_i \geq 0 \qquad \text{(LEND1)}$$

Solving for r again delivers one boundary for individuals to participate as a lender in the deposit market, $r_1^{lend}(a_i, D^{max})$. In contrast to the negative relationship of expected profit and funding costs r for banks, the expected profit for depositors is increasing in r, so that depositing is incentive compatible if the equilibrium interest rate lies above the boundary. Moreover, the effect of the regulator's choice of D^{max} on the participation constraints is ambiguous. On the one hand, since a^* is an increasing function in D, the participation constraint depend positively on D^{max}. The intuition is that an increasing a^* ceteris paribus increases the average success probability of investing banks, and hence increases the expected payoff for depositors. On the other hand, the constraint depends negatively on the moral hazard effect, which is also increasing in D^{max}. The participation constraint forming the decision about depositing or investing the endowment into a risky project depends positively on the individual abilities a_i. Obviously, since high-ability agents expect higher project returns than low-ability agents, they require a higher interest rate in order to offer deposits to banks.[26]

[23] The participation constraint is a quadratic function in r, so that there exists two interest rates that fulfill the constraint with equality. However, we can rule out the interest rate that would generate optimal projects $y_i \notin [0, 1]$.

[24] Note that the boundary does not depend on a_i, implying that either no or all investing agents are willing to take deposits.

[25] They use the expected value of the bankers' ability, $\frac{1}{2}(1 + a^*)$.

[26] We will evaluate the lending constraint (LEND1) always at bank a^*. Since this constraint is decreasing in a_i and a^* is the highest ability level for depositors, the maximum binding participation constraint (LEND1) can only be at a^*.

We know that individuals want to lever up their equity for investing into the risky project and become a bank if the equilibrium interest rate lies below the boundary for borrowing banks. We further know that there are individuals that are willing to lend if the equilibrium interest rate is above the boundary rate for depositing. Hence, a deposit market can only exist, if both borrower and lender can have an advantage from transferring funding. We proof the existence of the deposit market if and only if $r_{1i}^{bor} \geq r^{eq} \geq r_{1j}^{lend}$ is satisfied for at least some individuals $i, j \in I$ with ability $a_i \neq a_j$ in Appendix 2.A.2.

2.4 Equilibrium

Taking the participation constraints into account, we now characterize the equilibrium outcome. Since the deposit market is at the heart of our model, any assumption regarding its mechanism is essential. We suppose that all participating individuals enter the market at the same time, and the matching of banks and depositors is purely random. Note that depositing agents are indifferent between lending to as few banks as possible or to fully diversify their deposits. This is caused by the risk neutrality of individuals, the identical expected ability of the bankers, and the zero correlation between returns of the investment projects. For the same reason, we can exclude bargaining power for any agent.

In the previous section, we have identified situations in which a deposit market exists. Since we are interested in the effect of changes in the binding leverage ratio on banks' behavior, we first concentrate the analysis on the case in which banks want to, but are not allowed to take further deposits.[27]

We define the equilibrium in the following definition:

Definition 2.1. *An equilibrium is a set of allocations* $D_i, y_i, i \in [0,1], y_i \in [0,1]$ *and a deposit market interest rate* r^{eq}*, such that*

- *given the deposit rate, the allocation solves each agent's maximization problem*
- *the deposit market clears.*

For a binding leverage ratio, we claim that there exists only a pooling equilibrium in the deposit market.

[27] The case of an unconstrained equilibrium is discussed later in this section and its existence is proofed in Appendix 2.A.5.

Proposition 2.1. *There exists only a pooling equilibrium in the deposit market in the sense that every bank gets the same expected volume of deposits D^{max} at the same market clearing interest rate r^{eq}.*

There exists no separating equilibrium, in which banks with different abilities a_i prefer different contracts, i. e., contracts specifying different deposit rates and volumes.

Proof. See Appendix 2.A.3. ■

The intuition why there exists only a pooling equilibrium is straightforward. First, the individual ability a_i is not observable. Second, the participation constraint for running a bank (BOR1) is independent of a_i, which in addition is just a scaling factor for the expected profit from investing into the risky project. Hence, if the borrowing banks have the choice between two or more contracts, different banks always prefer the same contract. Finally, depositors can not distinguish between different abilities of bankers in order to claim ability-dependent deposit rates.

Proposition 2.2. *The allocation that solves the problem is given by:*

- $\forall$ *i with* $a_i \in \left[0, \frac{D^{max}}{C+D^{max}}\right[: D_i = 0$
- $\forall$ *i with* $a_i \in \left[\frac{D^{max}}{C+D^{max}}, 1\right] : D_i = D^{max}, y_i = \frac{1}{2} + \frac{rD^{max}}{2(C+D^{max})x}$.

The equilibrium interest rate is given by $r^{eq} = \frac{D^{max}x}{(C+D^{max})}$.

Proof. See Appendix 2.A.4. ■

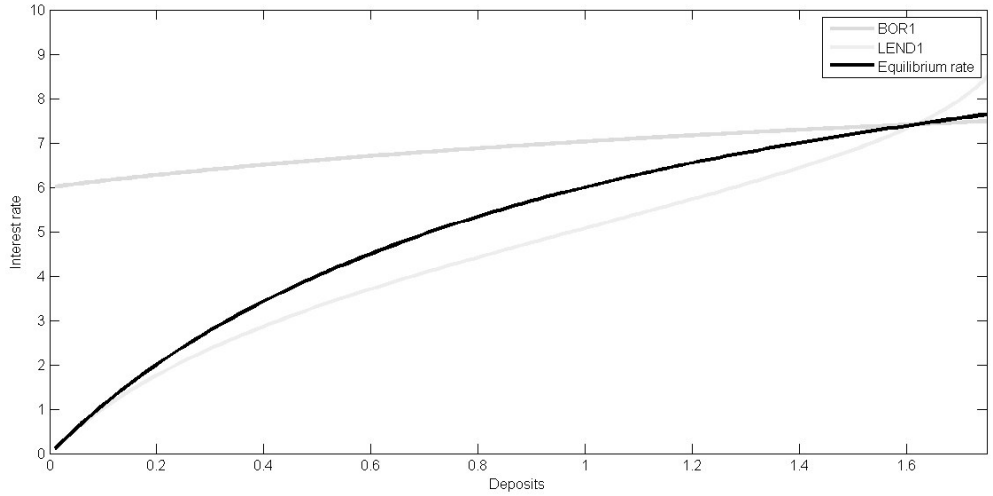

Figure 2.3: Participation constraints and equilibrium interest rate for parameter values $x = 12$ and $C = 1$.

The intuition for the equilibrium interest rate is as follows. Remember that there exists a certain ability level $a^* = \frac{D^{max}}{C+D^{max}}$ for which individuals with a higher ability want to take as many deposits as possible and invest into the risky project and individuals with a lower ability will act as depositors. Remember further that there exists an equilibrium deposit market interest rate that is below the borrowing constraints for all agents with ability above a^* and above the lending constraints for all agents with ability below a^*. Since the equilibrium interest rate serves as a market clearing price, individuals with exact the critical ability level a^* must be just indifferent between opening a bank and depositing. We illustrate the equilibrium interest rate for different levels of D^{max} in Figure 2.3.

Note that so far, we have analyzed the case in which the minimum capital requirements are binding. However, there also exists an unconstrained equilibrium for high values of the maximum level of deposits D^{max}, in the sense that banks do no longer enlarge their balance sheet if the regulator further weakens capital requirements. Technically, it is defined by the intersection of $r_1^{bor}(D_{uc}^{max})$ and $r_1^{lend}(D_{uc}^{max}, a_i|a_i = a^*)$.[28]

Intuitively, the existence of the unconstrained equilibrium stems from the following effect: For high values of D^{max}, the agent that is indifferent between lending and borrowing has a high ability a_i, and requires a high interest rate in order to offer its endowment as deposits. However, this high payment on debt decreases the expected profit for investing agents and would incentivize them to use only own endowment for the investment project. Hence, having an endogenous price for deposits, there exists a natural boundary for deposit taking although the regulator would allow a higher leverage.

2.5 Consequences of a Tighter Leverage Ratio

After having developed the equilibrium for different levels of capital regulation, we will now analyze in more detail the role of the deposit market and the effects emanating with respect to a binding leverage ratio.

Definition 2.2. *We define the allocation effect as the difference between the average ability of the pool of banks and the average ability of all individuals:*

$$AE = \frac{1}{2}(1 + a^*) - \frac{1}{2} = \frac{D^{max}}{2(C + D^{max})}.$$

The following propositions illustrates the effect of regulatory changes on the allocation effect:

[28] See Appendix 2.A.5 for a detailed proof.

Proposition 2.3. *The allocation effect is increasing in the maximum volume of deposits, D^{max}. In particular, the change of the allocation effect with respect to D^{max} is given by:*

$$\frac{\partial AE}{\partial D^{max}} = \frac{C}{2(C + D^{max})^2} > 0$$

Proof. See Appendix 2.C.1. ■

A stricter regulation leads to a decline in a^*, implying that some agents with a lower success probability decide to become a bank instead of being a depositor. Hence, ceteris paribus, a tighter leverage decreases the average success probability of banks.

As a second effect, our model incorporates a moral hazard behavior of banks in the choice of the projects' risk-return structure.

Definition 2.3. *In our model, it is convenient to define the moral hazard effect as the exceedance of the project risk over the efficient project:*

$$MHE = \frac{(D^{max})^2}{2(C + D^{max})^2}.$$

The following propositions illustrates the effect of regulatory changes on the moral hazard effect:

Proposition 2.4. *The moral hazard effect is increasing in the maximum volume of deposits, D^{max}. In particular, the change of the moral hazard effect with respect to D^{max} is given by:*

$$\frac{\partial MHE}{\partial D^{max}} = \frac{CD^{max}}{(C + D^{max})^3} > 0$$

Proof. See Appendix 2.C.2. ■

A tighter regulatory leverage ratio implies two effects on bank risk-taking that can be decomposed as follows:

$$\frac{\partial MHE}{\partial D^{max}} = \frac{rC}{2(C + D^{max})^2 x} + \frac{\frac{\partial r}{\partial D^{max}} D^{max}}{2(C + D^{max})x} > 0.$$

The first effect characterizes the change in the moral hazard from the leverage ratio (Jensen and Meckling (1976)). If the regulator strengthens regulation by demanding a larger share of equity (decrease in D^{max}), banks choose less risky projects since they have more 'skin in the game'. The second term describes an additional effect from a change in the interest rate on debt: A stricter regulation decreases the demand for deposits, and some individuals have to switch from depositing to being a bank, which, ceteris paribus,

decreases the average success probability in the pool of depositors. Since the 'best' agent in the pool of depositors has now a lower success probability and hence a lower expected return from its outside option to run a bank, depositors are now willing to offer their funding resources at a lower interest rate.[29]

Figure 2.4 illustrates the allocation and moral hazard effect for various degrees of D^{max} as well as the change of both effects due to a change of the regulation. For low levels of D^{max}, a stricter regulation generates high costs due to a strong decrease in the allocation veffect. More precisely, the change in the allocation effect decreases in D^{max}: For high values of D^{max}, only some agents choose to be a bank and borrow in the deposit market, if the regulation requires a larger leverage ratio.

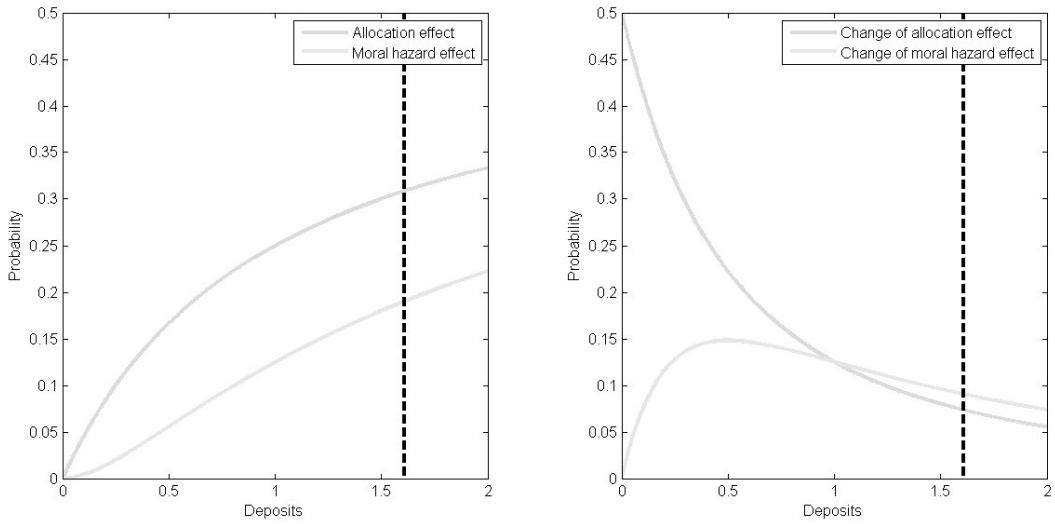

Figure 2.4: Allocation effect and moral hazard effect (left) and change of allocation effect and moral hazard effect (right) for parameter values $x = 12$ and $C = 1$.

Figure 2.5 shows the average success probability of the risky investment and the decomposition of its change into the components stemming from the two effects of the model, moral hazard and allocation.[30] The concavity of the average success probability demonstrates that the sensitivity of the allocation effect with respect to D^{max} is relatively strong for higher levels of capital requirements, but may be outweighed by the sensitivity of the moral hazard effect for a looser regulation.[31]

[29]See Appendix 2.B for a analytical derivation of the dependence between the equilibrium interest rate and D^{max}.

[30]The average success probability is given by $\left(\frac{1}{2} + AE\right) \cdot \left(\frac{1}{2} - MHE\right)$. The contribution of the allocation effect to the change of the average success probability is then given by $\frac{\partial AE}{\partial D^{max}} \cdot \left(\frac{1}{2} - MHE\right)$. Equivalently, the contribution of the moral hazard effect is then given by $-\frac{\partial MHE}{\partial D^{max}} \cdot \left(\frac{1}{2} + AE\right)$.

[31]Note, that the relative strength of both effects depends on the choice of the parameter values.

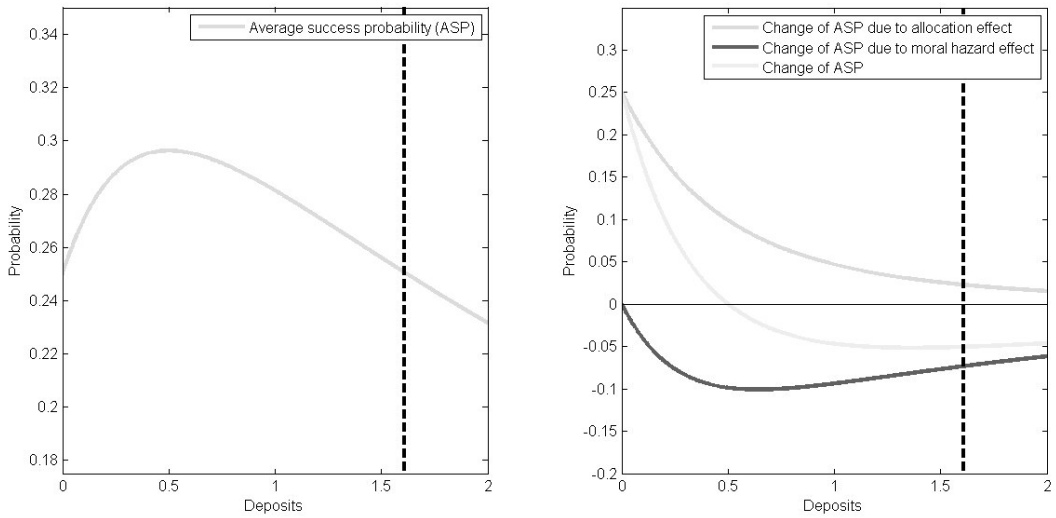

Figure 2.5: Average success probability (left) and contribution of allocation effect and moral hazard effect to the change of average success probability (right) for parameter values $x = 12$ and $C = 1$.

A side effect we want to mention is the fact that changes in capital requirements do not affect the investment volume of the banking sector. One concern of Morrison and White (2005) with regard to tighter capital requirements is a welfare mitigating decrease of the whole banking sector. However, endogenizing the interest rate on debt and reducing the instruments of the regulator to minimum capital requirements implies that the deposit market takes the role of controlling the number of banks and the volume of managed funds in the banking sector. It appears that the number of banks and the size of the banking sector are disentangled. This is one of the key differences to the model of Morrison and White (2005), where the number of banks is fixed by the number of licenses and hence, stricter capital requirements directly decrease the volume of managed funds. Moreover, the introduction of a deposit rate that equalizes demand and supply implies that the allocation problem is controlled by the deposit market. It incentivizes agents with a low ability to deposit their funds with a bank and high-ability agents to open a bank. However, a regulatory change in terms of stricter capital requirements affect the average success probability of the pool of banks in three different ways. First, a stricter regulation has an immediate effect on the banks' project choice. Since banks have 'more skin in the game', their incentive to take excessive risks diminishes. Second, the average ability of the pool of banks gets worse. Low ability agents decide to open a bank which increases the number of banks, but decreases the average success probability of all investing agents and thus, ceteris paribus, the expected return to depositors. The third effect of stricter regulation again affects the moral hazard behavior of banks. After some agents switched from being

a depositor to being a bank, the remaining supply side of debt has a lower ability and thus accepts a lower deposit rate, which translates into a decline of the optimal project risk chosen by banks. This result of a countervailing moral hazard and allocation problem with a constant volume of bank-financed investment projects is contrary to the findings of Morrison and White (2005).

2.6 Model Extension

2.6.1 Degree of Heterogeneity

In this section, we analyze the effect of different degrees of heterogeneity on the optimal level of minimum capital requirements. For this purpose, we will weaken the assumption that the individual ability is distributed on a unit interval and introduce a mean preserving spread as a more general notation.[32] More precisely, all agents are different with respect to an unobservable ability a_i, $a_i \sim U(\underline{a}, \overline{a})$, but the mean of the distribution is still assumed to be $a^{mean} = 0.5$. We define $\Delta_a = \overline{a} - \underline{a}$ as the degree of heterogeneity. Note that the representation of the payoffs and the investment choices of Section 2.3 still apply.

As in Section 2.3.1, there exists a critical ability a^*, below which agents will deposit their endowment at a bank. The remaining fraction of agents with ability $a_i \in [a^*, \overline{a}]$ will decide in favor of the investment project. Thus, depositors as well as the regulator know the expected ability of banks to be $\frac{1}{2}(a^* + \overline{a})$. Using the market clearing condition for the deposit market, we find the critical ability for any level of heterogeneity

$$a^* = \frac{\underline{a}C + \overline{a}D^{max}}{C + D^{max}}.$$

Thus, the critical ability depends positively on the regulatory maximum of deposit borrowing, D^{max}, and the strength of the effect is increasing in the degree of heterogeneity.[33]

The three effects of stricter regulation, derived in Section 2.5, differ in their reliance on the degree of heterogeneity. First, the direct moral hazard effect resulting from banks having 'more skin in the game' does not depend on the overall distribution of the ability level. In the maximization problem, banks make their decision regarding the investment project only based on their own ability.

[32] In order to focus only on the heterogeneity of ability in terms of variance, we fix the mean of the distribution at the same level as in the previous sections. We thus keep the results comparable and avoid a level effect introduced by differences in the mean. For the reason of simplicity, we still assume a uniform distribution.

[33] $\frac{\partial a^*}{\partial D^{max}} = \frac{\Delta_a C}{C + D^{max}} > 0$.

Second, the allocation effect depends directly on the heterogeneity of the banking sector. Due to the mean preserving spread, the average ability of banks has changed, while the average ability of all individuals remains constant. With the lower bound $\underline{a}$ and the upper bound $\overline{a}$ of the distribution of the ability, the allocation effect reads

$$AE = \frac{(2\overline{a} - 1)D^{max}}{2(C + D^{max})}.$$

Similar to Section 2.5, stricter regulation implies a decline in the critical ability. Thus, agents with a lower success probability decide to become a bank instead of lending their endowment to better agents. Hence, ceteris paribus, a stricter regulation decreases the success probability of banks. However, the strength of the allocation effect depends on the degree of heterogeneity. More precisely, the change of the allocation effect originating from a stricter regulation is the stronger the higher the degree of heterogeneity. The economic intuition is straightforward. The loss in average ability of banks through a stricter regulation gets stronger with a larger dispersion in the individuals' ability.

Finally, the additional moral hazard effect though the equilibrium interest rate on debt is also shown to be sensitive to the heterogeneity of agents' ability due to the fact that it affects the level of the critical ability a^*. With a more general degree of heterogeneity, the equilibrium interest rate reads $r^{eq} = \frac{\overline{a}(D^{max}-C)+C}{(C+\overline{a}D^{max})}x$. This interest rate on debt is still decreasing in the stringency of regulation, which, ceteris paribus, increases the success probability of banks. The strength of this effect is increasing in the degree of heterogeneity. Moreover, the interest rate declines in the dispersion of agents' ability.[34] Intuitively, this result stems from the fact that the average ability of those agents who decide to become a bank unambiguously increases with increasing heterogeneity. Hence, due to the increase in the average success probability of banks, depositors accept a lower compensation rate for the riskiness of their deposits.

Analytically, the moral hazard effect can be expressed in the more general case as

$$MHE = \frac{D^{max}(\overline{a}(D^{max} - C) + C)}{2(C + \overline{a}D^{max})(C + D^{max})}.$$

It is increasing in the level of debt, and this increase depends on the degree of heterogeneity as well as the ratio $\frac{C}{D^{max}}$.

[34] $\frac{\partial r^{eq}}{\partial D^{max}} = \frac{\overline{a}^2 C}{(C+\overline{a}D^{max})^2}x > 0$, $\frac{\partial^2 r^{eq}}{\partial D \partial \overline{a}} = \frac{2\overline{a}C^2}{(C+\overline{a}D^{max})^3}x > 0$, and $\frac{\partial r^{eq}}{\partial \overline{a}} = -\frac{C^2 x}{(C+\overline{a}D^{max})^2} < 0$.

A natural objective for the regulator is the maximization of expected aggregated profits in the economy,

$$\begin{aligned} AP &= \frac{1}{\overline{a}-\underline{a}} \int_{a^*}^{\overline{a}} \left[(C+D^{max})(1-y)a_i yx - (1-y)a_i r D^{max}\right] da_i - C \\ &= \frac{\overline{a}-a^*}{\overline{a}-\underline{a}} \left[(C+D^{max})\frac{1}{2}(\overline{a}+a^*)(1-y)yx - \frac{1}{2}(\overline{a}+a^*)(1-y)rD^{max}\right] - C. \end{aligned}$$

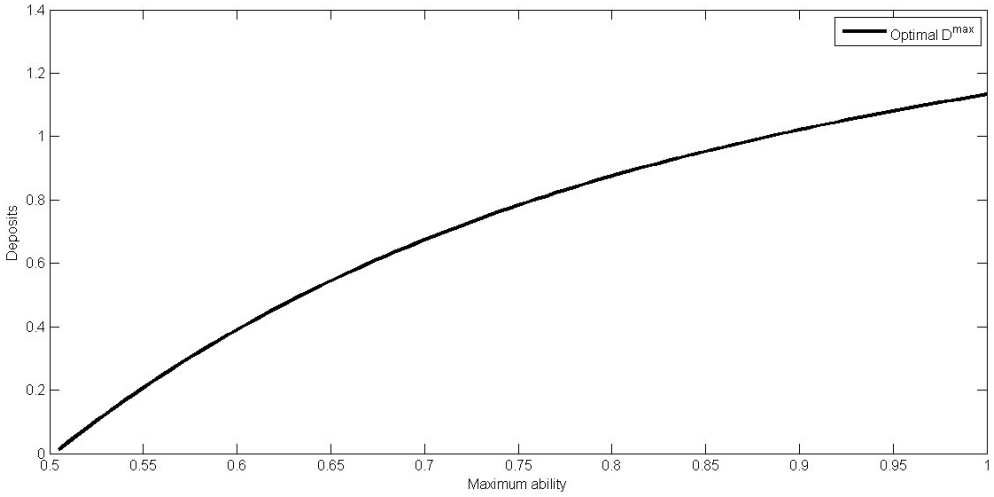

Figure 2.6: Optimal regulatory maximum amount of deposits D^{max} for parameter values $x = 12$ and $C = 1$.

In our model, expected profits are entirely generated by banks and then distributed among all individuals via the deposit market. Since the characteristic polynomial for the optimal regulatory maximum amount of deposits is of degree 5 and there does not exist a general analytical solution, we have solved the problem numerically, illustrated in Figure 2.6 for a maximum ability $\overline{a} \in]0.5, 1]$.[35] Not surprisingly, the optimal regulation for a decrease in the degree of heterogeneity approaches towards $D^{max} = 0$. In the extreme case where all agents have the same success probability, they would be indifferent between investing and lending, and since there would be no market for deposits, there would be no moral hazard behavior. For increasing heterogeneity, however, Figure 2.6 indicates that optimal regulation should allow debt financing up to a certain degree. Moreover, the optimal level of debt is increasing in the degree of heterogeneity. Economically, differences in the quality of lending decisions imply positive effects of specialization. High-ability agents can generate the highest expected payoff from investment projects and depositors can benefit from that by providing funding to them. However, debt financed investment projects imply a moral hazard behavior that undermines the positive effects of specialization.

[35] See Appendix 2.D.2 for a derivation of the characteristic polynomial.

2.6.2 Auditing Technology

We now appoint the regulator with a second instrument to improve the quality of the banking system. Similar to Morrison and White (2005), we introduce an auditing technology that allows the regulator to screen the ability of all agents and to award banking licenses. More precisely, the regulator will define a minimum ability level a^{min}, and only agents above this threshold will receive a license if they apply for it.[36] This screening technology, however, might be imperfect and it is unknown to all agents.

We assume that moral hazard is the regulator's concern of first order such that the timing of the decision structure looks as follows: The regulator first announces minimum capital adequacies, before individuals decide about being a bank or a depositor. The regulator then awards banking licenses, projects were running and returns are realized. As one extreme case, the regulator is employed with a perfect screening technology, and she will hand out a license for all banks with an ability above a^{min}. If, however, her screening ability is non-informative, she cannot learn the ability of the individuals and will award licenses to all agents that apply for it.[37] Therefore, for any imperfect screening technology, she will only identify the true ability of some applicants and thus, due to a lack of knowledge, allow some agents with an ability below a^{min}.

For a perfect screening technology, the allocation effect depends on the the scale of the market clearing vability a^* and the required regulatory minimum ability a^{min}. More precisely, the allocation effect now reads

$$AE = \begin{cases} \frac{1}{2}(1+a^*) - \frac{1}{2}\,, & if \qquad a^{min} \leq a^* \\ \frac{1}{2}(1+a^{min}) - \frac{1}{2}\,, & if \qquad a^{min} > a^* \end{cases}$$

If the constraint of a minimum ability level is not binding, all banks that apply for a banking license will receive a license. The allocation effect is thus identical to the one in Section 2.5, and a tighter leverage ratio will worsen the average quality of the banking sector. If, however, the constraint is binding, all agents with an ability above a^{min} are allowed to open a bank, while all agents with an ability between a^* and a^{min} will not get a license, although they apply for it. This auditing process results in an excess supply of deposits, and, since non-invested funds would deteriorate, all agents that cannot deposit

[36] As the regulator maximizes expected aggregate profits in the economy, she has no incentive to discriminate high ability agents in favor of low ability agents and therefore assigns a license to all agents above the minimum ability a^{min}.

[37] A non-informative screening technology corresponds to having no auditing technology as discussed in Section 2.5.

with a bank will invest their endowment on their own.[38] Thus, as long as the ability requirement is binding, a change in the minimum leverage ratio would not affect the quality of the banking sector.

This result allows us to discuss the role of an imperfect auditing technology. As the regulator cannot identify the true ability of all applicants, some agents that apply for a banking license, i. .e. all agents with an ability between a^* and 1, will be allowed to take deposits, irrespective of whether their ability is above a^{min} or not. Since a tighter leverage ratio results in a decrease in a^*, more agents will apply for a banking license, and the average ability of deposit taking agents will unambiguously decreases. Thus, the allocation effect is also present if a regulator is equipped with an (imperfect) auditing technology.

2.6.3 Storage technology as additional outside option

Finally, we assume that additionally, all individuals also have the option to store their resources at no cost with a zero expected profit:

$$E(\pi_i^{Storage}) = 0.$$

This implies two additional participation constraints:

$$(C + D^{max}) \left(\frac{1}{2} - \psi\right) a_i \left(\frac{1}{2} + \psi\right) x - \left(\frac{1}{2} - \psi\right) a_i r D^{max} - C r_f \geq 0, \qquad \text{(BOR2)}$$

and

$$\frac{1}{2}(1 + a^*) \left(\frac{1}{2} - \psi\right) rC - C r_f \geq 0. \qquad \text{(LEND2)}$$

For very strict capital requirements, some agents with a too low success probability can only generate a low expected return from the investment project and thus prefer not to switch to become a bank (see Figure 2.7). Thus, some part of the endowment of the economy will not be invested in investment projects. Note that depositing those funds is not possible due to the regulatory constraint. We call this situation limited participation equilibrium. More precisely, the limited participation equilibrium is characterized by a situation in which demand and supply of funding resources can not be equalized by an equilibrium interest rate that fulfills the participation constraints of all individuals. However, since (BOR2) is increasing in the ability level, there are still individuals with $a_i > a^*$ for which their individual participation constraint (BOR2) is above (LEND2) evaluated

[38] If we would allow for an inefficient storage technology, some agents would invest in storage rather than into the risky project on their own.

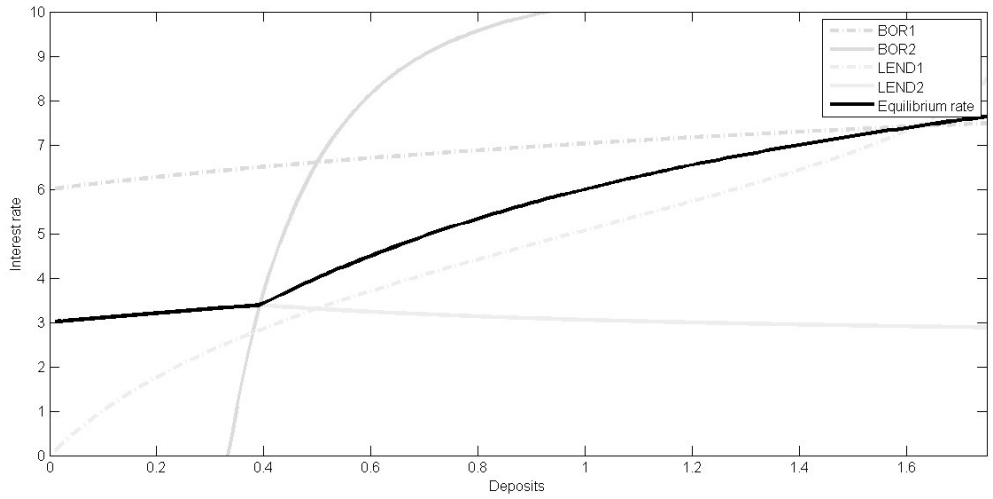

Figure 2.7: Participation constraints and equilibrium interest rate for parameter values $x = 12$ and $C = 1$.

at a^*. The excess supply of funds drives down the equilibrium interest rate to $r^{eq} = r_2^{lend}$ due to a Bertrand price competition argument and will rather be invested into the risk-free asset instead of the investment project. Hence, for very strict capital requirements, a decrease in D^{max} can mitigate banks' moral hazard and improve the average ability in the banking sector just as in Morrison and White (2005), but it comes at the cost of an inefficiently high investment into the risk-free asset. Note that limited participation does not necessarily require some individuals not to participate in the banking sector, but only that not all agents can deposit their complete funding resources.

2.7 Conclusion

By an allocation effect this model provides a novel mechanism of how the financial sector could be adversely affected by a binding leverage ratio. In an economy with heterogeneously skilled agents, there are three general equilibrium effects arising from increasing capital requirements: First, as equity is assumed to be expensive, the existing banks cannot absorb the excess supply of debt, which lowers the interest rate on debt and incentivizes agents with a lower monitoring skill to become a bank. Second, due to limited liability, there is the traditional 'skin in the game' effect that reduces banks' incentives to engage in high-risk project. Finally, the drop in the interest rate on debt weakens further moral hazard for banks as it incentivizes banks again to choose a lower project risk. Hence, the overall effect of regulatory changes on aggregate project risk is ambiguous.

We discuss the allocation effect in three alternative scenarios. First, we show that the

effect of regulatory changes differ in the degree of the heterogeneity regarding the ability level of agents: A tightening of the leverage ratio exacerbate the problem of allocating resources among individuals the more the larger the degree of heterogeneity in the banking sector is, as gains from specializations are particularly present among heterogeneous agents. Second, we equip the regulator with a second instrument to audit banks and to hand out banking licenses. While in Morrison and White (2005), this auditing technology results in the fact that only 'sound agents' start banking business, we argue that the allocation effect is still be present if the screening technology is of imperfect nature. Finally, we allow that agents can also transfer their endowment to the end of the period by a storage technology at no cost and with zero profits. Here, too, the allocation effect generally remains in place, and disappears only for very strict regulation at the cots of an excessive investment in the storage technology.

Thus, by the allocation effect our work provides one potential unintended consequence that might arise from the introduction of a leverage ratio in Basel III. If the leverage ratio becomes a binding constraint, one might expect new agents to enter the banking sector, just as it was observed in the UK: Branches of foreign banks have increased their investments after regulators have imposed higher capital requirements for UK banks. In a similar manner, our model helps to understand the substitution between banks and shadow banks, although we do not explicitly model the shift of the intermediation process from the regulated to the unregulated sector due to regulatory arbitrage. Along with the introduction of Basel I and Basel II, the investment volume in the shadow banking sector increased dramatically. However, one might think that not all agents in the shadow banking sector have the same monitoring skills as the regulated banking sector does since these agent might otherwise also have entered the regulated banking sector.

Appendix

2.A Proofs

2.A.1 Investing agents' choice w.r.t. y and D

The expected profit of investing agents is given by

$$E(\pi_i) = (C + D_i)(1 - y_i)a_i x y_i - (1 - y_i)a_i r D_i - C.$$

The optimal project choice is derived from the first-order condition with respect to y_i, i. e.

$$\begin{aligned} & \frac{\partial E(\pi_i)}{\partial y_i} \stackrel{!}{=} 0 \\ \Leftrightarrow \qquad & y_i^*(D_i, r) = \frac{1}{2} + \frac{rD_i}{2(C + D_i)x}, \end{aligned}$$

with $\frac{1}{2}$ being the efficient project, and the second term indicating a moral hazard effect due to limited liability. Obviously, the project risk increases in the moral hazard effect. This distortion from the efficient project depends not only on the level of deposits D_i, but also on the deposit rate r (see Appendix 2.C.2).

For the optimal amount of debt, we first plug in the optimal project choice y_i^*

$$E(\pi_i^{invest}) = (C + D_i)\left(\frac{1}{4} - \frac{r^2 D_i^2}{4(C + D_i)^2 x^2}\right) a_i x - \left(\frac{1}{2} - \frac{rD_i}{2(C + D_i)x}\right) a_i r D_i - C.$$

and differentiate w.r.t. D_i:

$$\begin{aligned} \frac{\partial E(\pi_i^{invest})}{\partial D_i} &= a_i x \left(\frac{1}{4} - \frac{r^2 D_i^2}{4(C + D_i)^2 x^2} - (C + D_i)\frac{\partial \frac{r^2 D_i^2}{4(C+D_i)^2 x^2}}{\partial D_i}\right) - a_i r \left(\frac{1}{2} - \frac{rD_i}{2(C + D_i)x} - D_i \frac{\partial \frac{rD_i}{2(C+D_i)x}}{\partial D_i}\right) \\ &= a_i \left(\frac{(C + D_i)^2 x^2 - r^2 D_i^2 - 2r^2 D_i C - 2(C + D_i)^2 xr + 2(C + D_i) r^2 D_i + 2r^2 D_i C}{4(C + D_i)^2 x}\right) \\ &= \frac{(C + D_i)^2 x(x - 2r) + r^2(D_i^2 + 2CD_i)}{4(C + D_i)^2 x}. \end{aligned}$$

Case 1 ($r < \frac{C+D_i}{2C+D_i}x$): $\frac{\partial E(\pi_i^{invest})}{\partial D_i} > 0$.

Case 2 ($r = \frac{C+D_i}{2C+D_i}x$): $\frac{\partial E(\pi_i^{invest})}{\partial D_i} = 0$.

$$\begin{aligned}\frac{\partial^2 E(\pi_i^{invest})}{\partial D_i^2} &= \frac{r^2(2D_i+2C)4(C+D_i)^2)x - 8(C+D_i)xr^2(D_i^2+2CD_i)}{16(C+D_i)^4x^2} \\ &= \frac{r^2C^2}{2(C+D_i)^3x} > 0.\end{aligned}$$

Note, that the first derivative has a root for some positive D_i. Since the second derivative is strictly positive, it indicates that we have a (global) minimum. Hence, we have a corner solution such that for $r = \frac{C+D_i}{2C+D_i}x$, the agent takes either deposits $D_i = D^{max}$ or $D_i = 0$.

Case 3 ($r > \frac{C+D_i}{2C+D_i}x$): $\frac{\partial E(\pi_i^{invest})}{\partial D_i} < 0$.

2.A.2 Proof of the existence of a deposit market

$\boxed{\Rightarrow}$ If a deposit market exists, there must be at least one agent depositing and one agent borrowing at some equilibrium interest rate. According to the participation constraint for banking, we know that $\forall r^{eq}$ with $r^{eq} \leq r^{bor}(D_i|D_i = D^{max})$, investing agents want to borrow in the deposit market D^{max} and invest $(C + D^{max})$ into the risky project instead of investing only C into the risky project. According to the participation constraints of lending agents, we know that $\forall r^{eq}$ with $r^{eq} \geq r^{lend}(a_j, D_j|D_j = D^{max})$, agents want to deposit their endowment C with a bank instead of investing C into the risky project. Hence, $r_i^{bor}(D_i|D_i = D^{max}) \geq r^{eq} \geq r_j^{lend}(a_j, D_j|D_j = D^{max})$.

$\boxed{\Leftarrow}$ by contradiction. Assume $\nexists$ deposit market. Then there is

(i) either no demand for deposits, i. e., $\forall i \in I$, either $r^{eq} > r^{bor}(D_i|D_i = D^{max})$,

(ii) or no supply of deposits, i. e., $\forall j \in I$, either $r^{lend}(a_j, D_j|D_j = D^{max}) > r^{eq}$,

(iii) or both.

2.A.3 Proof of Proposition 2.1

Existence of a pooling equilibrium

Denote the maximum regulatory credit volume by D^{max}. Consider a situation in which all agents with an ability $a_i \geq a^*(D^{max})$ borrow D^{max} at the same interest rate r^{eq}. We

know from the participation constraints that banks have no incentive to demand a lower deposit volume. Obviously, they also have no incentive to offer a higher interest rate.

Suppose some bank $i \in I$ only accepts an interest rate $r < r^{eq}$. Since r^{eq} makes the agent with ability $a^*(D^{max})$ indifferent between depositing and borrowing in the deposit market, agent $(a^*(D^{max}) - \epsilon)$ can be incentivized by an interest rate $r < (r^{eq} - \nu) < r^{eq}$ to switch from depositing to borrowing. Hence, it is beneficial for depositors of bank i to deposit at bank $(a^*(D^{max}) - \epsilon)$ the volume D^{max} with an interest rate $(r^{eq} - \nu)$. Since both investing C or depositing C is less worth for agent $i \in I$ than borrowing D^{max} and investing $(C + D^{max})$ at interest rate r^{eq}, she has no incentive to deviate.

Suppose some lending agent $j \in I$ only accepts an interest rate $r > r^{eq}$. Since there exists some agent $(a^*(D^{max}) + \epsilon)$, which can be incentivized to switch from borrowing to depositing for an interest rate $(r^{eq} + \nu)$, $r^{eq} < (r^{eq} + \nu) < r$, it is beneficial for the borrowing partner of agent $j \in I$ to borrow at agent $(a^*(D^{max}) + \epsilon)$ the volume D^{max} at the interest rate $(r^{eq} + \nu)$. Since investing C or borrowing D^{max} and investing $(C + D^{max})$ are less worth than depositing C at interest rate r^{eq}, agent $j \in I$ has no incentive to deviate. Offering a lower interest rate $r < r^{eq}$ or supplying a lower volume than C is never beneficial. Hence, also depositing agents have no incentive to deviate.

Non-existence of a separating equilibrium

Suppose two different contracts (r_1, D_1) and (r_2, D_2) with $D_1, D_2 \leq D^{max}$, so that we have for each bank $i \in I$:

$$(C + D_1)a_i y - a_i r_1 D_1 - C \geq (C + D_2)a_i y - a_i r_2 D_2 - C$$

or

$$(C + D_1)a_i y - a_i r_1 D_1 - C \leq (C + D_2)a_i y - a_i r_2 D_2 - C.$$

None of these inequalities do depend on a_i. Hence, all borrowing banks prefer the same contract.

2.A.4 Proof of Proposition 2.2

Suppose $r^{eq} = \frac{D^{max} x}{(C + D^{max})}$. Note that $\frac{D}{C+D} < \frac{2C+D}{C+D}$. Hence, according to Appendix 2.A.1, the borrowing decision is $D_i = D^{max}$.

Consider some agent a' for which $E(\pi_i^{invest} | a_i = a', y_i = y^*) > E(\pi_i^{deposit} | a_i = a')$. Since $\frac{\partial E(\pi_i^{invest})}{\partial a_i} > 0$ and $\frac{\partial E(\pi_i^{deposit})}{\partial a_i} = 0$, $\forall a'' > a'$ we have $E(\pi_i^{invest} | a_i = a'', y_i = y^*) > E(\pi_i^{deposit} | a_i = a'')$. Similar to this, $\forall a'''' < a'''$ with $E(\pi_i^{invest} | a_i = a''', y_i = y^*) < E(\pi_i^{deposit} | a_i = a''')$ we have $E(\pi_i^{invest} | a_i = a'''', y_i = y^*) < E(\pi_i^{deposit} | a_i = a'''')$.

For agent $a^* = \frac{D^{max}}{C+D^{max}}$, the interest rate r^{eq} solves $E(\pi_i^{invest}|a_i = a^*, y_i = y^*) = E(\pi^D)|a_i = a^*)$:

$$
\begin{aligned}
& & (C + D^{max})a^*(1-y^*)xy^* - r^{eq}a^*(1-y^*)D^{max} - C &= \frac{1}{2}(1+a^*)(1-y^*)Cr^{eq} - C \\
\Leftrightarrow & & D^{max}\left(\frac{1}{2} + \frac{D^{max}r^{eq}}{2(C+D^{max})x}\right)x - \frac{r^{eq}(D^{max})^2}{(C+D^{max})} &= \frac{1}{2}\frac{C+2D^{max}}{(C+D^{max})}r^{eq}C \\
\Leftrightarrow & \frac{1}{2}D^{max}x + \frac{(D^{max})^2}{2(C+D^{max})x}x\frac{D^{max}x}{(C+D^{max})} - \frac{(D^{max})^2}{(C+D^{max})}\frac{D^{max}x}{(C+D^{max})} &= \frac{1}{2}\frac{C+2D^{max}}{(C+D^{max})}C\frac{D^{max}x}{(C+D^{max})} \\
\Leftrightarrow & & \frac{1}{2}D^{max}x + \frac{1}{2}\frac{(D^{max})^3x}{(C+D^{max})^2} - \frac{(D^{max})^3x}{(C+D^{max})^2} &= \frac{1}{2}\frac{(C+2D^{max})CD^{max}x}{(C+D^{max})^2} \\
\Leftrightarrow & & D^{max}x(C+D^{max})^2 - (D^{max})^3x &= C^2D^{max}x + 2C(D^{max})^2x.
\end{aligned}
$$

According to the argumentation above, demand in the deposit market is then given by $\int_{a^*}^1 D^{max}di = (1-a^*)D^{max} = \left(\frac{C}{C+D^{max}}\right)D^{max}$ and supply by $\int_0^{a^*} Cdi = a^*C = \frac{D^{max}}{C+D^{max}}C$. Hence, the allocation solves the agents' problem and the deposit market clears.

2.A.5 Proof of the unconstrained equilibrium

We first show that there exists an intersection of $r_i^{bor}(D_i|D_i = D^{max})$ and $r_j^{lend}(a_j, D_j|D_j = D^{max})$:

$$
\begin{aligned}
& & r_i^{bor}(D_i|D_i = D^{max}) &= r_j^{lend}(a_j, D_j|D_j = D^{max}) \\
\Leftrightarrow & (C+D^{max})\left(\frac{1}{2}-\psi\right)a^*\left(\frac{1}{2}+\psi\right)x - \left(\frac{1}{2}-\psi\right)a^*rD^{max} - \frac{1}{4}Cxa^* &= \frac{1}{2}(1+a^*)\left(\frac{1}{2}-\psi\right)rC - \frac{1}{4}Cxa^* \\
\Leftrightarrow & & (C+D^{max})a^*\left(\frac{1}{2}+\psi\right)x - a^*rD^{max} &= \frac{1}{2}(1+a^*)rC \\
\Leftrightarrow & & a^*(C+D^{max})x - a^*rD^{max} &= rC + a^*rC \\
\Leftrightarrow & & a^*(C+D^{max})(x-r) &= rC \\
\Leftrightarrow & & D^{max}(x-r) &= rC \\
\Leftrightarrow & & r &= \frac{xD^{max}}{C+D^{max}}.
\end{aligned}
$$

We now show that this intersection defines the equilibrium interest rate $r^{eq} = r^{bor}(D_i|D_i = D^{max}) = r^{lend}(a_i, D_i|a_i = a^*, D_i = D^{max})$:

$\forall r^{eq} \leq r^{bor}(D_i|D_i = D^{max}$, the demand in the deposit market is given by $\lim_{D^{max}\to\infty}(1-a^*)\cdot D^{max}$ and 0 otherwise. The supply is given by a^*C $\forall r^{eq} \geq r^{lend}$ and 0 otherwise. Denote the individual lending volume at which $r^{bor}(D_i|D_i = D^{max})$ and $r^{lend}(a_i, D^{max}|a_i = a^*, D_i = D^{max})$ intersect by D_{uc}^{max}. Since $r^{lend}(a_i, D^{max}|a_i = a^*, D_i = D^{max}) > r^{bor}(D_i|D_i = D^{max})$ $\forall D^{max} > D_{uc}^{max}$, maximum supply in the deposit market is given by $a_{crit}^* =$

$a^*(D_{uc}^{max})C$. Since demand for debt financing $\to \infty$ if $D^{max} \to \infty$ (due to $\frac{\partial((1-a^*)\cdot D^{max})}{\partial D^{max}} > 0$) and the equilibrium interest rate tries to balance demand and supply, $r^{eq} = r^{bor}(D_i|D_i = D_{uc}^{max}) = r^{lend}(a_i, D^{max}|a_i = a_{crit}^*, D_i = D_{uc}^{max})$.

Banks have no incentive to offer a higher interest rate $r_i > r^{eq} = r^{bor}(D_i|D_i = D_{uc}^{max})$ since for $r_i > r^{bor}(D_i|D_i = D_{uc}^{max})$, it is optimal to invest only $(C + D^{max})$ into the risky project. Since there is excess demand, accepting only a lower interest rate $r_i < r^{eq}$ by some bank $i \in I$ leads to $D_i = 0$. This is equivalent to investing $(C + D^{max})$ into the risky project, which is not optimal. Hence, banks have no incentive to deviate.

Suppose some lending agent $j \in I$. Accepting only some interest rate $r_j > r^{eq}$ leads to a demand of 0, because of $r_j > r^{bor}(D_i|D_i = D_{uc}^{max}) = r^{eq}$. By construction, investing $(C+D^{max})$ at a equilibrium interest rate r^{eq} is not optimal for agent j. Offering an interest rate $r_j < r^{bor}(D_i|D_i = D_{uc}^{max})$ can also not be optimal because profits from lending in the deposit market are increasing in r_j. Hence, lending agents have no incentive to deviate.

Obviously, the market equilibrium as the equilibrium in the deposit market does also hold for all finite $D^{max} > D_{uc}^{max}$.

2.B Equilibrium Interest Rate

Solve for equilibrium interest rate r^{eq}:

$$
\begin{aligned}
& (C+D)\left(\frac{1}{2}-\psi\right)a^*\left(\frac{1}{2}+\psi\right)x - \left(\frac{1}{2}-\psi\right)a^* rD - C = \frac{1}{2}(1+a^*)\left(\frac{1}{2}-\psi\right)rC - C \\
\Leftrightarrow \quad & (C+D)a^*\left(\frac{1}{2}+\psi\right)x - a^* rD = \frac{1}{2}(1+a^*)rC \\
\Leftrightarrow \quad & (C+D)\frac{D}{C+D}\left(\frac{1}{2}+\frac{rD}{2(C+D)x}\right)x - \frac{D}{C+D}rD = \frac{1}{2}\left(1+\frac{D}{C+D}\right)rC \\
\Leftrightarrow \quad & D\frac{(C+D)x+rD}{2(C+D)x}x - \frac{rD^2}{C+D} = \frac{1}{2}\frac{C+2D}{C+D}rC \\
\Leftrightarrow \quad & Dx(C+D) + rD^2 - 2rD^2 = (C+2D)rC \\
\Leftrightarrow \quad & r^{eq} = \frac{Dx}{(C+D)}.
\end{aligned}
$$

$$
\frac{\partial r^{eq}}{\partial D} = \frac{x(C+D)-Dx}{(C+D)^2} = \frac{xC}{(C+D)^2}.
$$

$\Rightarrow$ for any D, we have $\frac{\partial r^{eq}}{\partial D} > 0$.

2.C Moral Hazard and Allocation Effect

2.C.1 Proof of the effect of D^{max} on the allocation effect

From the expected profit from deposit lending,

$$E(\pi^D) = \frac{1}{2}(1 + a^*(D^{max}))(1 - y(D^{max}, r))rC,$$

we get the allocation effect:

$$AE = \frac{1}{2}a^*(D^{max}) = \frac{D^{max}}{2(C + D^{max})}.$$

Since equity capital is exogenously given, the allocation effect depends only on D^{max} according to

$$\frac{\partial AE}{\partial D^{max}} = \frac{C}{2(C + D^{max})^2} > 0.$$

As the comparative statics points out, an increase in the volume of additional funds from depositors D^{max} leads to a stronger allocation effect.

2.C.2 Proof of the effect of D^{max} on the moral hazard effect

From optimal project choice

$$y^* = \frac{1}{2} + \frac{r^{eq}D^{max}}{2(C + D^{max})x},$$

we get the moral hazard effect:

$$MHE = \frac{r^{eq}D^{max}}{2(C + D^{max})x}$$

depending on the equilibrium interest rate r^{eq}. Plugging in $r^{eq} = \frac{D^{max}x}{(C+D^{max})}$ yields

$$MHE = \frac{(D^{max})^2}{2(C + D^{max})^2}$$

The moral hazard effect depends not only on D^{max}, but also on the interest rate that has to be paid for deposits. The equilibrium interest rate, however, is also depending on D^{max} (see Appendix 2.B). Then the moral hazard effect depends on D^{max} according to

$$\frac{\partial MHE}{\partial D^{max}} = \frac{C\left[\frac{\partial r^{eq}}{\partial D^{max}} \cdot D^{max} + r^{eq}\right] + \frac{\partial r^{eq}}{\partial D^{max}} \cdot (D^{max})^2}{2(C + D^{max})^2 x}$$

Plugging in for the equilibrium interest rate yields

$$\frac{\partial MHE}{\partial D^{max}} = \frac{CD^{max}}{(C + D^{max})^3} > 0.$$

Since the first derivative of r with respect to D^{max} is positive, we find an increasing moral hazard effect if the volume of additional funds from depositors D^{max} increases. Thus, the decrease of D^{max} (equivalent to a stricter regulation) on the one hand weakens the allocation effect, which is negative for the aggregate expected profits, but on the other hand also decreases the moral hazard effect.

2.D Various degrees of heterogeneity

2.D.1 Moral Hazard Effect

$$\begin{aligned} MHE &= \frac{D^{max}}{2(C+D^{max})x} r^{eq} \\ &= \frac{D^{max}(\overline{a}(D^{max}-C)+C)}{2(C+\overline{a}D^{max})(C+D^{max})} \end{aligned}$$

with

$$r^{eq} = \frac{\overline{a}(D^{max}-C)+C}{(C+\overline{a}D^{max})} x.$$

$$\begin{aligned} \frac{\partial MHE}{\partial D^{max}} &= \frac{C}{(C+D^{max})^2 x} r^{eq} + \frac{D^{max}}{2(C+D^{max})x} \frac{\partial r^{eq}}{\partial D^{max}} > 0. \\ \frac{\partial^2 MHE}{\partial D^{max} \partial \overline{a}} &= \frac{C}{(C+D^{max})^2 x} \frac{\partial r^{eq}}{\partial \overline{a}} + \frac{D^{max}}{2(C+D^{max})x} \frac{\partial^2 r^{eq}}{\partial D^{max} \partial \overline{a}} \\ &= \frac{C^2}{(C+D)^2(C+\overline{a}D)^3} \left(\sqrt{\overline{a}}D^{max}+C\right)\left(\sqrt{\overline{a}}D^{max}-C\right). \end{aligned}$$

Thus,

$$\begin{aligned} &\frac{\partial^2 MHE}{\partial D^{max} \partial \overline{a}} < 0, \text{if} \sqrt{\overline{a}} < \frac{C}{D^{max}}, \\ &\frac{\partial^2 MHE}{\partial D^{max} \partial \overline{a}} = 0, \text{if} \sqrt{\overline{a}} = \frac{C}{D^{max}}, \\ &\frac{\partial^2 MHE}{\partial D^{max} \partial \overline{a}} > 0, \text{if} \sqrt{\overline{a}} > \frac{C}{D^{max}}. \end{aligned}$$

2.D.2 Optimal Capital Regulation

$$\begin{aligned} AP &= \frac{1}{\overline{a}-\underline{a}} \int_{a^*}^{\overline{a}} \left[(C+D^{max})(1-y)a_i yx\right] da_i - C \\ &= \frac{\overline{a}-a^*}{\overline{a}-\underline{a}} \left[(C+D^{max})\frac{1}{2}(\overline{a}+a^*)(1-y)yx\right] - C. \end{aligned}$$

Using $y = \frac{1}{2} - \frac{r^{eq} D^{max}}{2(C+D^{max})x}$, $a^* = \frac{\overline{a}(D^{max}-C)+C}{C+D^{max}}$ and $r^{eq} = \frac{\overline{a}(D^{max}-C)+C}{C+\overline{a}D^{max}}x$, and defining $\widetilde{MHE}$ as the moral hazard effect without the interest rate (i. e., the pure 'skin in the game effect') and AA as the average ability of banks, we find

$$\begin{aligned} AP &= Cx \left[\left(\frac{1}{4} - \underbrace{\frac{(D^{max})^2}{4(D^{max}+C)^2 x^2}}_{\widetilde{MHE^2}} \underbrace{\frac{x^2(\overline{a}(D^{max}-C)+C)^2}{(\overline{a}D^{max}+C)^2}}_{(r^{eq})^2} \right) \underbrace{\frac{1}{2}\left(\frac{2\overline{a}D^{max}+C}{(D^{max}+C)}\right)}_{AA} \right] - C \\ &= \frac{1}{4}Cx \cdot AA - Cx \cdot AA \cdot \widetilde{MHE^2} \cdot (r^{eq})^2 - C. \end{aligned}$$

Denote $D^{max} = D$. Taking the first derivative wrt D:

$$\begin{aligned} \frac{\partial AP}{\partial D} &= Cx \left[\frac{1}{4}\frac{\partial AA}{\partial D} - \frac{\partial AA}{\partial D}\widetilde{MHE^2} \cdot (r^{eq})^2 - AA \cdot \frac{\widetilde{MHE^2}}{D} \cdot (r^{eq})^2 - AA \cdot \widetilde{MHE^2} \cdot \frac{(r^{eq})^2}{D} \right] \\ &= Cx \left[\frac{C(2\overline{a}-1)}{8(C+D)^2} - \frac{C(2\overline{a}-1)D^2x^2(\overline{a}(D-C)+C)^2}{8x^2(C+D)^4(\overline{a}D+C)^2} - \frac{(2\overline{a}D+C)CDx^2(\overline{a}(D-C)+C)^2}{4x^2(C+D)^4(\overline{a}D+C)^2} \right. \\ &\quad \left. - \frac{(2\overline{a}D+C)D^2 2\overline{a}^2 Cx^2(\overline{a}(D-C)+C)}{8x^2(C+D)^3(\overline{a}D+C)^3} \right]. \end{aligned}$$

The characteristic equation is then given by:

$$\begin{aligned} (\overline{a}D+C)^3(C+D)^2(2\overline{a}-1) =& (\overline{a}(D-C)+C)^2(\overline{a}D+C)D^2(2\overline{a}-1) \\ &+ (\overline{a}(D-C)+C)^2(\overline{a}D+C)2D(2\overline{a}D+C) \\ &+ (\overline{a}(D-C)+C)2D^2\overline{a}^2(2\overline{a}D+C)(C+D). \end{aligned}$$

Chapter 3

Financial Fragmentation and Economic Growth in Europe*

This chapter is based on joint work with Isabel Schnabel.[1]

3.1 Introduction

> *"While financial integration deepened significantly after the Euro was introduced, the global crisis caused that process to go into reverse. And we can see the importance of financial integration for the single currency all the more in its absence. In the periphery, financial fragmentation has led to high interest rates for firms and households, and disrupted monetary policy transmission. In the core, it has led to exceptionally low interest rates for savers and potentially distorted asset prices. Consequently, the whole of the Euro area would benefit from lasting financial reintegration - and indeed, addressing financial fragmentation has been one of the key tasks of euro area policy-makers, including the ECB, over the past years."*
>
> Mario Draghi (2014)

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Banking sector integration is a key objective of the European Union (EU). After a substantial deepening of financial integration before the global financial crisis, the process started to reverse with the onset of the crisis. Under the pressure of regulators and national governments, banks started to shift their focus towards their "core markets." Consequently, the European banking sector is far more fragmented today than it had been before the crisis. European policy makers are concerned about this development because banking sector integration may affect European growth prospects, the transmission of the European Central Bank's (ECB) monetary policy, and financial stability (see the speech by Draghi, 2014).

This analysis is the first attempt to investigate the real growth effects of the ongoing fragmentation process in European banking markets. Using data from 2000 to 2012, our dataset covers the period of integration before the global financial crisis and the following period of fragmentation. We allow for heterogeneous effects by distinguishing between crisis and non-crisis times, phases of domestic bank deleveraging and other times, as well as times of disintegration and integration. Our analysis suggests that financial fragmentation generates significant growth losses and emphasizes the need for financial reintegration in Europe. In particular, we find substantial growth effects of banking sector integration in EU member countries (measured by foreign bank assets over GDP) over our sample period. Interestingly, growth effects are more than four times bigger during times of crisis than in normal times. Similarly striking differences are found in phases of strong domestic bank deleveraging compared to other times, but less so in periods of financial disintegration. This seems to reflect the importance of foreign capital as an insurance mechanism against negative shocks to domestic bank lending in times of crisis and deleveraging.[2]

We further analyze the impact of cross-border lending on industry growth differentials. For cross-border lending we find mixed results, whereas our main results on foreign bank assets prove to be robust to this modification. This suggests that especially the presence of foreign banks via branches and subsidiaries is important to reduce the negative effects of shocks to domestic bank lending, in particular during times of severe financial constraints. Results are also robust to measuring banking sector integration by foreign loans to non-financial corporations instead of foreign bank assets.

Using industry-level data from Eurostat, we apply the methodology of Rajan and Zingales (1998) and investigate production growth differentials on industry level. We assume that industries with a high dependence on external finance are more constrained in their

[2]This view is supported by a related paper by Hoffmann and Sørensen (2015) who document how domestic bank dependence made small and medium enterprises in Europe more vulnerable to local shocks.

growth potential by financial frictions than industries with an inherently lower need for external capital. Deeper banking sector integration may reduce these frictions and hence increase the differential of industry production growth between financially dependent and non-dependent industries. The main advantage over country-level approaches is a more credible identification. Since industry-specific growth can be considered exogenous to the development of banking sector integration, reverse causality is less of a concern than in country-level studies. Moreover, given the three-dimensional feature of our data set (country, industry, and time), the approach allows us to control broadly for unobserved heterogeneity by including the full set of two-dimensional fixed effects.

Our study intends to identify short run growth effects of integration; therefore our analysis relies on annual data rather than long run averages as in the original Rajan-Zingales analysis. Banking sector integration is measured by total assets of foreign banks over GDP. Hence, we focus on the overall amount of foreign bank assets rather than the composition of bank assets, in contrast to most other papers on banking sector integration, which analyze the growth effects of the *share* of foreign assets. During times of crisis, subsidiaries of foreign banks tend to adjust their lending differently than domestic banks.[3] While this automatically leads to changes in the share of foreign banks in total bank assets during a crisis, it does not necessarily imply that the overall availability of capital changes in a particular direction.

Before the crisis the process of banking sector integration in Europe was seen as a key feature of the convergence process in which Eastern European transition as well as periphery countries could catch up to the core and at the same time finance current account deficits over a longer time horizon. Since the financial and sovereign debt crisis, however, this has changed completely. Since then, the European banking sector has experienced a process of sharp fragmentation. Banks began to reduce business in foreign countries by withdrawing capital and closing branches and subsidiaries. This disintegration process is widely documented in the literature. Giannetti and Laeven (2012) and Cetorelli and Goldberg (2011) show that during the crisis banks decreased their foreign lending more strongly than their home lending. A more differentiated picture is drawn by De Haas and van Horen (2013). Using loan level data, they find a substantial heterogeneity of the "flight home effect." Banks reduced their lending less if the market was geographically

[3]See De Haas and van Lelyveld (2010) for evidence that foreign subsidiaries reduce lending less than domestic banks during host country crises and De Haas and van Lelyveld (2014) for opposite evidence for the Great Recession in 2008-2009.

near, if they had more experience in the market, if they were present via a subsidiary and if they acted in cooperation with a domestic lender.[4]

Particularly in Europe, regulatory and political pressure appear to have reinforced the process of fragmentation. Motivated by the fact that internationally active banks had to be rescued by national governments, regulators and national authorities started to act protectionist.[5] Politicians conditioned the rescue packages in many cases on measures that reinforced fragmentation. For example, Commerzbank was rescued under the condition of shifting their focus on lending towards German small and medium firms. In the United Kingdom, banks could obtain cheap central bank funding under the condition of supporting local corporations. On supra-national level, the European Commission investigated the rescue of European banks with respect to their compliance with European state aid regulations. As in the case of German Landesbanken, they often asked for restructuring measures implying a substantial reduction of foreign business (for an overview of the EU state aid practice, see Lannoo and Napoli, 2010).

Our study adds to the literature on the growth effects of financial integration and on the disrupting effects of financial crises. The benefits and costs of financial integration are still debated in the literature.[6] This is consistent with theoretical work by Gourinchas and Jeanne (2006) and Coeurdacier, Rey, and Winant (2013) who show that if there are any positive growth effects at all, they are expected to be relatively small. Evidence of growth effects of banking sector integration is slightly more positive. By studying growth on industry level, Bruno and Hauswald (2014) find an overall positive growth effect of a higher share of foreign banks. Beck, Demirgüç-Kunt, and Maksimovic (2004) argue that a higher share of foreign banks reduces obstacles from banking sector concentration because smaller firms can more easily obtain external financing. Giannetti and Ongena (2012) find that foreign banks improve the access to credit and thereby reduce financial constraints for firms. However, there are also papers doubting the benefits of banking sector integration. Gormley (2010) investigates foreign bank entry in India and finds that foreign banks crowded out domestic banks, worsening access to credit for most firms. Similarly, Detragiache, Tressel, and Gupta (2008) argue theoretically that welfare might

[4]Formal commitment also has a stabilizing effect, as shown by De Haas, Korniyenko, Pivovarsky, and Loukoianova (2012). They use commitment letters of the Vienna Initiative to demonstrate that banks that had committed to exposures in Central and Eastern Europe reduced their lending there substantially less during the crisis than in countries without such a commitment. Moreover, banks participating in the Vienna Initiative reduced overall lending less than other banks.

[5]See Rose and Wieladek (2014) for evidence that nationalized non-British banks decreased lending to and increased interest rates for UK firms. In contrast, nationalized British banks did not engage in financial protectionism.

[6]For an excellent overview, see Kose, Prasad, Rogoff, and Wei (2009).

be reduced by foreign bank presence. According to their model, hard information can be better interpreted by foreign than by domestic banks. As a result, borrowers whose type can be revealed by hard information can obtain lower rates, while the others have to pay higher interest rates. Hence, the welfare effect of foreign banks remains ambiguous.

However, Europe seems to be different. Guiso, Jappelli, Padula, and Pagano (2004) document a significant "growth dividend" for countries in the EMU from improved financial market development through deeper financial integration. Similarly, Prasad, Rajan, and Subramanian (2007) and Abiad, Leigh, and Mody (2009) illustrate that in Europe the patterns of financial integration and economic growth are different from the rest of the world.[7] More specifically, Masten, Coricelli, and Masten (2008) find evidence that especially countries with a relatively high degree of financial development could benefit. According to their argument, countries have to build up significant capacity to absorb capital inflows. However, financial integration is unlikely to be the only source of the European success story (Imbs, 2009). Friedrich, Schnabel, and Zettelmeyer (2013) argue in favor of a complementary relationship between financial integration and political integration in Eastern Europe, which helped financial integration with Western Europe to realize its growth-enhancing potential by affecting investors' expectations.

In contrast to the question of growth effects through financial integration, evidence of a causal relationship of financial crises on economic growth is much clearer. Kroszner, Laeven, and Klingebiel (2007) and Dell'Ariccia, Detragiache, and Rajan (2008) provide robust evidence of significant negative growth effects of financial crises. However, both studies do not intend to figure out the channels of these adverse effects. Most closely related to our work is the paper by Eichengreen, Gullapalli, and Panizza (2011), which provides a synthesis of the literature on the growth effects of financial integration and crises. Applying the Rajan-Zingales methodology in a broad country sample, they estimate the growth effect of financial integration while controlling for the depth of the financial system and distinguishing between decades with and without crises. They confirm the generally positive impact of financial integration on growth, but they find that financial integration did not have any impact in times of crisis. Hence, they conclude that countries can benefit from financial integration during normal times, but not in times of crises.[8]

[7]For evidence that the EMU experienced a substantial financial integration process, e. g., see Lane (2006), Lane and Milesi-Ferretti (2008), Schmitz and von Hagen (2011), and Kim, Moshirian, and Wu (2006). Spiegel (2009) tries to disentangle the channels through which banking sector integration strengthened. He finds a "pairwise" effect in the sense that integration deepened especially through banking relationships in which both banks are hosted in the EMU.

[8]In contrast, Glick, Guo, and Hutchison (2006) argue that countries with more open capital accounts suffer less often from crises.

However, Europe may again be different. Therefore, the recent crisis offers an interesting laboratory to re-examine the effect of financial integration in times of crisis within a European sample. Moreover, Eichengreen, Gullapalli, and Panizza (2011) focus on the long run growth effects of financial integration by considering average industry production growth over a decade. Such an approach may not be able to capture growth effects during times of financial distress when integration can revert quickly. By estimating the model on a yearly basis, we are able to identify the short run growth effects of financial integration.

This chapter is organized as follows: Section 3.2 sets the stage by describing the measurement of banking sector integration and showing the evolution of these measures in Europe. Section 3.3 explains the methodology used in our analysis. Section 3.4 gives an overview of the data. Section 3.5 contains the main regression results for the growth effects of foreign banks. Section 3.6 contains two extensions: the consideration of cross-border lending as well as lending to non-financial firms instead of total bank assets. Finally, Section 3.7 concludes.

3.2 Banking sector integration in Europe

3.2.1 Measuring financial integration

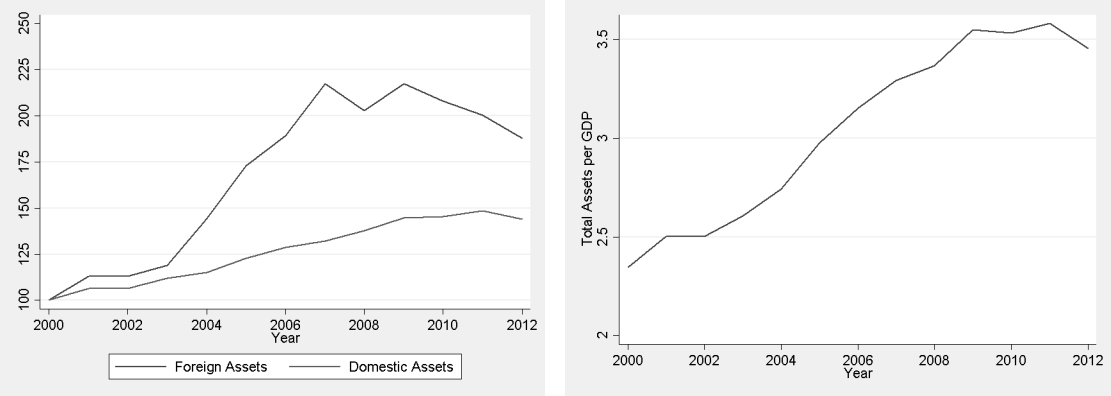
One possibility of measuring financial integration is using de jure measures, based on legal restrictions of international capital flows. Information is, for example, provided by the *Annual Report on Exchange Arrangements and Exchange Restrictions* (AREAER), comprising a large list of indicators of legal capital controls. However, as Kose, Prasad, Rogoff, and Wei (2009) point out, these measures represent formal aspects, which may differ substantially from the administrative implementation of capital controls and from the actual size of cross-border capital flows. Hence, the authors argue in favor of aggregated transaction-based de facto measures, since they better indicate the actual degree of financial integration. Moreover, they conclude that quantity-based measures should be preferred over price-based measures because the cross-country comparison of equity and bond prices may suffer from distortions due to illiquidity and varying risk premia.[9] Furthermore, stock measures should be preferred over flow measures, which typically suffer from a high volatility and from larger measurement errors than stock measures.

[9]Bekaert, Harvey, Lundblad, and Siegel (2013), however, argue that the cross-country differences between industry valuations give a good indication of equity market integration. Specifically, they argue that in a fully integrated market, discount rates and expected earnings growth differentials across industries should be similar across European countries. Applying this approach to the European Union they find evidence of increased integration since 1990 until the global financial crisis.

The developments in European financial markets illustrate the superiority of using de facto measures, since de jure capital controls are no longer present in Europe and did not emerge in the crisis either. Nevertheless, financial markets are now far more fragmented than they had been right before the crisis. Hence, we are using de facto measures in our analysis. Specifically, we are using total assets of foreign banks relative to GDP as our main measure of banking sector integration.

3.2.2 Patterns of integration and fragmentation in the European banking sector

Since the adoption of the Euro, European banking sectors have steadily deepened their integration towards a single European banking market. Figure 3.1(a) depicts the evolution of total assets of foreign and domestic banks over GDP in the European Union. It shows that, relative to GDP, foreign bank assets doubled from 2000 to 2008 and increased much faster than domestic bank assets. Since 2008, however, banks have started to reduce their foreign presence by closing or selling foreign affiliates and by reducing assets, implying a decrease of assets of foreign banks until 2012. Domestic bank assets over GDP have remained relatively constant since 2008 and started to decrease only in 2011; a similar development is observed for total bank assets over GDP (Figure 3.1(b)). Hence, on aggregate level the bank deleveraging process seems to have been driven largely by a reduction in foreign bank assets.



(a) Foreign and domestic bank assets / GDP

(b) Total bank assets / GDP

Figure 3.1: Total assets of foreign and domestic banks over GDP in the European Union (left chart, year 2000 = 100) and total bank assets over GDP (right chart). Source: Own calculations.

Further, the mild reduction in domestic bank assets may be related to the ECB's liquidity support (especially the LTROs), which was often invested in sovereign bonds

and helped to avoid balance sheet reductions (Acharya and Steffen, 2015). Figure 3.2 illustrates the development of the share of foreign assets in total bank assets and gives a similar impression as Figure 3.1(b). Between 2000 and 2007, the share of foreign bank assets doubled, but it started to decrease with the onset of the crisis.

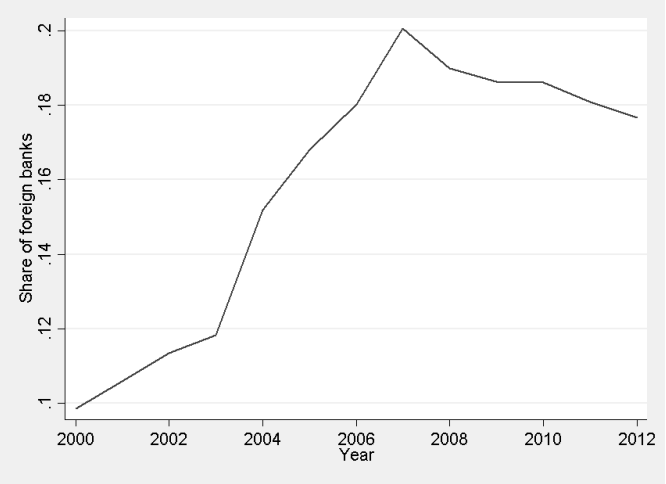


Figure 3.2: Share of foreign bank assets in total bank assets. Source: Own calculations.

Table 3.1 provides a more detailed picture of banking sector integration in the European Union. It contains country-specific information about the mean size of European banking sectors (from 2000 to 2012) and the importance of domestic and foreign banks.European countries appear to be quite heterogeneous with respect to the size of their banking sectors as well as the shares of foreign banks. Western European countries tend to have bigger banking sectors than Eastern European countries. Ireland has the largest banking sector with a mean size of seven times GDP (the peak is given by more than ten times GDP in 2009).[10] In contrast, Romania exhibits the smallest banking sector relative to GDP with a mean value of 60%. The share of foreign banks, however, is on average higher in Eastern European countries. Estonia has a the highest share of foreign bank assets (93.5%). Countries like the Czech Republic and Slovenia show similarly large values. The reason lies in a far-reaching privatization process as part of the transformation process from former Soviet republics to members of the European Union, in which Western banks acquired large parts of the banking sectors in Eastern Europe. In Western Europe, Finland has the highest foreign share with 49% of total assets. Sweden is the country with the lowest share of foreign banks (7.6% of total bank assets).

[10]In the European Union, Luxembourg has the biggest banking sector with mean total assets of about 30 times GDP. However, it is not included in the sample as will be explained in Section 3.4.

Table 3.1: Banking sector integration in European countries

Country	Mean TA banking sector over GDP	Mean TA foreign banks over GDP	Mean TA domestic banks over GDP	Mean share foreign banks
Austria	3.054	0.517	2.537	0.169
Belgium	3.239	0.999	2.240	0.310
Bulgaria	0.986	0.764	0.222	0.775
Czech Republic	1.062	0.939	0.122	0.885
Denmark	3.829	0.662	3.167	0.174
Estonia	1.369	1.282	0.087	0.935
Finland	1.980	1.098	0.883	0.490
France	3.406	0.322	3.084	0.095
Germany	3.095	0.236	2.859	0.076
Greece	1.845	0.406	1.439	0.226
Hungary	1.115	0.584	0.530	0.524
Ireland	7.149	2.296	4.853	0.323
Italy	2.030	0.212	1.818	0.098
Latvia	1.475	0.772	0.702	0.518
Lithuania	0.849	0.677	0.172	0.795
Netherlands	3.476	0.353	3.123	0.102
Poland	0.784	0.467	0.317	0.596
Portugal	2.664	0.612	2.052	0.233
Romania	0.599	0.438	0.161	0.721
Slovakia	0.948	0.839	0.109	0.892
Slovenia	1.359	0.385	0.974	0.281
Spain	2.637	0.249	2.388	0.094
Sweden	2.474	0.190	2.284	0.076
United Kingdom	4.483	1.048	3.435	0.235

Notes: TA = total assets. Values denote averages over years 2000-2012.

3.3 Methodology

We apply the approach of Rajan and Zingales (1998) and study differences between industry production growth rates in countries with different degrees of banking sector integration. Rajan and Zingales (1998) argued that industries are characterized by their inherent need for external capital to finance their capital expenditures beyond using internal financing. If banking sector integration reduces financial constraints for industrial firms, industries that rely heavily on external financing should benefit more in terms of production growth. Studying the effect of banking sector integration on growth on industry level has two main advantages. First, reverse causality issues are mitigated as it is unlikely that production growth of specific industries affects banking sector integration. This problem is further reduced by including the first lag of the integration variable. Second, we can include a full set of two-dimensional fixed effects, which allows to control broadly for unobserved heterogeneity. However, this also has a downside: The methodology does not allow for the identification of absolute growth effects because part of the effect of banking sector integration on economic growth is absorbed by the fixed effects. Hence, causal inference can only be drawn with respect to the effects of banking sector integration on production growth differentials between industries differing with respect to their dependence on external finance.

3.3.1 Empirical model

Our baseline equation is a modification of that by Rajan and Zingales (1998), using annual data instead of long run averages and distinguishing between foreign and domestic assets:

$$\begin{aligned}\text{Production growth}_{i,j,t} = \alpha_{i,j} + \beta_{j,t} + \gamma_{i,t} \\ + \delta_0 \cdot \text{Industry share}_{i,j,t-1} \\ + \delta_1 \cdot \text{Ex. dependence}_j \cdot \text{Total assets of foreign banks}_{i,t-1} \\ + \delta_2 \cdot \text{Ex. dependence}_j \cdot \text{Total assets of domestic banks}_{i,t-1} \\ + \epsilon_{i,j,t}.\end{aligned}$$

i denotes the country, j the industry, and t the year. Following Rajan and Zingales (1998), we include the lagged share of industry production as a fraction of GDP to account for catching-up effects of young industries. The coefficient of interest is δ_1, which captures the differential growth effect of banking sector integration. We control for the domestic provision of external finance via the interaction term of domestic bank assets over GDP and external dependence. Due to the three-dimensional structure of our dataset, we can include

a large set of fixed effects to control for unobserved heterogeneity. Country-industry fixed effects, $\alpha_{i,j}$, control for all time-invariant factors varying on country-industry level, e. g., constant subsidies for a given industry in a given country. Industry-time fixed effects, $\beta_{j,t}$, capture industry-specific developments affecting all countries. One example might be a global industry shock like oil price changes. Finally, we include country-time fixed effects, $\gamma_{i,t}$, which capture factors that affect all industries in a specific country and year in the same way, e. g., country-specific business cycles, which influence demand in all industries. In all regressions standard errors are clustered on industry level.

Our study is designed to estimate short run effects of banking sector integration on industry production growth. In contrast to most other studies focussing on the composition of bank assets, we measure banking sector integration as total assets of foreign banks relative to GDP (rather than the fraction of foreign in total bank assets). This allows us to identify the effect of additional foreign capital provided by the banking sector, holding domestic bank assets constant.

3.3.2 Definition of crises, deleveraging and disintegration

Our analysis distinguishes between crisis times and normal times, times of domestic bank deleveraging and other times, and banking sector disintegration and integration by defining three sets of dummy variables. All dummies are on a country-year basis. Table 3.2 shows their definitions.

Table 3.2: Definition of financial crises, phases of disintegration and deleveraging

Variable	Value	Definition$_{i,t}$
Crisis$_{i,t}$	1	**Beginning of crisis:** Significant distress in banking sector and rescue measures by government (Laeven and Valencia, 2013a), **End of crisis:** Real GDP growth positive and decrease in unemployment rate
	0	otherwise
Deleveraging$_{i,t}$	1	Change in domestic bank assets / GDP from year $t-1$ to year $t \leq$ 35th percentile ($\leq$ 25th perc. / $\leq$ 15th perc.) of the distribution
	0	otherwise
Disintegration$_{i,t}$	1	Change in foreign bank assets / GDP from year $t-1$ to year $t \leq$ 35th percentile ($\leq$ 25th perc. / $\leq$ 15th perc.) of the distribution
	0	otherwise

For the dummy variable *Crisis*, we use the country-specific beginning of the crisis from Laeven and Valencia (2013a) who provide a comprehensive database of banking crises from 1970 to 2011. The beginning is defined by two conditions. First, there have to be indicators of significant distress in the banking sector, such as bank liquidation, bank runs, and significant losses. Second, the government has to provide significant rescue measures (see Laeven and Valencia, 2013a). As shown in Table 3.3, there is substantial heterogeneity across countries. Some countries in our sample did not experience a crisis; examples are Estonia, Poland, and Finland. Since the database only provides information about the beginning of the crisis, we define the end as the first year when real GDP growth is positive and the unemployment rate is decreasing. We add the second condition because GDP growth rates are typically very sensitive to government spending. In the crisis, growth rates plummeted massively in 2009 but many countries experienced a positive GDP growth rate already in 2010 because of large fiscal stimuli. At the same time, many countries still experienced increasing rates of unemployment and had to provide significant rescue packages to the banking sector. Hence, we do not think that defining the end of the crisis based on GDP growth alone is appropriate. Table 3.3 gives an overview of the country-specific timing of the crisis.

The dummy variable *Deleveraging* measures the extent to which domestic banks shrink their balance sheets. We define it as a binary variable, being equal to 1 if in country i the value of total assets of domestic banks over GDP in year t minus the value in year $t-1$ is below a certain threshold, and 0 otherwise. Our thresholds are based on the precentiles of the distribution of the annual changes of domestic bank assets over GDP. Our starting point is the 35th percentile, which is close to a change of zero, which is a natural benchmark for a deleveraging process (see Table 3.4). Moreover, we consider the 25th and the 15th percentile, which still provide us with a sufficient number of observations on both sides of the thresholds.

As counterpart of domestic bank deleveraging, we consider disintegration, which measures the shrinking of balance sheets by foreign banks. *Disintegration* is defined analogously to *Deleveraging*. Hence, it has a value of 1 if in country i the change of foreign bank assets over GDP in year t compared to year $t-1$ is smaller than a certain threshold. We use the same thresholds as before, namely the 35th (which is again close to 0), the 25th and the 15th percentile (see Table 3.4).

Table 3.3: Country-specific summary statistics (1)

Country	Crisis	Number of years in crisis	Number of years with dom. delev.	Number of years with disint.
Austria	2008-2009	2	5	4
Belgium	2008-2010	3	6	4
Bulgaria	-	0	1	2
Czech Republic	-	0	4	3
Denmark	2008-2011	4	3	4
Estonia	-	0	0	2
Finland	-	0	3	2
France	2008-2010	3	3	5
Germany	2008-2009	2	6	2
Greece	2008-2012	5	3	3
Hungary	2008-2010	3	3	3
Ireland	2008-2012	5	3	5
Italy	2008-2012	5	2	3
Latvia	2008-2010	3	1	2
Lithuania	-	0	2	3
Netherlands	2008-2010	3	2	5
Poland	-	0	5	4
Portugal	2008-2012	5	2	4
Romania	-	0	2	3
Slovakia	-	0	5	3
Slovenia	2008-2012	5	2	2
Spain	2008-2012	5	0	2
Sweden	2008-2010	3	3	4
United Kingdom	2007-2011	5	4	5

Notes: The table contains the number of years that a country is in a financial crisis based on the definition in Table 3.2. Domestic deleveraging and disintegration are constructed here using a cutoff value of zero, Hence, domestic deleveraging is defined as a reduction of domestic bank assets / GDP from year $t-1$ to year t and disintegration as a reduction of foreign bank assets / GDP from year $t-1$ to year t.

Table 3.4: Percentiles of the change of Domestic bank assets and Foreign bank assets over GDP

Variable	10%	15%	20%	25%	30%	35%	40%	45%	50%
Δ Dom. bank assets / GDP	-0.116	-0.066	-0.034	-0.011	-0.003	0.006	0.020	0.026	0.041
Δ For. bank assets / GDP	-0.170	-0.084	-0.054	-0.019	-0.013	-0.005	0.003	0.009	0.014

Variable	55%	60%	65%	70%	75%	80%	85%	90%	Mean
Δ Dom. bank assets / GDP	0.060	0.081	0.105	0.121	0.157	0.216	0.263	0.362	0.072
Δ For. bank assets / GDP	0.020	0.029	0.035	0.044	0.057	0.073	0.096	0.162	-0.036

Notes: Percentiles for the change of foreign and domestic bank assets over GDP are on country-year-level and are unweighted by the number of industry-country-year observations.

3.4 Data

The analysis is based on industry-level data from EU countries. We drop small countries serving as financial centers, namely Malta, Cyprus, and Luxembourg, as is common in the literature. On the one hand, they do not provide a sufficient number of industry observations. On the other hand, they exhibit features of financial centers, which may distort our results because the values of banking sector integration can be extreme compared to the remaining countries. In addition, Croatia does not provide data on the assets of foreign branches and subsidiaries. Hence, our final sample consists of the remaining 24 EU member countries.

Industry production Annual industry data are obtained from the Eurostat database *Structural Business Statistics*, which provides production data on an annual basis up to 2012 for countries of the European Union. Data are collected according to the European industry classification NACE Rev. 1.1 (until 2008) and NACE Rev. 2 (since 2008). In order to make results comparable to previous studies, we match the NACE industry classification using official correspondence tables from UNIDO to the 3- and 4-digit industry sectors originally studied in the work of Rajan and Zingales (1998). This procedure yields 35 industry sectors. Industry production values are deflated by the consumer price index.[11]

Macroeconomic variables, such as GDP and inflation rates are also obtained from the Eurostat database. All data are converted in euros based on the corresponding exchange rates for non-eurozone countries.

External dependence The measure of external dependence is defined by Rajan and Zingales (1998) as

$$\text{External dependence} = \frac{\text{Capital expenditures} - \text{Cash-flow from operations}}{\text{Capital expenditures}}.$$

It is taken from Laeven and Valencia (2013b) who updated the initial values of Rajan and Zingales (1998) by using firm-level data from the US for the period of 1980-2006. Table 3.5 displays the industries and corresponding values for external dependence.

Banking sector integration We measure banking sector integration by de facto indicators, using total assets of branches and subsidiaries of foreign-owned EU banks over GDP, named *Foreign bank assets*, as reported by the ECB. *Domestic bank assets* are defined as the residual of total bank assets minus foreign bank assets. Hence, it also

[11] A detailed description can be found in Appendix 3.A.

Table 3.5: External dependence

Industrial Sector	ISIC Rev. 2	External dependence
Tobacco	314	-1.76
Leather	323	-0.98
Footwear	324	-0.56
Pottery	361	-0.52
Other chemicals	352	-0.07
Furniture	332	-0.07
Petroleum refineries	353	0.03
Apparel	322	0.05
Printing and publishing	342	0.06
Basic excluding fertilizers	3511	0.06
Beverages	313	0.06
Spinning	3211	0.08
Nonmetal products	369	0.09
Pulp, paper	3411	0.10
Synthetic resins	3513	0.10
Transportation equipment	384	0.13
Paper and products	341	0.13
Wood products	331	0.14
Food products	311	0.14
Textile	321	0.17
Metal products	381	0.19
Iron and steel	371	0.24
Plastic products	356	0.24
Glass	362	0.24
Petroleum and coal products	354	0.27
Ship	3841	0.30
Nonferrous metal	372	0.32
Rubber products	355	0.37
Motor vehicle	3843	0.38
Electric machinery	383	0.39
Machinery	382	0.50
Other industries	390	0.52
Office and computing	3825	0.66
Drugs	3522	0.78
Professional goods	385	0.85
Radio	3832	0.93

Notes: The table contains the external dependence ratios provided by Laeven and Valencia (2013b), constructed from data for the United States for the period 1980–2006.

contains foreign non-EU banks. Data on assets of foreign non-EU banks are incomplete, hence using them would result in a large loss of observations. Since the share of assets of foreign non-EU banks is typically very small, the residual provides a good approximation of domestic bank assets.

Table 3.6 shows the descriptive statistics for our sample. Due to large outliers, industry production growth rates are winsorized at the 0.5%-level; thereby the mean decreases from 0.4% to 0.1%.

Table 3.6: Summary statistics

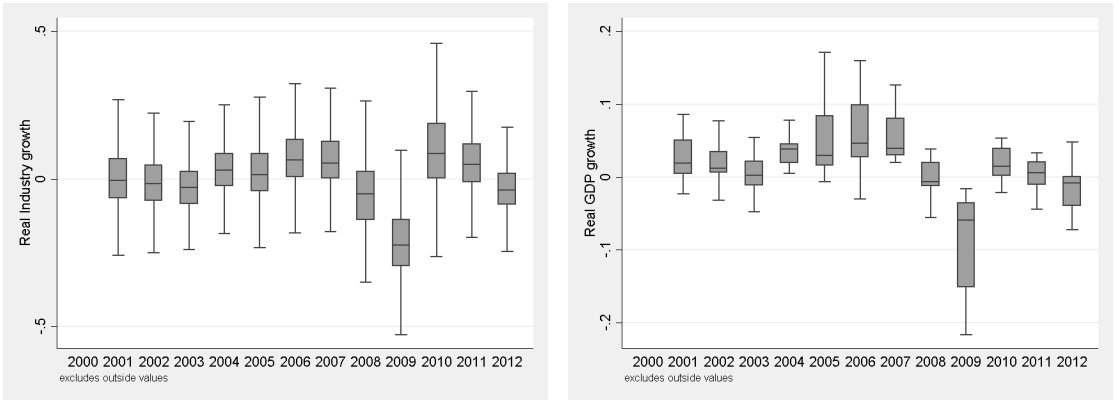
Variable	Mean	Std. Dev.	Min.	Max.	N
Production growth (unwinsorized)	0.004	0.211	-1	6.324	5,414
Production growth (winsorized 0.5%)	0.001	0.162	-0.573	0.887	5,414
Industry share	0.016	0.021	0.0001	0.238	5,414
Foreign bank assets / GDP	0.590	0.482	0.042	3.715	5,414
Domestic bank assets / GDP	1.879	1.298	0.041	6.902	5,414
Credit inflow / GDP	0.073	0.066	0	0.576	4,386
Foreign bank credit to non-fin. corp. / GDP	0.110	0.080	0.013	0.472	4,507
Domestic bank credit to non-fin. corp. / GDP	0.284	0.199	0.009	0.805	4,507
External dependence	0.140	0.424	-1.76	0.93	5,414
Financial crisis	0.234	0.423	0	1	5,414
Deleveraging (cutoff = 0)	0.318	0.466	0	1	5,414
Disintegration (cutoff = 0)	0.338	0.473	0	1	5,414

Figure 3.3(a) illustrates the distribution of real industry production growth rates for each year over all countries in the European Union. The evolution over time is very similar to that of real GDP growth rates shown in Figure 3.3(b). However, the median of industry production growth exhibits a much higher volatility than that of GDP growth (note the different scales).

The mean over all industry-country-year observations of total assets of foreign branches and subsidiaries is 59.0% of GDP, whereas the mean of total assets of domestic banks is 187.9% of GDP.[12]

Roughly one fifth of country-year observations fall into a crisis period and one third into a phase of financial disintegration or deleveraging of domestic banks (using a cutoff of zero for both variables), respectively (see Table 3.6). Appendix Table 3.15 displays the

[12]See Section 3.6 for a description of the variables Credit inflow and Domestic/Foreign credit to non-financial corporations.

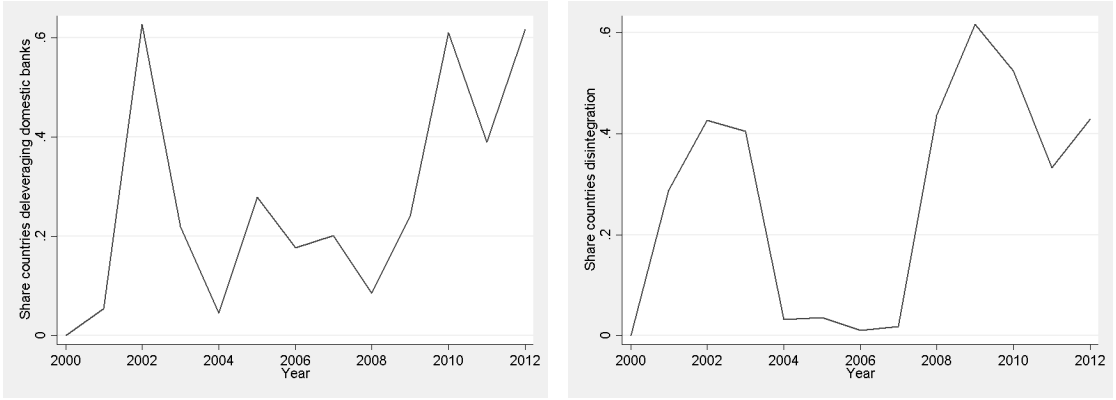


(a) Real industry production growth rates **(b)** Real GDP growth rates

Figure 3.3: Real industry production growth rates (left chart) and real GDP growth rates (right chart) by year over all EU countries. Boxes denote the median and the 75th and 25th percentile, whiskers denote the closest observation to 1.5 times the interquartile range above the 75th and below the 25th percentile. Source: Own calculations.

correlation structure between the dummy variables. Overall the correlations are relatively small. Interestingly, the correlation between times of crisis and periods of domestic bank deleveraging is close to zero. Figure 3.4 illustrates that deleveraging and disintegration were also associated to the bursting of the dot-com bubble in 2001 (which did not lead to a banking crisis) and not just to the recent crisis, which may explain the low correlation.

Additional country-specific statistics are found in Table 3.3 and in Appendix Table 3.14.



(a) Deleveraging (share of countries) **(b)** Disintegration (share of countries)

Figure 3.4: Share of country-year observations with deleveraging of domestic banks as well as disintegration using a cutoff of zero (see text for the construction of these variables). Source: Own calculations.

3.5 Banking sector integration and industrial production growth in Europe

3.5.1 Banking sector integration over the cycle

We start our analysis by documenting the growth effect of foreign bank assets over the entire cycle (2000 until 2012) before distinguishing different subsamples.

We find a positive growth effect of banking sector integration in the European Union over the entire sample. The coefficient of the interaction term between the amount of foreign assets over GDP and industries' external dependence is statistically highly significant (see the first regression column in Table 3.7). This is in line with previous studies, which found that foreign bank presence has a positive growth effect (see, e. g., Bruno and Hauswald, 2014; Giannetti and Ongena, 2012).[13] The industry share enters with a negative and highly significant coefficient. This is in line with previous studies. In contrast, the coefficient of the interaction between total assets of domestically owned banks and external dependence is statistically insignificant.

To gauge the economic significance of the estimated effects, we calculate the *differential in real growth rates* by Rajan and Zingales (1998), as is common in the literature (Friedrich, Schnabel, and Zettelmeyer, 2013; Guiso, Jappelli, Padula, and Pagano, 2004; Masten, Coricelli, and Masten, 2008).

Consider first a country with a high amount of foreign bank assets over GDP (75th percentile of the distribution), corresponding to 0.820 (see Table 3.8). We can express the growth effect of integration in a given country as the growth differential between two industries differing in their need for external financing (more specifically, the industries at the 75th and 25th percentile of the distribution of external dependence):

$$\begin{aligned}\text{Growth differential}_{75\%-25\%} \text{ in country}_{75\%} =& \text{estim. coefficient} \\ & \cdot (\text{ex. dependence}_{75\%} - \text{ex. dependence}_{25\%}) \\ & \cdot \text{foreign bank assets}_{75\%} \\ =& 0.116 \cdot (0.37 - 0.060) \cdot 0.820 = 0.0295\end{aligned}$$

[13] In general, this growth-enhancing effect of banking sector integration might be induced by better lending conditions for corporations. The analyses of Claessens, Demirgüç-Kunt, and Huizinga (2001) and Giannetti and Ongena (2009) point in this direction as they argue that foreign bank entry depresses margins and profitability for domestic banks, improves the capital allocation and mitigates frictions in the credit market.

Table 3.7: Estimation results for hypothesis *Normal times vs. times of crisis* measuring banking sector integration as Foreign bank assets

VARIABLES	**Over the cycle** Production growth	**Normal times** Production growth	**Times of crisis** Production growth	**Difference** Production growth
Industry share	-3.060***	-4.220***	-3.351**	4.220**
	(0.644)	(1.478)	(1.598)	(1.700)
Industry share in times of crisis				0.869
				(2.623)
Industry growth effect of foreign bank assets,	0.116***	0.0973***	0.451***	0.0973***
depending on external dependence	(0.0275)	(0.0272)	(0.185)	(0.0313)
Industry growth effect of foreign bank assets				0.354*
in times of crisis, depending on external dependence				(0.213)
Industry growth effect of domestic bank assets,	-0.0265	0.00289	-0.00954	0.00289
depending on external dependence	(0.0219)	(0.0227)	(0.0838)	(0.0262))
Industry growth effect of domestic bank assets				-0.0124
in times of crisis, depending on external dependence				(0.101)
Constant	0.127***	-0.0943***	-0.217*	0.0469*
	(0.0196)	(0.0319)	(0.110)	(0.0239)
Differential in real	1.83***	1.53***	7.10***	5.57*
growth rates foreign bank assets	(0.433)	(0.428)	(2.913)	(3.354)
Differential in real	-1.83	0.20	-0.66	-0.86
growth rates domestic bank assets	(1.515)	(1.571)	(5.800)	(6.988)
Observations	5,414	4,148	1,266	5,414
Number of industries	713	701	415	713
Country-time fixed effects	yes	yes	yes	yes
Industry-time fixed effects	yes	yes	yes	yes
Country-industry fixed effects	yes	yes	yes	yes

Standard errors clustered on industry-level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Over the cycle, an industry with a high dependence on external financing grew on average by 2.95 percentage points (pp) per year faster than an industry with a relatively low dependence on external financing in a country with a relatively high degree of banking sector integration. For a country with a relatively low value of foreign bank assets (25th percentile), the difference between industry growth rates is 1.12 pp (growth differential$_{75\%-25\%}$ in country$_{25\%}$ = 0.0112). Hence, the cross-country difference between the growth differentials is 1.83 pp per year. This number is also given in the lower part of Table 3.7 (column 1).

Table 3.8: Distribution of variables for construction of the differential in real growth rates

Variable	10%	25%	50%	75%	90%
Foreign bank assets / GDP	0.190	0.312	0.532	0.820	1.314
Domestic bank assets / GDP	0.163	0.633	2.004	2.865	3.618
Credit Inflow / GDP	0.017	0.038	0.059	0.103	0.145
Foreign bank credit to non-fin. corp. / GDP	0.030	0.056	0.093	0.161	0.219
Domestic bank credit to non-fin. corp. / GDP	0.035	0.094	0.268	0.427	0.518
External dependence	-0.520	0.060	0.140	0.370	0.660

Notes: Percentiles for all variables are on country-year level except for external dependence, which is on industry level. Hence, all variables are unweighted by the number of industry-country-year observations.

3.5.2 Banking sector integration during the crisis

We expect that the strength of the relationship between banking sector integration and industry production growth differs during times of crisis and in normal times. In particular, during a crisis domestic banks reduce financing to the real sector, which translates into more severe financial constraints. This makes foreign financing more valuable in a crisis. The extent to which firms became financially constrained during the crisis is described in detail by Campello, Graham, and Harvey (2010). Using survey methods, they illustrate that many firms considered themselves as financially restricted. Duchin, Ozbas, and Sensoy (2010) provide evidence that corporate investment decreased significantly after the onset of the crisis. They argue that the first wave of investment reductions can be attributed to more severe financial constraints because of a negative shock to credit supply. In addition, the analyses of Kroszner, Laeven, and Klingebiel (2007) and Dell'Ariccia, Detragiache, and Rajan (2008) suggest that during crises growth of industrial value added depends on the availability of external finance. According to their studies industries depending more strongly on external funding grew less during past crises. This is likely to play a role during the crisis in Europe, too, because corporate lending has experienced negative growth rates in many European countries since 2009. It suggests a tightening

of financial conditions although it might also be induced by demand effects (see European Central Bank, 2013). We therefore expect a stronger effect of foreign bank assets on production growth during times of crisis.

Hypothesis 3.1. *Ceteris paribus, the effect of banking sector integration on industry production growth differentials is stronger during the crisis than in normal times.*

The last three columns of Table 3.7 provide the estimation results for Hypothesis 3.1: The first regression gives the results for normal times and the second regression for times of crisis. In the third regression we include the interactions of all variables with the crisis variable to obtain the difference between the two subsamples.

In all regressions the coefficient of the interaction term between total assets of foreign branches and subsidiaries and industries' external dependence is positive and highly statistically significant. However, in times of crises, the coefficient is more than four times larger than during normal times. The results of the third regression show that the difference between the coefficients of normal times and times of crisis is statistically significant. This result is economically important. While during normal times the differential in real growth rates was 1.5 pp per year, it increased during the crisis to 7.1 pp per year. Particularly the growth effect during times of crisis is remarkably high, suggesting an important role of foreign financing during times of domestic distress.

The coefficient of the interaction between total assets of domestically owned banks and external dependence is again statistically and economically insignificant both in normal times and crisis periods. The observed differences between the effects of foreign and domestic banks might be due to better lending decisions of foreign banks, which may be particularly important in times of crises. As Buch, Koch, and Koetter (2009) show, more successful banks are more likely to do cross-border business. Hence, foreign banks should be on average more successful than domestic banks, which might translate into higher industrial production growth.[14]

[14]Koetter and Wedow (2010) directly investigate whether the quantity of loans or rather the quality of loans matters for economic growth. Using stochastic frontier analysis to measure the quality, they investigate economic growth and loan supply in different German regions and find a significant growth effect of the quality and an insignificant effect of the quantity of loans.

3.5.3 Banking sector integration in times of domestic bank deleveraging

In the financial crisis banks had to reduce the high leverage they had built up before, reinforcing the real effects of the crisis.[15] To reduce this procyclicality, the new regulatory framework Basel III contains a redefinition of eligible capital and requires higher core capital ratios, while allowing for a countercyclical adjustment. Banks reacted to these developments by increasing their capital, but at the same time started to shrink their balance sheets.[16] This process is not only seen as an adverse development. A report by the European Systemic Risk Board (2014b) diagnoses an "overbanking" problem in Europe, which would indeed call for a shrinking of bank balance sheets.

Due to the impact of regulatory pressure, the shrinking of balance sheets and the reduction of credit provision are unlikely to be fully or even mainly driven by demand effects. Since there is evidence of real effects of lending shocks[17], we expect that additional capital provided by foreign banks should be particularly beneficial in terms of industrial production growth in times of strong domestic bank deleveraging.

Hypothesis 3.2. *Ceteris paribus, the effect of banking sector integration on industry production growth differentials is stronger in times of strong deleveraging of domestic banks than at other times.*

In Table 3.9 we report the growth effect of additional foreign bank assets conditional on the deleveraging of domestic banks. The estimation results confirm the relevance of foreign capital in mitigating financial constraints. First, we find a stronger growth effect of foreign bank assets in phases of domestic deleveraging than at other times under all three thresholds. Second, the stronger the asset reduction of domestic banks the stronger the growth effect. This supports our hypothesis. Intuitively, foreign banks provide an insurance to industrial firms against negative shocks to domestic bank lending. This is well in line with the results by Hoffmann and Sørensen (2015) who focus on the impact of bank dependency of small and medium-sized enterprises on risk-sharing in Europe. Not surprisingly, the larger the deleveraging shock, the higher the benefit of foreign bank presence. In phases of strong deleveraging ($\leq$ the 25th percentile, corresponding to a decrease in domestic bank assets over GDP by 1.1 pp) the growth effect is economically

[15] See Adrian and Shin (2010) for evidence of a strong procyclicality of bank leverage. Brunnermeier (2008) explains this behavior by reduced market liquidity and increasing margin requirements.

[16] For an overview of EU bank deleveraging, see Bologna, Caccavaio, and Miglietta (2014).

[17] See for example Peek and Rosengren (1997) for evidence of real effects of a lending shock stemming from foreign banks rather than domestic banks.

large with a differential of real growth rates of 7.5 pp per year. When using more extreme cutoffs, the effects become even larger.

3.5.4 Banking sector integration in phases of disintegration

Previous studies on the relationship between banking sector integration and economic growth have typically assumed a symmetric growth effect in times of integration and disintegration. However, it is not obvious that firms are affected symmetrically when financial conditions change. There are two competing explanations for potential differences. On the one hand, banking sector integration may have a stronger impact on industrial production growth in times of financial disintegration. In times of integration, lax financial constraints may hardly affect firms' production decisions. In times of disintegration, however, constraints may become binding such that firms have to adjust their production and investment plans.[18] According to this argument, we expect foreign bank assets to have a stronger growth effect during times of financial disintegration. On the other hand, the effect may be weaker in times of disintegration if growth effects are largely driven by spill-over effects, e. g., of technological knowledge (see Kose, Prasad, Rogoff, and Wei, 2009). Since disintegration can only occur where banking sector integration took place before, technological spillover effects in times of integration may not fully disappear if disintegration occurs. According to this explanation, we would expect a larger coefficient of the interaction term of foreign bank assets with external dependence during the integration phase. However, the latter explanation is rather related to long-term growth and it seems likely that growth effects are overall stronger during phases of disintegration.

Hypothesis 3.3. *Ceteris paribus, the effect of banking sector integration on industry production growth differentials is stronger in times of disintegration than in times of integration.*

Columns (1) and (2) of Table 3.10 show indeed a stronger effect of banking sector integration on industrial growth in the presence of disintegration. The coefficient of the interaction between external dependence and foreign bank assets is significant and positive and implies a differential in real growth rates of about 4.7 pp per year. Columns (3) to (6), however, no longer provide a significant coefficient in times of disintegration and the coefficient even becomes negative for low cutoffs. This suggests that in sudden-stop episodes with a sharp reversal of capital flows, foreign capital reduces industry growth

[18] See Campello, Graham, and Harvey (2010) for the effects of financial constraints on investment activities during the crisis.

Table 3.9: Estimation results for hypothesis *Deleveraging of domestic banks* measuring banking sector integration as Foreign bank assets

	Deleveraging ≤ 35th perc.	**Deleveraging > 35th perc.**	**Deleveraging ≤ 25th perc.**	**Deleveraging > 25th perc.**	**Deleveraging ≤ 15th perc.**	**Deleveraging > 15th perc.**
VARIABLES	Prod. growth	Prod. growth	Prod. growth	Prod. growth	Prod. growth	Prod. growth
Industry share	-3.738**	-2.418***	-5.790***	-2.542***	-7.460***	-2.851***
	(1.540)	(0.581)	(1.495)	(0.597)	(2.550)	(0.655)
Industry growth effect of for. bank	0.159	0.0700	0.479**	0.0751*	1.682**	0.0903**
assets, depending on ex. dep.	(0.206)	(0.0461)	(0.199)	(0.0396)	(0.803)	(0.0384)
Industry growth effect of dom. bank	-0.0659*	-0.0374	0.0160	-0.0330	0.437	-0.0226
assets, depending on ex. dep.	(0.0358)	(0.0560)	(0.0654)	(0.0480)	(0.362)	(0.0269)
Constant	0.0858	0.0440	1.039***	-0.0319	-0.0176	-0.517***
	(0.0525)	(0.0312)	(0.118)	(0.0331)	(0.198)	(0.0167)
Differential in real	2.50	1.10	7.54**	1.18*	26.49**	1.42**
growth rates foreign bank assets	(3.244)	(0.726)	(3.134)	(0.624)	(12.646)	(0.605)
Differential in real	-4.56*	-2.59	1.11	-2.28	30.24	-1.56
growth rates domestic bank assets	(2.477)	(3.875)	(4.525)	(3.321)	(25.048)	(1.861)
Observations	1,941	3,473	1,340	4,074	717	4,697
Number of industries	666	674	583	704	383	707
Country-time fixed effects	yes	yes	yes	yes	yes	yes
Industry-time fixed effects	yes	yes	yes	yes	yes	yes
Country-industry fixed effects	yes	yes	yes	yes	yes	yes

Standard errors clustered on industry-level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

differentials (although not significantly). Overall the results are less clearcut than for the preceding hypotheses.

3.6 Extensions and robustness

In this section we run additional regressions in order to check the robustness of our results. First, we analyze the role of cross-border lending and check whether the results on foreign assets are robust to controlling for credit inflows. Second, we focus on loans to non-financial corporations abstracting from other types of assets like interbank loans.

3.6.1 The role of cross-border lending

So far we have measured banking sector integration by foreign bank presence. One may wonder whether similar growth effects can be obtained for cross-border lending. This would imply that foreign bank presence could be substituted by credit inflows.

The literature suggests, however, that foreign banks located in the reference country may be better able to deal with financial frictions because the distance between lenders and borrowers matters for bank lending, in particular in lending relationships where soft information is important (such as lending to small- and medium-sized companies). In an important paper, Degryse and Ongena (2005) demonstrate that the distance between lender and borrower shapes the specification of loan contracts. Agarwal (2010) provides evidence that distance plays an important role for banks in acquiring private information with consequences for the provision and pricing of credits. The economic relevance is demonstrated by DeYoung, Glennon, and Nigro (2008) who show that loan default of small businesses increases in the geographical distance. Bruno and Hauswald (2014) provide more direct evidence of lower growth effects of cross-border lending relative to lending via foreign branches and subsidiaries. While the growth effect of foreign bank presence is positive and significant in their paper, cross-border lending has a positive, but slightly insignificant coefficient. Therefore, we expect cross-border lending to have a smaller growth effect than credit provision via foreign affiliates because the geographical distance between borrower and lender is typically bigger in the case of cross-border lending.

The data on cross-border lending are taken from the ECB, which provides information about credit provided to non-financial institutions (households and corporations) to the reference country by banks hosted in the rest of the eurozone. Equivalently to foreign and domestic bank assets we normalize these figures by GDP. This variable will be called

Table 3.10: Estimation results for hypothesis *Integration vs. Disintegration* measuring banking sector integration as Foreign bank assets

	Disintegration ≤ 35th perc.	**Disintegration > 35th perc.**	**Disintegration ≤ 25th perc.**	**Disintegration > 25th perc.**	**Disintegration ≤ 15th perc.**	**Disintegration > 15th perc.**
VARIABLES	Prod. growth	Prod. growth	Prod. growth	Prod. growth	Prod. growth	Prod. growth
Industry share	-3.210**	-4.747***	-4.420***	-4.476***	-8.258	-4.619***
	(1.352)	(1.079)	(1.359)	(1.241)	(6.424)	(1.486)
Industry growth effect of for. bank	0.295*	0.0601	0.0155	0.0674	-1.778	0.0776*
assets, depending on ex. dep.	(0.153)	(0.0552)	(0.311)	(0.0586)	(1.242)	(0.0451)
Industry growth effect of dom. bank	0.0628	-0.0534*	0.222	-0.0598*	0.911	-0.0470**
assets, depending on ex. dep.	(0.0639)	(0.0296)	(0.295)	(0.0312)	(0.583)	(0.0231)
Constant	0.370***	0.164***	0.287	-0.0248	0.316	0.124***
	(0.0862)	(0.0292)	(0.317)	(0.0231)	(0.209)	(0.0288)
Differential in real	4.65*	0.95	0.24	1.06	-28.00	1.22*
growth rates foreign bank assets	(2.409)	(0.869)	(4.898)	(0.923)	(19.559)	(0.710)
Differential in real	4.35	-3.69*	15.36	-4.14*	63.03	-3.25*
growth rates domestic bank assets	(4.421)	(2.048)	(20.412)	(2.159)	(40.339)	(1.598)
Observations	1,659	3,755	1,019	4,395	474	4,940
Number of industries	635	693	498	695	299	696
Country-time fixed effects	yes	yes	yes	yes	yes	yes
Industry-time fixed effects	yes	yes	yes	yes	yes	yes
Country-industry fixed effects	yes	yes	yes	yes	yes	yes

Standard errors clustered on industry-level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Credit inflow in the following. Since the ECB does not distinguish between households and corporations, this measure overestimates the credit provision to corporations. Nevertheless, it should give a relatively good indication of the evolution of cross-border corporate lending. For country-specific information on cross-border lending, see Table 3.11.

To investigate the role of cross-border banking, we rerun our main regressions adding an interaction term between external dependence and credit inflow. Table 3.12 displays the results from these regressions. Over the cycle we find a positive and significant coefficient on the interaction between cross-border lending and external dependence. The differential in real growth rates is 1.4 pp per year and therefore somewhat smaller than the growth effect from foreign bank assets (1.7 pp per year). Interestingly, the coefficient of the interaction between external dependence and foreign bank assets remains more or less unchanged relative to the baseline estimation (see Table 3.7).

When distinguishing between times of crisis and normal times, the significant positive growth effect of cross-border lending vanishes in both subsamples. This is surprising as we expected cross-border lending to play a role in mitigating financial constraints at least in times of crisis (see the last three columns in Table 3.12). Instead the coefficient is negative in both subsamples, so there is no stable and economically significant growth effect of cross-border lending. Interestingly, the coefficients of foreign bank assets and their statistical significance are similar to the baseline analysis (see Table 3.7).

The results of these regressions show that cross-border lending has a less robust growth effect than the provision of credit via foreign branches and subsidiaries. The coefficients do not provide consistent evidence that in times of more severe financial constraints cross-border lending plays a positive role in buffering negative lending shocks, although the coefficients often go in the expected direction. Most importantly, the growth effects of foreign bank assets, i. e., of banks being present in the loans' destination country, do not change qualitatively by controlling for cross-border lending. Hence, our main results are robust to this modification. Taken together, the results suggest that cross-border lending is unlikely to generate comparable positive growth effects as foreign bank presence.

3.6.2 Loans to non-financial corporations

So far, our results were based on total assets by foreign and domestic banks. However, typically a large share of banks' balance sheets is not directly associated with lending to corporations. For example, interbank loans and mortgage lending to households constitute a substantial fraction of banks' balance sheets. We therefore repeat our baseline analysis

Table 3.11: Additional measures of banking sector integration

Country	Mean credit inflow over GDP	Mean foreign credit to non-fin. corp. over GDP	Mean domestic credit to non-fin. corp. over GDP
Austria	0.055	0.094	0.438
Belgium	0.108	0.106	0.209
Bulgaria	0.135	0.299	0.086
Czech Republic	0.069	0.170	0.022
Denmark	0.087	0.018	0.088
Estonia	0.053	0.415	0.028
Finland	0.029	0.175	0.122
France	0.033	0.037	0.362
Germany	0.046	0.0315	0.328
Greece	0.074	0.093	0.329
Hungary	0.087	0.140	0.127
Ireland	0.362	0.234	0.500
Italy	0.015	0.059	0.458
Latvia	0.040	0.228	0.206
Lithuania	0.009	0.202	0.066
Netherlands	0.132	0.0547	0.480
Poland	0.045	0.090	0.061
Portugal	0.056	0.142	0.495
Romania	0.052	0.122	0.045
Slovakia	0.062	0.210	0.026
Slovenia	0.189	0.150	0.379
Spain	0.043	0.074	0.675
Sweden	0.049	0.037	0.452
United Kingdom	0.114	0.068	0.220

Notes: Values denote averages over years 2000-2012.

Table 3.12: Estimation results measuring banking sector integration as Foreign bank assets and Credit inflow

VARIABLES	**Over the cycle** Production growth	**Normal times** Production growth	**Times of crisis** Production growth	**Difference** Production growth
Industry share	-3.985***	-4.984***	-3.341**	-4.984***
	(0.725)	(1.425)	(1.551)	(1.698)
Industry share in times of crisis				1.644
				(2.438)
Industry growth effect of foreign bank assets,	0.108**	0.113***	0.452**	0.113**
depending on external dependence	(0.0399)	(0.0374)	(0.201)	(0.0445)
Industry growth effect of foreign bank assets				0.339
in times of crisis, depending on external dependence				(0.246)
Industry growth effect of domestic bank assets,	-0.0453	0.00996	-0.00946	0.00996
depending on external dependence	(0.0287)	(0.0335)	(0.0832)	(0.0399)
Industry growth effect of domestic bank assets				-0.0194
in times of crisis, depending on external dependence				(0.0981)
Industry growth effect of credit inflow,	0.680**	-0.238	-0.0245	-0.238
depending on external dependence	(0.317)	(0.952)	(1.392)	(1.134)
Industry growth effect of credit inflow				0.213
in times of crisis, depending on external dependence				(2.301)
Constant	0.0838***	-0.0166	-0.171*	0.0418*
	(0.0188)	(0.0431)	(0.101)	(0.0242)
Differential in real	1.70**	1.78***	7.12**	5.34
growth rates foreign bank assets	(0.628)	(0.589)	(3.165)	(3.874)
Differential in real	-3.13	0.69	-0.65	-1.34
growth rates domestic bank assets	(1.99)	(2.318)	(5.757)	(6.788)
Differential in real	1.37**	-0.48	-0.05	0.43
growth rates credit inflow	(0.639)	(1.918)	(2.805)	(4.637)
Observations	4,386	3,120	1,266	4,386
Number of industries	706	679	415	706
Country-time fixed effects	yes	yes	yes	yes
Industry-time fixed effects	yes	yes	yes	yes
Country-industry fixed effects	yes	yes	yes	yes

Standard errors clustered on industry-level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

using data on loans to non-financial corporations only. Again, we normalize these values by GDP.

Unfortunately, the precise data needed for this robustness check is not available. The ECB provides information about loans to non-financial corporations of the entire banking sector on a country-year basis for all countries in the European Union. However, the data source lacks the distinction of loans provided by foreign and domestic banks. We therefore have to approximate the share of credit provided by foreign banks using the previously defined share of foreign banks based on total assets. This limitation of the data has to be kept in mind when interpreting the regression results. For country-specific information on foreign and domestic credit to non-financial corporations, see Table 3.11.

The results in Table 3.13 confirm the main conclusions from our baseline regressions. Over the cycle there is a strong and highly significant growth effect of banking sector integration. The higher the volume of loans by foreign banks, the higher the differential in industry production growth rates. The differential in real growth rates is 2.9 pp per year, about 1 pp per year higher than in the baseline regressions (Column 1). This supports the relevance of bank loans by foreign banks for production growth.

Again there is a substantial difference between normal times and times of crisis. In times of financial distress, the growth effect of foreign bank credit is about two times higher than during normal times. The differential in real growth rates increases to about 4.9 pp per year. However, the difference is no longer statistically significant (Columns 2-4). Overall these regressions again support the results from the main regressions.

3.7 Conclusion

In this chapter, we investigated the real growth effects of banking sector integration in times of financial fragmentation and bank deleveraging in the European Union. Our study is motivated by concerns of European policy makers that the broad fragmentation process in the European financial system since the crisis hampers European growth perspectives. Before the crisis, financial integration in the European Union deepened rapidly. Since the crisis, however, regulators and national governments have started to push banks into a re-nationalization of banking sectors and sharp deleveraging. Rescue packages were only granted if they were combined with restructuring plans often containing discouragements of cross-border business, and higher capital requirements forced banks to reduce their balance sheets and the provision of external financing to corporations.

Table 3.13: Estimation results measuring banking sector integration as Foreign bank credit to non-financial corporations

VARIABLES	**Over the cycle** Production growth	**Normal times** Production growth	**Times of crisis** Production growth	**Difference** Production growth
Industry share	-3.784***	-5.334***	-3.612**	-5.334***
	(0.868)	(1.486)	(1.561)	(1.755)
Industry share in times of crisis				1.721
				(2.597)
Industry growth effect of foreign bank credit to non-MFI,	0.891***	0.859***	1.507*	0.859***
depending on external dependence	(0.240)	(0.222)	(0.856)	(0.262)
Industry growth effect of foreign bank credit to non-MFI				0.649
in times of crisis, depending on external dependence				(0.933)
Industry growth effect of domestic bank credit to non-MFI	-0.314***	0.00681	-2.661***	0.00681
depending on external dependence	(0.102)	(0.227)	(0.640)	(0.268)
Industry growth effect of domestic bank credit to non-MFI				-2.668***
in times of crisis, depending on external dependence				(0.724)
Constant	0.0618*	-0.243***	0.249***	0.0342
	(0.0339)	(0.0493)	(0.0591)	(0.0250)
Differential in real	2.90***	2.80***	4.91*	2.11
growth rates foreign credit to non-MFI	(0.781)	(0.723)	(2.786)	(3.037)
Differential in real	-3.24***	0.07	-27.47***	-27.54***
growth rates domestic credit to non-MFI	(1.053)	(2.343)	(6.607)	(7.474)
Observations	4,574	3,308	1,266	4,574
Number of industries	703	678	415	703

Standard errors clustered on industry-level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In our econometric analysis, we use industry production data provided by Eurostat from 2000 to 2012, containing the financial crisis as well as the European sovereign debt crisis, and apply the Rajan-Zingales methodology to a sample of 35 industries and 24 countries. Banking sector integration in the European Union is measured by total assets of branches and subsidiaries of foreign EU banks relative to GDP. Exploiting the three-dimensional structure of our dataset, we are able to include a large set of fixed effects to credibly identify the effect of banking sector integration on industrial production growth. The large heterogeneity of the banking sectors of the member countries of the European Union further strengthens the robustness of our analysis.

Our results show that the concerns regarding financial fragmentation are justified. Over the entire sample, banking sector integration has a substantial positive effect on industry growth differentials. This implies in turn that the observed process of fragmentation caused substantial losses in terms of industry production growth. We find a stronger growth effect during the crisis than in normal times, as well as in times of domestic bank deleveraging relative to other times. During the crisis the effect is more than four times bigger than during normal times, with a differential of real industry production growth rates of about 7.1 percentage points. Similarly large effects were prevalent in times of domestic bank deleveraging. The growth effects at other times are smaller but still substantial and statistically significant. Although we cannot make any statements about the overall effect of banking sector integration at the macroeconomic level, the estimated effects on industry growth differentials are certainly economically important. The results are also robust to focussing on foreign loans to non-financial corporations instead of foreign bank assets. Taken together these results provide strong evidence of the important role of integrated banking sectors in buffering the economic consequences of crises and in exploiting growth potentials in the European Union.

Our results including credit inflows provide evidence of a different role of cross-border lending as compared to lending in foreign countries via branches and subsidiaries. Lending via foreign affiliates generates significant effects on the differential between industrial production growth rates even when controlling for cross-border lending, while cross-border credit provision does not have a robust growth effect across periods. While the effect of foreign bank presence is particularly pronounced during times of crisis and domestic bank deleveraging, the same is not true for cross-border lending. We therefore conclude that obtaining soft information about borrowers by being geographically near is particularly beneficial in times when external financing is scarce. Furthermore, it demonstrates that simply replacing bank presence in the destination countries by cross-border lending is not

possible.

Throughout all of our analyses we do not find a robust positive growth effect of domestic bank assets. The substantial difference to the strong growth effect of foreign bank assets is remarkable and requires further investigation. It is in line with the current debate stressing that the size of the banking sector in general plays a minor role in promoting economic growth and points towards a potential "overbanking" problem, as was diagnosed by the European Systemic Risk Board (2014b) for the European banking sector. This strand of the literature argues that the growth-enhancing role of a deeper financial sector holds only for relatively small financial sectors. If it exceeds some threshold (relative to the size of GDP), countries no longer benefit from a bigger financial sector. The statistically insignificant coefficients of total assets of domestically owned banks provide evidence in this direction.

Based on our results, we conclude that banking sector integration plays an important role for economic growth in the European Union, particularly in the current phase of fragmentation and deleveraging. Therefore, concerns of European politicians and officials of the ECB about the adverse growth effects of the ongoing disintegration process in the European banking sector seem to be legitimate. Further fragmentation of the European banking sector is likely to make financial constraints even more severe. Especially when domestic banks shrink their balance sheets, financial fragmentation has exceptionally strong negative growth effects. The ECB seems to be aware of the need for an appropriate management of the deleveraging process. The robust finding of strong negative growth effects of financial fragmentation calls for additional international efforts to overcome protectionist tendencies on national level. They also cast doubts on measures by the European Commission fostering financial disintegration. Finally, they emphasize the importance of projects fostering financial integration at the European level. The Banking Union and the planned Capital Markets Union may set the stage for a new era of European financial integration, which we believe is an important building block of future growth perspectives in the European Union.

Appendix

3.A Industry production data

Industry production data

Up to 2008, industry production data of the Eurostat database *Structural business statistics* are collected on 2-, 3-, and 4-digit levels of the European industry classification NACE Rev. 1.1 (corresponding to the international classification ISIC Rev. 3.1). Since 2008, the industry classification system in the European Union in use has been NACE Rev. 2 (corresponding to ISIC Rev. 4). In order to make results comparable to previous studies, we match the NACE industry classification using official correspondence tables from UNIDO to the 3- and 4-digit industry sectors originally studied in the work of Rajan and Zingales (1998). For sectors where a perfect matching was not possible, we match NACE-sectors to the most closely related sectors of ISIC Rev. 2. We are then left with 93 3-digit NACE Rev. 2 sectors. Note that the sector *Synthetic resins* (ISIC Rev. 2 code 3513) of the Rajan-Zingales study could not be matched to any single 3-digit NACE Rev. 2 sector and is therefore dropped from the analysis. The 93 3-digit NACE-sectors were then aggregated on the ISIC Rev. 2 level to 35 sectors, in order to obtain a sector classification as close as possible to previous studies with one observation per country, year, and ISIC Rev. 2 classification. Note that we drop all industries with a production value of less than 0.01% of GDP. These industries are so small that they only contain a very small number of firms.

3.B Dataset

Table 3.14: Country-specific summary statistics (2)

Country	Mean industry growth	Mean GDP	Mean GDP growth
Austria	0.0178	248,964.10	0.0121
Belgium	0.0067	304,360.60	0.0113
Bulgaria	0.0301	23,753.91	0.0350
Czech Republic	0.0239	109,052.30	0.0526
Denmark	-0.0306	205,547.30	0.0088
Estonia	0.0298	10,920.68	0.0491
Finland	0.00042	157,881.60	0.0127
France	-0.0197	1,726,604.00	0.0098
Germany	-0.0061	2,269,810.00	0.0051
Greece	0.0386	186,066.50	-0.0018
Hungary	0.0045	79,090.56	0.0042
Ireland	-0.0185	152,842.00	0.0171
Italy	-0.0096	1,410,333.00	-0.0009
Latvia	0.0607	13,406.28	0.0380
Lithuania	-0.0107	20,384.68	0.0559
Netherlands	-0.0040	520,437.10	0.0084
Poland	0.0520	263,343.60	0.0357
Portugal	-0.0100	153,383.10	-0.0034
Romania	0.0366	87,384.24	0.0036
Slovakia	0.0496	44,698.15	0.0616
Slovenia	-0.0190	29,620.18	0.0033
Spain	-0.0207	883,222.90	0.0139
Sweden	0.0139	304,457.90	0.0203
United Kingdom	-0.0444	1,717,795.00	-0.0057

Table 3.15: Correlation coefficients

Variable	Crisis	Disintegration	Deleveraging
Crisis	1		
Disintegration	0.2051	1	
Deleveraging	-0.0010	0.1694	1

Notes: For the variables *Disintegration* and *Deleveraging* cutoffs of 0 are used in this table.

Chapter 4

Real Growth Effects of European Bank Bailouts During the Financial Crisis

4.1 Introduction

This chapter investigates real growth effects of banking sector support measures in the European Union (EU) during the financial and the sovereign debt crises. These measures were implemented to support failing banks in order to avoid severe damage for real economic activity. Between 2008 and 2013 countries in the EU provided total capital support of about 640 billion Euro. In addition, outstanding liquidity aid at the peak in 2009 had a volume of about 910 billion Euro.[1] These figures account for about 5% and 7.5% of European GDP, respectively.

Our work provides a comprehensive analysis of the growth effects of banking sector support in Europe during the financial and sovereign debt crises. Data availability allows studying the effects on industrial growth for six years of crisis until 2013 and, therefore, to investigate effects on short run as well as medium run growth. Our study differentiates between annual deviations from average growth rates as well as effects on growth averages over the sample period. As we argue, banking sector support that increases annual deviations from the average can be interpreted as a short-run growth effect. An increase of the averages of growth rates over the entire sample period is a shift in the trend growth performance and hence, can be denoted as medium run growth effect.[2] In this regard, our

[1]The crisis hit countries very differently. In Belgium and Ireland about 90% of the banking sector (as measured by total assets) received support and, consequently, were under investigation by the European Commission. In contrast, in Germany and UK, only between 30% to 40% received state aid (see Koopman (2013)).

[2]Since our sample is restricted to six years and comprises a long period of crisis in many countries, we suggest that the average growth rates cannot be interpreted as a steady state growth performance.

analysis provides guidance on the design of potential future banking sector support should it become necessary again. Since we use detailed statements of the European Commission about national rescue packages, our study can further distinguish between capital-related measures such as direct recapitalizations and impaired asset relief on the one hand and liquidity support such as guarantees and other liquidity measures on the other hand.

We hypothesize that capital-related measures are particularly growth-stimulating in the medium run, whereas liquidity support, in particular guarantees, has a positive growth effect in the short run. To motivate our hypotheses, we provide some stylized theoretical underpinning: Banks face decreasing capital ratios due to an increase in risk-weighted assets in times of crisis.[3] After a normalization, a better capital position due to capital injections should enable these banks to increase corporate financing by expanding the balance sheet in the medium run. By providing evidence for a positive growth effect of loan supply, Peek, Rosengren, and Tootell (2003) and Rosengren and Peek (2000) show that this in turn can spur growth.[4] Guarantees, however, are important in the short run since they decrease banks' refinancing cots on the capital market. This is particularly relevant during crisis periods and enables them to roll-over or issue new corporate loans with a positive margin. Therefore, guarantees buffer negative short-term effects. Hence, the growth effect should die out relatively fast when funding costs normalize again. Our empirical results support the hypothesized heterogeneous effects in the medium and the short run. In general, capital injections appear to have positive medium run growth effects. In the short run, the effect tends to be insignificant or even negative. Probably, banks might have to undergo a deeper consolidation phase first and therefore reduce lending even more. Liquidity measures tend to have positive growth effects in the short run, but no robust effect in the medium run. We conclude that liquidity aid is particularly important to buffer the short-term consequences of bank distress.

We analyze industry production growth in the European Union over the period from 2008 to 2013 and apply the methodology by Rajan and Zingales (1998). They proposed to investigate differences between industrial growth rates to obtain a reliable indication of real economic growth effects. The approach is based on the presumption that firms with a high need for external financing should benefit most if financial frictions are reduced.

Therefore, we interpret our results as medium run effects.

[3]During the crisis, recapitalizations were typically implemented by instruments that strengthened tier 1 capital (see Section 4.2). Therefore, we adopt this notation for our theoretical analysis in Section 4.3.

[4]Stein and Kashyap (2000) show that monetary policy passes through differently depending on the balance sheet structure, which provides indirect evidence for the growth relevance of measures related to repairing bank balance sheets.

In the classical setting, industrial production growth rates are averaged over the sample period and the variables of interest enter as initial values (alternatively as averages over the sample period). This identifies medium run growth effects. We extend the previous literature by additionally adjusting the methodology in the sense of Dell'Ariccia, Detragiache, and Rajan (2008). Here, the time dimension is exploited, too. The possibility to control for a large variety of unobserved heterogeneity by including the full set of two-dimensional fixed effects strengthens the identification considerably. However, only the short run effects in form of deviations from medium run averages can be identified.

Our study adds to the literature on the effects of banking sector interventions on economic growth. Thereby, studies investigate qualitative aspects such as whether and, if yes, how much aid should be provided, but also quantitative issues of which instruments and in which composition should be applied.[5] Theoretically, the advantageous effects of bailouts are questionable. On the one hand, Diamond and Rajan (2005) formalize the intuitive result that recapitalizations are beneficial if there is enough liquidity in the financial system, but banks have a solvency problem. Liquidity infusions, however, are helpful in cases where solvency problems arise from liquidity shortages in the system. On the other hand, they also show that in specific cases bank bailouts may lead to a complete meltdown of the financial system due to excess demand for liquidity. Regarding the question how to implement banking sector support, Gorton and Huang (2004) argue that in the case of liquidity shortages the government can provide support more effectively than the market. Philippon and Schnabl (2013) compare the effects of buying equity, purchasing assets and providing guarantees. As they demonstrate, buying equity is the dominant form of intervention and, therefore, should be the preferred measure. Related to the debate whether the financial crisis in Europe could have been resolved more quickly by requiring banks more aggressively to accept support, they further investigate whether a voluntary or compulsory form of interventions is preferable. In particular, they show that the compulsory form is dominating if large support measures are necessary. The effects of support measures on real economic growth are analyzed by Sandri and Valencia (2013). They illustrate that welfare gains of recapitalizations may emerge due to a reduction of output fluctuations. Similarly, Kollmann, Roeger, and Veld (2012) derive growth effects of recapitalizations that are comparable to general government spending.

Empirically, the positive effects of banking sector support seem to be limited at best. Laeven and Valencia (2012) show that guarantees had only slight mitigating effects

[5]Our study focuses on governmental bailout policies rather than monetary policy. This issue is studied, e. g., by Farhi and Tirole (2012).

on withdrawal pressure during past crises. For the financial crisis of 2008/2009, there is evidence that only large capital injections could stimulate loan growth significantly (Mariathasan and Merrouche (2012)). In addition, regarding real effects, the literature is inconclusive as well and does not provide a clear picture. The tendency, however, is an insignificant impact of bank support. On the country-level, Claessens, Klingebiel, and Laeven (2004) do not find a positive effect of banking sector support in the form of reduced output costs. Detragiache and Ho (2010) even find support for negative effects of fiscal costs associated with bailout policies. Also on the firm-level, there is only limited evidence for positive effects. Klingebiel, Kroszner, Laeven, and van Oijen (2001) show in a firm-level study that bank recapitalization measures do not seem to affect stock returns. Giannetti and Simonov (2013) assess the Japanese crisis. Here, a positive stock market response for borrowers of banks with government support could be detected. But, since these firms did not create more jobs, positive real effects are questionable. Dell'Ariccia, Detragiache, and Rajan (2008) investigate the effect of banking crises.[6] They use the same methodological approach as our study and, in an extension, account for banking sector support by using a simple binary measure. They find a depressive effect of crises but an insignificant impact of support measures in terms of growth differentials for different industries. In contrast to our work, previous studies rely on restricted samples or simple binary measures of interventions and therefore, may not comprehensively identify the associated effects. Since our results indicate opposite effects of different bailout categories, results of previous studies probably comprise offsetting effects. Therefore, the granular and comprehensive disclosure of bank bailout measures in the European Union in conjunction with detailed data on European industry production gives our analysis important advantages over previous analyses. Furthermore, our study relates to the qualitative question, which instruments and in which composition should be applied.

A further strand of the literature focuses on bank resolution. In general, banking sector support may be beneficial relative to bank closure since, if appropriately designed, it can be non-distortionary with respect to lending decisions (see Aghion, Bolton, and Fries (1999)).[7] In comparison to the inconclusive empirical literature on the effects of bailouts, bank resolution is more positively evaluated in terms of growth effects (see Korte (2015)). In this regard, Japan's long-lasting growth misery provides an impressive example. As Peek and Rosengren (2005) and Caballero, Hoshi, and Kashyap (2008) argue, an insuf-

[6]Kroszner, Laeven, and Klingebiel (2007) also try to figure out differences between normal times and periods with banking crises. However, in contrast to the analysis of Dell'Ariccia, Detragiache, and Rajan (2008), they split the sample and investigate the effects of financial development during times of crisis and normal times.

[7]For a general discussion of efficient banking sector support, see Dewatripont and Freixas (2011).

ficient resolution of insolvent banks and firms prohibited medium run improvements of overall economic development.

Our study is most closely related to the work by Laeven and Valencia (2013b). They investigate the effects of bank rescue packages on the growth of listed firms in 2009. Applying the methodological approach of Rajan and Zingales (1998) on a large sample of countries, they show that in particular the amount of recapitalization measures seems to have stimulated value added by reducing financial frictions. Similar to our work, the study by Laeven and Valencia (2013b) contains precise measures of amounts of banking sector support. However, it does not account for the crisis itself, which is likely to distort the results. Granting bank support and the financial crisis itself are obviously highly correlated. If financial frictions are imposed by the crisis and bank rescue helps to reduce these frictions, controlling for the crisis itself is necessary to disentangle these effects. Furthermore, Laeven and Valencia (2013b) restrict their analysis on 2009 and focus on listed firms only. Our study, in comparison, allows investigating growth effects over the entire crisis period for most of the countries and analyzes total industrial production growth. By controlling for the financial crisis, we improve the identification considerably. Since we control for total assets of the banking sector, we further rule out potential size effects.

This chapter is organized as follows: Section 4.2 provides an overview of the bailout policies as well as amounts used in the European Union during the financial and sovereign debt crisis. Next, Section 4.3 derives our hypothesis based on stylized theoretical considerations. Section 4.4 explains the Rajan-Zingales methodology, which we apply in our empirical analysis. It further illustrates the difference between the approaches to identify the medium run and the short run effects. In Section 4.5 the data sources and descriptive statistics are explained. Afterwards, the main results of the analysis are illustrated in Section 4.6. Section 4.7 provides further evidence for the relationship between growth and bank rescue policies. Finally, Section 4.8 concludes.

4.2 Banking sector support in the European Union during the financial crisis

This section provides an explanation of the different instruments and documents a heterogeneously distributed use of bailout measures between countries and over time.

4.2.1 Institutional aspects of banking sector support measures in the European Union

The European case is characterized by a number of specific institutional details of state aid implementation. On the one hand, national governments were in charge of supporting their banks. Accordingly, rescue packages contained purely national resources. On the other hand, the aid had to be approved by the European Commission, judging bank support on its compliance with the principles of competition in the single market. By a fundamental decision, in December 2008, the Commission communicated to approve all support measures, but required an appropriate contribution of the respective banks to the burden sharing, in particular for direct recapitalizations as well as impaired asset relief (see European Commission (2009)). Their implementation required significant reductions of the balance sheet, in many cases by a cutback of foreign business, adjustments of governance and an adequate remuneration of state aid.[8]

Based on the taxonomy of the European Commission, which coordinated actions on European level, bank rescue measures are categorized into four types, i. e., direct recapitalizations, impaired asset relief, guarantees, and liquidity support (the following description is based on European Commission (2011) and Lannoo and Napoli (2010)):[9]

Recapitalization measures Direct recapitalizations was the preferred measure of governments to provide capital support to banks. Typically, it strengthened tier 1 capital to improve regulatory adequacy. In particular, recapitalizations were provided in form of silent participations and preferred shares. The implementation of these packages differed significantly. At the extreme, some countries provided open schemes for all banks (such as France and Denmark) while other countries exclusively provided emergency aid in form of ad-hoc measures (such as Belgium and the Netherlands).[10] Despite these differences of implementation, all these measures contained a clear-cut remuneration policy, which implied a minimum remuneration rate between 7.8% in Spain and 12% in UK.[11]

Impaired asset relief Furthermore, capital support had the form of impaired asset relief programs. In general, they can be designed to purchase impaired assets or provide

[8] In Chapter 3, we assume that this policy was a main driver of the fragmentation process in the European banking sector since the financial crisis and show that this had strong negative growth effects.

[9] For a more detailed taxonomy, see Calomiris, Klingebiel, and Laeven (2004).

[10] A mixed policy was applied by Germany, which implemented a scheme, used by Commerzbank among others, but also provided ad-hoc capital (in particular to the Landesbanks).

[11] The benchmark range defined by the ECB was 7% to 9.3%.

guarantees in the form of loss absorbency. While direct recapitalizations were massively used in 2008, asset relief became relevant since 2009. The rationale behind the purchase of impaired assets is to reduce risk-weighted assets of banks and therefore, to set free capital. Remuneration contained discounts on the fair value of the purchased assets as well as an additional fee. However, asset relief programs were difficult to implement. Setting-up legal structures for bad banks, the identification of impaired assets and the complexity of an appropriate remuneration made this measure only implementable in the medium run.[12] In some cases, asset relief was provided in form of ad-hoc measures, giving more flexibility in defining appropriate conditions. Technically, the European Commission defines the volume of asset relief support by the difference between the transfer price and the market value.

Guarantees A massive drying-up of the wholesale funding market constitutes an important feature of the financial crisis. To provide a backstop against withdrawals, most of the sovereigns used guarantees as the major instrument for liquidity support. To avoid distortions, guarantees were generally applied to senior liabilities. With respect to bonds, guarantees could only used for newly issued instruments, but only those with a maturity of less than five years were guaranteed. In addition, governments raised guarantees on deposits. The focus on guaranteeing senior liabilities was intended to add some weak form of safeguard against potential losses for the government. Similar to other instruments, guarantees were provided via schemes or on an ad-hoc basis. From the beginning, the existence of schemes were defined as being temporary with a relatively short focus of 6 months. In case of further need after expiration, a separate positive decision had to be taken.

Liquidity measures Liquidity support during the crisis was mainly provided by central banks. However, in specific cases also governments granted loans to distressed banks. Nevertheless, guarantees on issued debt remained the major instrument for improving the liquidity situation of banks in all years of the crisis.

4.2.2 Volume of bank bailouts during the financial crisis

Figure 4.1 provides an aggregate overview of the different categories of bank rescues in the EU since the onset of the financial crisis. In 2008, governments relied heavily on direct recapitalizations and guarantees for bank debt. Thereafter, a more balanced mix of instruments was applied since national authorities also used significant amounts of other

[12]For technical details of asset relief measures in the EU, see Boudghene and Maes (2012).

liquidity measures and impaired asset relief programs. Moreover, all four instruments peaked in 2009 with respect to the implemented volume.

Table 4.1 and Table 4.2 provide country-specific information on banking sector support separately for direct recapitalizations and asset relief as well as guarantees and other liquidity support, respectively. All numbers denote aggregated figures over time. Both tables illustrate that some countries did not have to provide state aid. All these countries are Eastern European countries with smaller and more internationalized banking sectors.[13] In countries with the necessity to support failing banks, instruments were used very heterogeneously with respect to their size and mix. While in Sweden the volume of guarantees and liquidity was about 20 times higher than the amount of capital injections, Belgium provided capital and liquidity at a similar level.

On an annual basis, Table 4.3 gives an overview of the number of countries that provided aid. In particular, direct recapitalizations and guarantees were used more extensively relative to asset relief programs and other liquidity support. Direct liquidity support was mainly provided by central banks, and difficulties in the implementation and high costs probably kept banks and sovereigns from the application of impaired asset relief programs.[14] Similar to the aggregated amount, in all four categories, the maximum of countries that implemented aid was reached in 2009. The clusters of countries that adopted capital-related measures around 2008/2009 and 2012/2013 reflects on the one hand the financial crisis and on the other hand the following sovereign debt crisis.

Table 4.18 in the Appendix additionally provides information on the country-level on European banking sectors and illustrates that they are relatively heterogeneous with respect to their size and the degree of internationalization. Moreover, in the sample period, the European banking sector underwent massive changes. Before the crisis, the European banking sectors expanded heavily, mainly driven by the biggest banks (see European Systemic Risk Board (2014b)). Since the crisis, however, a deleveraging process took place that reduced balance sheets and increased capital ratios (see Bologna, Caccavaio, and Miglietta (2014)). Moreover, integration of European banking markets diminished strongly. Both the number of foreign banks as well as the share of foreign assets reduced strongly since 2008 (see European Central Bank (2015)).[15] In Chapter 3 we investigate the

[13]See Table 4.18 in the Appendix.

[14]The Landesbank Baden-Württemberg (LBBW) received in 2009 guarantees for a portfolio of about 12.7 billion Euro. Still in 2014, the bank had to pay a commission of about 190 million Euro. Hence, total profit (before taxes) was reduced by about 30% in 2014 (see Landesbank Baden-Württemberg (2014)).

[15]Furthermore, the concentration of the national banking sectors seems to have slightly increased, particularly in the periphery countries (see Schoenmaker and Peek (2014)).

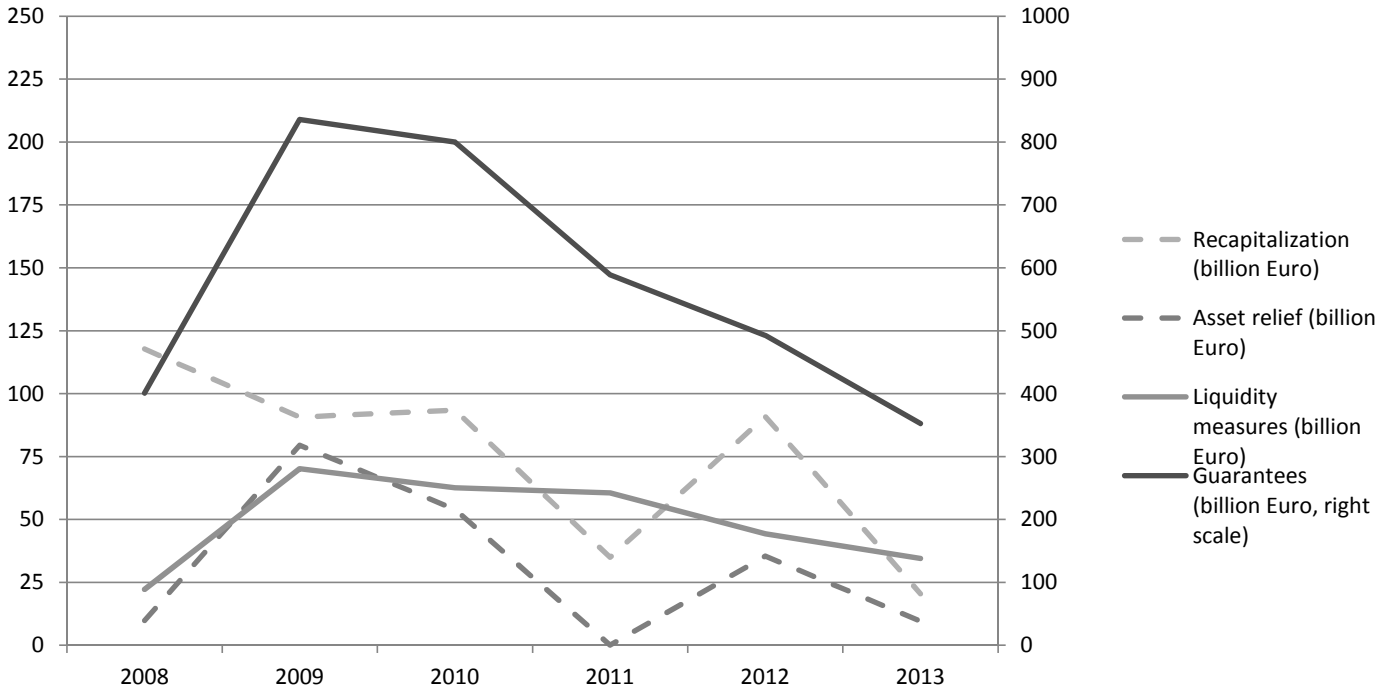


Figure 4.1: Total bank bailout measures in the European Union (liquidity measures: outstanding amounts, capital-related measures: additionally provided amounts). Source: European Commission.

Table 4.1: Capital injections between 2008-2013

Country	Recap. 2008-2013 in bnEUR	Recap. 2008-2013 in % of GDP	Asset relief 2008-2013 in bnEUR	Asset relief 2008-2013 in % of GDP	Total capital inject. 2008-2013 in bnEUR	Total capital inject. 2008-2013 in % of GDP
Austria	11.10	3.73	0.50	0.17	11.60	3.90
Belgium	23.32	6.51	21.83	5.82	45.14	12.33
Bulgaria	0.00	0.00	0.00	0.00	0.00	0.00
Croatia	0.00	0.00	0.00	0.00	0.00	0.00
Czech Republic	0.00	0.00	0.00	0.00	0.00	0.00
Denmark	10.77	4.62	0.32	0.13	11.09	4.75
Estonia	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.00	0.00	0.00	0.00	0.00	0.00
France	25.05	1.26	1.20	0.06	26.25	1.32
Germany	64.17	2.55	79.97	3.15	144.15	5.70
Greece	40.85	20.71	0.00	0.00	40.85	20.71
Hungary	0.21	0.23	0.00	0.00	0.21	0.23
Ireland	62.78	37.58	2.60	1.57	65.38	39.16
Italy	7.95	0.50	0.00	0.00	7.95	0.50
Latvia	0.54	2.88	0.41	2.26	0.95	5.15
Lithuania	0.23	0.67	0.00	0.00	0.23	0.67
Netherlands	23.02	3.62	5.00	0.81	28.02	4.43
Poland	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	7.85	4.66	3.10	1.72	10.95	6.38
Romania	0.00	0.00	0.00	0.00	0.00	0.00
Slovakia	0.00	0.00	0.00	0.00	0.00	0.00
Slovenia	3.15	8.72	0.00	0.00	3.15	8.72
Spain	61.85	5.82	32.90	3.11	94.76	8.94
Sweden	0.78	0.24	0.00	0.00	0.78	0.24
United Kingdom	100.14	5.41	40.41	2.43	140.54	7.84

Notes: Recapitalizations and impaired asset relief denote total amounts over the period 2008-2013. Total capital injections denote the sum of direct recapitalizations and impaired asset relief. Source: European Commission.

Table 4.2: Guarantees and liquidity state aid between 2008 and 2013

Country	Guarantees 2008-2013 in bnEUR	Guarantees peak year in % of GDP	Liquidity peak year in bnEUR	Liquidity peak year in % of GDP	Total liquidity sup. peak year in bnEUR	Total liquidity sup. peak year in % of GDP
Austria	19.33	6.57	0.00	0.00	19.33	6.57
Belgium	46.78	13.38	0.00	0.00	46.78	13.38
Bulgaria	0.00	0.00	0.00	0.00	0.00	0.00
Croatia	0.00	0.00	0.00	0.00	0.00	0.00
Czech Republic	0.00	0.00	0.00	0.00	0.00	0.00
Denmark	145.00	60.14	1.97	0.24	145.59	60.39
Estonia	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.12	0.06	0.00	0.00	0.12	0.06
France	92.73	4.78	0.00	0.00	92.73	4.78
Germany	135.03	5.50	4.75	0.18	135.03	5.50
Greece	62.30	32.08	6.90	3.05	65.05	33.50
Hungary	0.00	0.00	2.46	2.64	2.46	2.64
Ireland	284.25	169.08	0.91	0.52	284.25	169.08
Italy	85.68	5.30	0.00	0.00	85.68	5.30
Latvia	0.54	2.87	0.97	5.18	1.52	8.05
Lithuania	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	40.90	6.48	30.40	4.92	66.40	10.75
Poland	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	16.60	9.86	3.81	2.12	16.78	9.96
Romania	0.00	0.00	0.00	0.00	0.00	0.00
Slovakia	0.00	0.00	0.00	0.00	0.00	0.00
Slovenia	2.15	5.94	0.00	0.00	2.15	5.94
Spain	71.97	6.82	19.31	1.79	75.44	7.15
Sweden	19.92	5.40	0.00	0.00	19.92	5.40
United Kingdom	158.22	9.51	33.31	1.79	169.23	9.32

Notes: Guarantees and other liquidity measures denote the maximum of outstanding amounts in the period 2008-2013. Total liquidity support denotes the sum of guarantees and other liquidity support. Source: European Commission.

Table 4.3: Number of countries with state aid measure

Number of countries	2008	2009	2010	2011	2012	2013
Direct recapitalizations	9	14	8	8	11	9
Impaired asset relief	1	6	5	0	4	3
Guarantees	12	18	17	18	17	16
Other liquidity support	7	9	9	8	8	8

growth effects of the fragmentation as well as the deleveraging in the European banking sector and find particular strong negative growth effects of these developments.

4.3 Hypothesis and theoretical considerations

Previous studies do not distinguish between short run and medium run effects of bank bailout policies. Empirically, Laeven and Valencia (2013b) base their study on the real growth effects of rescue measures only on data from 2009. Also, theoretical studies do not explicitly account for different time patterns. Therefore, to motivate our hypothesis, we provide some stylized theoretical thoughts.

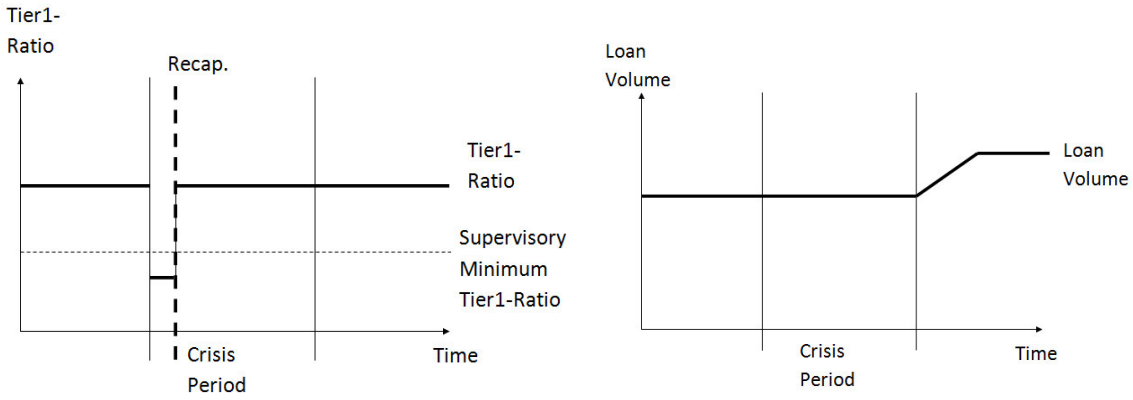
Consider one bank and the following three different time periods: Normal times - times of crisis - normal times, denoted by 0, 1 and 2. The bank's assets only consist of a portfolio of loans with volume L_t, which correspond to risk-weighted assets of RWA_t. We assume that a reduction of loans implies a negative effect on real growth and vice versa, i. e., $growth_t = f(L_t - L_{t-1})$ with $f'(L_t - L_{t-1}) > 0$. The interest rate on issuing new loans is assumed to be constant throughout all periods at r^{loan}. The bank is financed via debt D_t and core capital E_t, implying a tier 1 capital ratio of $TR_t = \frac{E_t}{RWA_t}$. We assume the initial value to be above the supervisory minimum: $TR_0 > \overline{TR}$. Furthermore, the bank does not have enough cash to finance new loans[16] and, as it is common in practice, issuing a new loan is processed such that after signing the contract the subsequent payment is refinanced on the funding market at an interest rate $r_t^{fund} = r^{base} + \delta_t$. r^{base} denotes a given money market interest rate and δ_t the bank's individual spread. We assume that r^{base} is constant over time, but δ_t varies for the different time periods. For simplicity, the loan and the refinancing have a perfect maturity match.

Regarding the three different time periods, we assume the following:[17]

[16] E. g., this is also assumed in Philippon and Schnabl (2013).

[17] For simplicity, the evolution of funding spreads is independent of the bank's capital situation. In reality, there probably exists a negative relationship.

- $RWA_1 > RWA_0 = RWA_2$ for a constant volume of loans: In the crisis period, risk-weighted assets increase and then normalize again.
- $\delta_1^{ng} > \delta_0 = \delta_2$: Without government guarantees, the funding spread increases relative to the pre- and the post-crisis period. With government guarantees we assume $\delta_0 = \delta_1^g = \delta_2$.
- $r^{loan} > r^{base} + \delta_0 = r^{base} + \delta_2$: In the pre- and the post-crisis period, the bank can generate a positive margin from issuing a loan and refinancing it on the capital market.
- $r^{loan} < r^{base} + \delta_1^{ng}$: Without guarantees the bank can not generate a positive margin from refinancing a new loan on the capital market during the crisis.
- $r^{loan} > r^{base} + \delta_1^g$: With guarantees, the bank can generate a positive margin from issuing a loan and refinancing it on the capital market during the crisis.



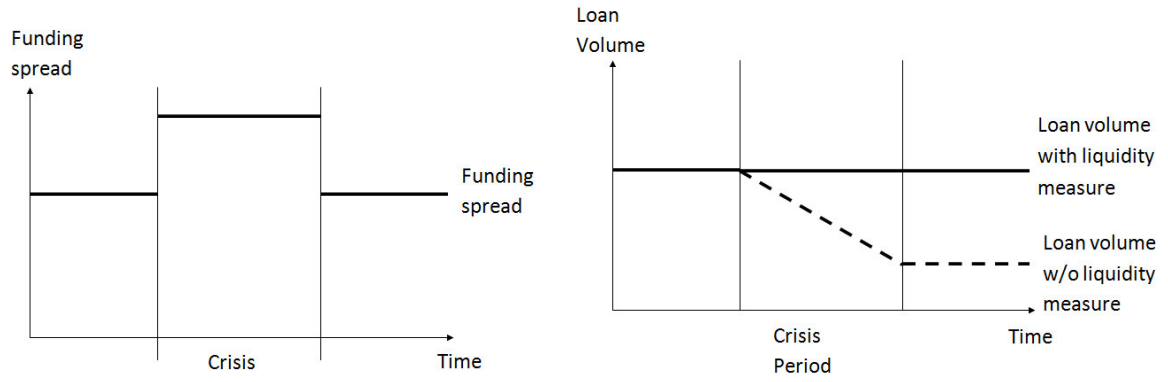
(a) Tier 1-ratio **(b)** Loan volume

Figure 4.2: Tier 1 ratio and loan volume for pre-crisis, crisis- and post-crisis-period under the assumption of a bailout via capital injections.

When a crisis starts, risk-weighted assets will typically increase due to worse ratings on borrowers. In addition, the bank will probably suffer from losses, which decreases equity to $E_2 < E_1$. Both effects will lead to a decrease of the tier 1 ratio, $TR_2 < TR_1$, which may fall below the supervisory minimum level, as could be seen for many banks during the financial crisis. Without additional capital provided by the government, the bank would have to be shut down.[18] With additional capital, however, the bank can still operate. Further, if the bailout is designed such that the tier 1 ratio remains constant, the bank

[18] As Myers (1977) mentions, firms with a debt overhang may have problems to raise additional equity capital. In this sense a bailout via capital injections can be seen as the only way to still fulfill supervisory requirements, as we consider in our example.

will be able to hold constant the loan volume.[19] After the crisis, risk-weighted assets again normalize and equity capital might be above the initial value due to $E_3 > E_1$. To fulfill the initial tier 1 ratio $TR_1 = TR_3$, the bank has additional capacities to increase the loan volume or, as it happened since the crisis, to fulfill higher capital requirements without decreasing the loan volume (see Figure 4.2).[20]



(a) Funding spread **(b)** Loan volume

Figure 4.3: Funding spread and loan volume for pre-crisis, crisis- and post-crisis-period under the assumption of government guarantees on newly issued debt.

Similarly to the increase of risk-weighted assets in the crisis period, the bank will likely face rising funding spreads, in our model illustrated by $\delta_0 < \delta_1^{ng}$.[21] If funding gets too expensive, the bank will immediately stop issuing new loans, and the loan volume will decrease. Indirect evidence for this effect is provided by Ivashina and Scharfstein (2010) and Dagher and Kazimov (2015) who document that banks reduced lending more strongly if their funding relied to a larger extent on wholesale funding than on stable deposits. According to their argumentation, commercial papers were difficult to issue during the crisis since investors tried to invest more strongly in insured deposits. Hence, banks with a large share of wholesale funding were more liquidity-constrained during the crisis than banks with a high share of deposits. In our model setup, with governmental guarantees on newly issued debt, the bank will be able to roll over loans due to the realization of a

[19]The results of Black and Hazelwood (2013) on the loan volume of US banks that received support measures from the TARP program (troubled asset relief program) vs. non-TARP banks provide some indication that this pattern was present during the financial crisis.

[20]Intuitively, also an asset relief should be able to improve the tier 1 ratio. However, practically, this instrument is often only applicable either in combination with a capital injection or in case of high market values of the impaired assets. If these assets are booked as loans and receivables they enter the balance sheet at amortized costs. Particularly during a crisis, the assets have a market value below the book value. Realized losses then immediately reduce equity capital. Hence, the positive effect of reducing risk-weighted assets can be set off, or even additional capital requirements may emerge.

[21]See, e. g., Brunnermeier (2008) for an evolution of bank funding spreads during the crisis.

positive margin.[22] Hence, negative consequences for borrowers can be avoided (see Figure 4.3).[23] In contrast to additional bank capital, which first holds constant bank business and has the potential to increase business in the post-crisis period, guarantees immediately imply that banks can still provide loans instead of shutting down new business. In the medium run, after a normalization of funding spreads, i. e., $\delta_2 < \delta_1^{ng}$, the bank no longer needs guarantees to generate a positive margin on new loans. Positive medium run growth effects should therefore not emerge.

Based on these theoretical considerations, we expect different growth patterns of capital and liquidity-related rescue measures. With regard to capital-related bailouts we hypothesize:

Hypothesis 4.1. *Ceteris paribus, capital-related rescue measures have a stronger real growth effect in the medium run than in the short run.*

With regard to support measures focusing on liquidity and based on the theoretical underpinnings, our hypothesis reads:

Hypothesis 4.2. *Ceteris paribus, liquidity-related rescue measures have a positive real growth effect in the short run, but no effect in the medium run.*

4.4 Methodology

Our analysis is based on the approach proposed by Rajan and Zingales (1998). It stipulates regressing a measure of industrial production growth on bailout policies interacted with the industry-specific dependence on external financing. If bank support reduces financial frictions, industries with a high external dependence should benefit more and exhibit higher growth rates. Thereby, external dependence is seen as an industry characteristic that does not vary over time and between countries. A strong argument for this approach is a reduction of endogeneity concerns. External dependence can credibly be expected to be exogenous since it is unlikely that bank support is granted with respect to specific characteristics of certain industries.

We include the interaction of a measure of the crisis with external dependence to account for the direct effect of the crisis on financial frictions. As Campello, Graham, and

[22] To provide an intuitive illustration of the functioning of guarantees, we focus on guarantees for newly issued debt.

[23] Indirect evidence for this effects is provided by Levintal (2013). The study investigates bank income shocks and find significant positive growth effects.

Harvey (2010) and Duchin, Ozbas, and Sensoy (2010) show, corporates became strongly financially constraint during the crisis. We therefore suggest that controlling for a measure of the crisis per se is necessary to obtain reliable results (see Dell'Ariccia, Detragiache, and Rajan (2008), Kroszner, Laeven, and Klingebiel (2007) and Bijlsma, Dubovik, and Straathof (2015) for the growth relevance of a financial crisis). Otherwise, our results would suffer from an omitted variable bias. In addition, we include two standard control variables. First, the industry share controls for the well-documented pattern that smaller industries tend to grow faster than older and bigger industrial sectors. Second, we include a measure for the development of the financial sector. Although there are increasing doubts about positive growth effects of financial development for high levels of financial development (see Arcand, Berkes, and Panizza (2012)), controlling for the size of the financial sector is still relevant. Since financial development is typically measured by size, we include total assets of the banking sector measured in terms of GDP as a control variable.

4.4.1 Medium run analysis

To investigate medium run growth effects we report results using the specification initially proposed by Rajan and Zingales (1998):

$$\begin{aligned}\text{Avg. Production growth}_{i,j} = \alpha_i + \beta_j \\ + \delta_0 \cdot \text{Init. Industry share}_{i,j} \\ + \delta_1 \cdot \text{Ext. dependence}_j \cdot \text{Total amount bank support}_i \\ + \delta_2 \cdot \text{Ext. dependence}_j \cdot \text{No. of years in Financial crisis}_i \\ + \delta_3 \cdot \text{Ext. dependence}_j \cdot X_i + \epsilon_{i,j}.\end{aligned}$$

i denotes the country and j the industry. This specification regresses average production growth on initial values of the industry share and the amount of bank support. The vector X_i contains a further control variable varying on the country level and with potential effect on industry growth differentials, i. e., the size of the banking sector. We include one-dimensional fixed effects to capture country-specific (α_i) as well as industry-specific (β_j) developments.

In this approach, we investigate average growth over a window of six years. By doing so, we obtain a pure cross-country analysis. Initially applied by Rajan and Zingales (1998), this approach is typically used to identify growth effects that are relevant in the medium run. During this time, governments put in place support measures at different

points in time and in a differing number of years. Obviously, the period under investigation contains the implementation of the bailout policies, which might distort our results. However, governments applied rescue measures mainly in the first years under investigation. Moreover, in a robustness check, we use a subsample of the rescue measures to obtain a clearer cutoff between bailout and growth period and find that the results of our main analysis are robust to this variation.

In a conservative approach we aggregate measures of state aid over the entire sample period. Hence, a country's volume of direct recapitalizations is the sum of recapitalizations over the entire period from 2008 until 2013. This applies to all four measures. However, note that guarantees and other liquidity support are defined as outstanding amounts. Hence, in a given year, it contains existing as well as newly provided support, which cannot be disentangled. Intuitively, weighting guarantees by their maturity gives us an idea of how much banks could benefit from more favorable refinancing conditions. In this approach, guaranteed debt with maturity of two years has the same weight as debt with maturity of one year with an immediate roll-over for a second year.[24]

4.4.2 Short run analysis

To identify short run growth effects, we estimate the following equation based on the model proposed by Dell'Ariccia, Detragiache, and Rajan (2008):

$$\begin{aligned}\text{Production growth}_{i,j,t} = \alpha_{i,j} + \beta_{j,t} + \gamma_{i,t} \\ + \delta_0 \cdot \text{Industry share}_{i,j,t-1} \\ + \delta_1 \cdot \text{Ex. dependence}_j \cdot \text{Amount bank support}_{i,t-1} \\ + \delta_2 \cdot \text{Ex. dependence}_j \cdot \text{Financial crisis}_{i,t-1} \\ + \delta_3 \cdot \text{Ex. dependence}_j \cdot X_{i,t-1} + \epsilon_{i,j,t}.\end{aligned}$$

i denotes the country, j the industry, and t the year. We include all possible two-dimensional fixed effects to control for unobserved heterogeneity. By adding country-time dummies ($\gamma_{i,t}$) we can control for all effects that hit all industries in a specific country in a given year. Industry-time dummies ($\beta_{j,t}$), can control for industry-specific, but country independent effects in a given year. By adding country-industry dummies ($\alpha_{i,j}$) we rule out all time invariant effects that affect a specific industry in a given country.

[24]Moreover, it is comparable to the aggregation of capital measures by applying the same weight to each year of implementation. However, the different definition of capital and liquidity measures prohibits a direct comparison of coefficients in the following analyses.

This approach deviates from the loan-run analysis. Relevant for the medium run perspective is mean growth over a longer time horizon. In the short run, we are mainly interested in temporary effects, i. e., deviations of growth from its medium run mean. This is achieved by exploiting the time-dimension. The fixed effects also include the average industry growth rate in a given country. Hence, this approach identifies the effect of banking sector support on the deviation of the industrial growth rate from its mean value in a given year and therefore, can deliver an indication of the short run effects. Furthermore, variables measuring state aid are on an annual basis.

4.5 Data

This section provides an overview of our data sources as well as descriptive statistics. Table 4.4 gives an overview of the definition of the variables we use.

We exclude three countries from our sample, namely Malta, Cyprus, and Luxembourg. First, they do not provide a sufficient number of different industry observations, and second, they also exhibit features of financial centers. This may distort our results since the figures related to their banking sector structure might be extreme compared to the remaining countries.[25] Hence, our final sample consists of the remaining 25 EU member countries.

4.5.1 Industrial production growth

Industry data are collected from Eurostat. The database *Structural Business Statistics* provides comprehensive production data on an annual basis up to 2013 for countries of the European Union. Until 2008, industries were classified according to the classification scheme NACE Rev. 1.1. Subsequently, industries' classification switched to the methodology of NACE Rev. 2. Using official correspondence tables from UNIDO, we match the data to the 3- and 4-digit sectors originally studied in the work of Rajan and Zingales (1998) and finally obtain a set of 35 industries.[26] We deflate industry production values by the corresponding consumer price index.

Macroeconomic variables, such as GDP and inflation rates, are also obtained from the Eurostat database. All data are provided in EUR based on corresponding exchange rates

[25] In the literature it is standard to drop countries serving as financial centers. We still include Ireland and United Kingdom in our sample, since the size of the banking sector is still comparable to other countries and both countries host a significant number of industries.

[26] A detailed description can be found in Appendix 4.A.

Table 4.4: Definition of variables

Variable	Definition$_{i,t}$
Production growth	Real growth rate of industrial production value. Industry-country-level, annual data.
Industry share	Industrial production value relative to GDP. Industry -country-level, annual data.
Capital injections	Aggregation of used volumes of direct recapitalizations and impaired asset relief denominated by total assets of the banking sector. Country-level, annual data.
Liquidity support	Aggregation of outstanding used volumes of guarantees and other liquidity support denominated by total assets of the banking sector. Country-level, annual data.
Direct recapitalizations	Volume of used direct recapitalizations denominated by total assets of the banking sector. Country-level, annual data.
Impaired asset relief	Volume of used impaired asset relief denominated by total assets of the banking sector. Country-level, annual data.
Guarantees	Volume of outstanding used guarantees denominated by total assets of the banking sector. Country-level, annual data.
Other liquidity support	Volume of outstanding used other liquidity support denominated by total assets of the banking sector. Country-level, annual data.
Crisis	Binary measure: 1 if crisis, 0 if normal times. Beginning of crisis: Significant distress in banking sector and rescue measures by government Laeven and Valencia (2013a), End of crisis: Positive Real GDP growth and decrease in unemployment rate. Country-level, annual data.
Total assets banking sector	Total assets of all banks in a given country (domestic and foreign owned) denominated by GDP. Country-level, annual data.

for non-Eurozone countries.

4.5.2 External dependence

The measure of external dependence is defined by Rajan and Zingales (1998) as

$$\text{External dependence} = \frac{\text{Capital expenditures} - \text{Cash-flow from operations}}{\text{Capital expenditures}}.$$

Data for the dependence on external finance are obtained from Laeven and Valencia (2013b) who updated initial values of Rajan and Zingales (1998) by using firm-level data from the US for the period from 1980 to 2006. Table 4.5 displays the industries and corresponding values. Obviously, for many industries these values are positive. By considering the life cycle of a specific firm, one would suggest that in total this firm would have to generate a cash flow that is higher than all investment activities in order to survive. Hence, the external dependence should be negative. In general, this is true. But as Rajan and Zingales (1998) demonstrate, the external dependence is typically very high for young firms and then subsequently decreases until the index becomes negative. Hence, for relatively young industries positive values are realistic.[27]

4.5.3 Banking sector variables

Data on banking sector support are provided by the European Commission. For the period from 2008 to 2013, the dataset contains information about the absolute volume of support provided each year and for each member country of the EU. For our purpose, these data are then transformed into relative measures with respect to the size of the banking sector, measured by total assets. While Laeven and Valencia (2013b) measure bank support in terms of GDP, in our view, the definition in terms of the size of the banking sector is the more appropriate view on the impact on the banking sector. In particular, a specific value of support in terms of GDP may apply to both, big rescue packages for small banking sectors and small rescue packages for very big sectors. Since we expect that, depending on the size of the banking sector (relative to GDP), banking sector support may has a decreasing effect, we partly neutralize it by measuring state aid in terms of total assets. As a robustness check, however, we also apply a definition of state aid based on GDP. Moreover, since we control for the size of the banking sector, we implicitly capture the dimension of support relative to GDP, too. Respective data on financial development, which we measure as total bank assets, are obtained from the ECB.

[27]However, there also exist different interpretations of the concept of external dependence. Fisman and Love (2007) argue that industries are more likely to differ in their growth potential rather than their need for external financing.

Table 4.5: External dependence

Industrial Sector	ISIC Rev. 2	External dependence
Tobacco	314	-1.76
Leather	323	-0.98
Footwear	324	-0.56
Pottery	361	-0.52
Other chemicals	352	-0.07
Furniture	332	-0.07
Petroleum refineries	353	0.03
Apparel	322	0.05
Printing and publishing	342	0.06
Basic excluding fertilizers	3511	0.06
Beverages	313	0.06
Spinning	3211	0.08
Nonmetal products	369	0.09
Pulp, paper	3411	0.10
Synthetic resins	3513	0.10
Transportation equipment	384	0.13
Paper and products	341	0.13
Wood products	331	0.14
Food products	311	0.14
Textile	321	0.17
Metal products	381	0.19
Iron and steel	371	0.24
Plastic products	356	0.24
Glass	362	0.24
Petroleum and coal products	354	0.27
Ship	3841	0.30
Nonferrous metal	372	0.32
Rubber products	355	0.37
Motor vehicle	3843	0.38
Electric machinery	383	0.39
Machinery	382	0.50
Other industries	390	0.52
Office and computing	3825	0.66
Drugs	3522	0.78
Professional goods	385	0.85
Radio	3832	0.93

Notes: The table contains the external dependence ratios provided by Laeven and Valencia (2013b), constructed for the United States for 1980-2006.

In our analyses we identify effects both on an aggregate level distinguishing between capital injections and liquidity measures as well as on a disaggregate level. For the analyses on the aggregate level, we sum up direct recapitalizations and impaired assets relief to obtain a measure of total capital injections and guarantees and other liquidity support as a measure of total liquidity support. Since only a small number of countries put impaired asset relief as well as other liquidity support into effect, our main interest is in direct recapitalizations and guarantees. We report results for the analyses on the disaggregated level both with and without impaired asset relief and other liquidity support.

In addition to the interaction term between banking sector support and external dependence, we include the interaction between a variable capturing whether a country is in a financial crisis and industries' external dependence. Since the extent of a crisis is potentially impossible to measure, we stick to the approach of Dell'Ariccia, Detragiache, and Rajan (2008) and apply a binary variable. While the beginning of the crisis is adopted from Laeven and Valencia (2013a), the end is defined by the first year in which GDP growth is positive and the unemployment rate decreases. For a country-specific overview of the years in crisis, see Table 4.18.

4.5.4 Descriptive statistics

Table 4.6 provides descriptive statistics of the sample used for the medium run analysis. Since our dataset comprises the financial and sovereign debt crisis, mean industrial production growth is relatively low and exhibits a relatively large standard deviation. In general, industrial production growth is much more volatile than GDP growth. This was particularly pronounced during the financial crisis, when industrial growth rates decreased more than GDP growth in 2008 and 2009, but also recovered much faster in 2010.

Table 4.7 provides information about the sample in the short run analysis. Due to winsorizing annual production growth at the 0.5%-level, the average annual production growth in the sample drops from 0.65% to 0.32%. This is mainly driven by a few number of extremely large positive growth rates that are redefined to the 99.5%-level.

4.6 Results

This section contains our main results. We first report estimation results for the medium run growth effects based on mean production growth rates over the sample period. Thereafter, the analysis of the short run growth effects exploits the full set of annual data and investigates only the variation from medium run trends.

Table 4.6: Summary statistics medium run analysis

Variable	Mean	Std. Dev.	Min.	Max.	N
Mean production growth	-0.0268	0.0734	-0.395	0.661	444
Industry share	0.0156	0.0214	0.000113	0.198	444
Capital injections	0.0133	0.0171	0	0.0665	444
Liquidity support	0.0656	0.0952	0	0.600	444
Direct recapitalizations	0.0103	0.0156	0	0.0665	444
Impaired asset relief	0.00303	0.00517	0	0.0199	444
Guarantees	0.0585	0.0951	0	0.599	444
Other liquidity support	0.00705	0.0168	0	0.0965	444
Financial crisis	2.822	2.205	0	6	444
Total assets of the banking sector	2.576	1.625	0.722	9.266	432
External dependence	0.154	0.377	-1.76	0.93	444

Notes: Mean production growth based on winsorized annual production growth. Period: 2008-2013.

Table 4.7: Summary statistics short run analysis

Variable	Mean	Std. Dev.	Min.	Max.	N
Production growth	-0.0207	0.227	-0.888	4.741	2,922
Production growth (winsorized 0.5%)	-0.0244	0.182	-0.559	0.876	2,922
Industry share	0.0150	0.0227	0.000101	0.273	2,922
Capital injections	0.00263	0.00807	0	0.0700	2,922
Liquidity support	0.0147	0.0285	0	0.174	2,922
Direct recapitalizations	0.00212	0.00777	0	0.0700	2,922
Impaired asset relief	0.000511	0.00176	0	0.0133	2,922
Guarantees	0.0130	0.0274	0	0.174	2,922
Other liquidity support	0.00164	0.00432	0	0.0292	2,922
Financial crisis	0.507	0.500	0	1	2,922
Total assets of the banking sector	2.526	1.573	0.594	9.720	2,922
External dependence	0.130	0.426	-1.76	0.93	2,922

Notes: Period: 2008-2013.

4.6.1 Medium run growth effects

Our baseline results for the medium run analysis are provided in Table 4.8 based on total capital injections and total liquidity support. The regressions are applied on the full sample period from 2008 to 2013. In all columns the coefficient of the interaction between total capital injections and industries external dependence is positive and statistically significant with a value between 1.84 and 2.84. Hence, capital injections positively affect the growth differential between highly and less dependent industries. In contrast, in all regressions, the coefficient of the interaction between liquidity support and external dependence is negative, but in only two cases statistically significant. In particular, when including total banking assets, liquidity support no longer has a significant growth effect.

The results are fully in line with our expectations that capital support has a much stronger focus in the medium run than liquidity support. As we argue, capital-related support is focused on general viability and hence, should enable banks to survive the crisis and to provide industry financing in the medium run. Contrastingly, liquidity support is mostly granted as a short-term measure to bridge liquidity shortages, and enables banks to refinance newly issued loans. The liquidity measure is negative and statistically significant in some cases. Hence, it seems to have potential negative effects. In the EU, the Commission put much emphasize on compliance with competition in the single market. Hence, they approved the provision of guarantees for issued debt with maturity less than five years only. Concerns that after this period refinancing without guarantees could become difficult may have set incentives to increase investment into highly liquid instruments rather than illiquid corporate financing, pushing growth in the short run, but depressing it in the medium run.

To translate the regression coefficients into real economic impact, we derive the differential in real growth rates as proposed by Rajan and Zingales (1998). It exploits variation on the industry-country level. Table 4.9 contains the corresponding data on country- and industry-heterogeneity. In this regard, consider a country that provides a relatively large amount of capital injections relative to the size of the banking sector, e. g., at the 75%-level of the distribution. This value is 0.0184. By considering two industries with different external dependences (e. g., at the 25%- and the 75%-percentile, given by 0.06 and 0.37), we obtain a difference of average industrial production growth rates in the country with

Table 4.8: Medium run analysis with aggregated state aid measures

	Medium run 2008-2013	**Medium run 2008-2013**	**Medium run 2008-2013**	**Medium run 2008-2013**
VARIABLES	Av. prod. growth	Av. prod. growth	Av. prod. growth	Av. prod. growth
Industry share	-0.0455	-0.0355	-0.116	-0.108
	(0.164)	(0.163)	(0.179)	(0.179)
Capital injections per total assets,	2.328**	2.841**	1.843*	2.239**
depending on external dependence	(1.064)	(1.050)	(0.980)	(0.923)
Liquidity support per total assets,	-0.986**	-0.730*	-0.274	-0.137
depending on external dependence	(0.404)	(0.411)	(0.432)	(0.486)
Financial crisis,		-0.0113**		-0.00802*
depending on external dependence		(0.00534)		(0.00460)
Total banking sector assets per GDP,			-0.0352**	-0.0329**
depending on external dependence			(0.0145)	(0.0139)
Constant	0.0684*	0.0884**	0.121**	0.161*
	(0.0404)	(0.0380)	(0.0457)	(0.0805)
Observations	444	444	432	432
R-squared	0.389	0.398	0.426	0.431
Country fixed effects	yes	yes	yes	yes
Industry fixed effects	yes	yes	yes	yes

Standard errors clustered on the industry-level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.9: 75th and 25th percentiles as well as median of variables for banking sector state aid and external dependence (1)

Variable	25%	Median (50%)	75%
Capital injection per total assets (annual)	0	0	0.00188
Liquidity support per total assets (annual)	0	0.00280	0.0188
Direct recapitalizations per total assets (annual)	0	0	0.00114
Impaired asset relief per total assets (annual)	0	0	0
Guarantees per total assets (annual)	0	0.00117	0.0162
Other liquidity support per total assets (annual)	0	0	0.000554
Capital injection per total assets (total)	0	0.00970	0.0184
Liquidity support per total assets (total)	0	0.0460	0.0972
Direct recapitalizations per total assets (total)	0	0.00450	0.0112
Impaired asset relief per total assets (total)	0	0	0.00226
Guarantees per total assets (total)	0	0.0432	0.0807
Other liquidity support per total assets (total)	0	0	0.0126
External dependence	0.060	0.140	0.37

Notes: Percentiles for the banking sector support variables are on the country-year-level and for external dependence on the industry-level and therefore, are unweighted by the number of industry-country-year observations.

high capital injections of

$$\begin{aligned}\Delta\text{Av. production growth rates}^{75\%}_{75\%\text{-}25\%} =& \text{Coefficient} \cdot \text{Capital injections}_{75\%} \\ & \cdot (\text{Ex.Dep}_{75\%} - \text{Ex.Dep}_{25\%}) \\ & = 2.328 \cdot 0.0184 \cdot (0.37 - 0.06) = 0.0133.\end{aligned}$$

Thus, the more dependent industry could grow by about 1.33 percentage points (pp) per year faster than a less dependent industry. In a country with low capital injections (in our case the 25%-percentile is indeed given by 0), the difference between the highly and the less dependent industry is given by 0. By comparing these two differences, we obtain the differential in real growth rates, which is the inter-country-difference between the inter-industry production growth rates. Hence, in this example, the average annual differential in real growth rates is about 1.33 pp per year (Table 4.8, column 1). With respect to the different regressions, the differential of real growth rates ranges between 1.05 and 1.62 pp per year. This effect is economically significant.

Disaggregating bank support in Table 4.10 shows qualitatively similar results. The growth effects of direct recapitalizations and impaired asset relief are positive in all regressions and statistically significant in many cases. The differentials of real growth rates induced by direct recapitalizations range between 0.63 pp and 1.08 pp per year, being

Table 4.10: Medium run analysis with disaggregated state aid measures

	Medium run 2008-2013	**Medium run 2008-2013**	**Medium run 2008-2013**	**Medium run 2008-2013**
VARIABLES	Av. prod. growth	Av. prod. growth	Av. prod. growth	Av. prod. growth
Industry share	-0.0300	-0.0954	-0.0367	-0.117
	(0.164)	(0.179)	(0.158)	(0.178)
Direct recapitalizations per total assets,	3.082**	2.021*	3.116**	1.814
depending on external dependence	(1.411)	(1.192)	(1.419)	(1.181)
Assets relief per total assets			1.488	4.370**
depending on external dependence			(2.690)	(2.064)
Guarantees per total assets	-0.685	-0.0624	-0.729	-0.114
depending on external dependence	(0.413)	(0.481)	(0.436)	(0.478)
Other liquidity support per total assets,			0.134	-0.444
depending on external dependence			(0.561)	(1.005)
Financial crisis,	-0.0115**	-0.00737*	-0.0125**	-0.00706
depending on external dependence	(0.00524)	(0.00429)	(0.00547)	(0.00542)
Total banking sector assets per GDP,		-0.0309**		-0.0371***
depending on external dependence		(0.0127)		(0.0118)
Constant	0.0867**	0.142*	0.0906**	0.174**
	(0.0386)	(0.0793)	(0.0386)	(0.0837)
Observations	444	432	444	432
R-squared	0.399	0.426	0.400	0.432
Country fixed effects	yes	yes	yes	yes
Industry fixed effects	yes	yes	yes	yes

Standard errors clustered on the industry-level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

slightly smaller than for aggregated capital injections. In addition, impaired asset relief programs implied a differential in real growth rates of 0.31 pp per year (column 4). Their growth effect is still notable since countries did not use asset relief extensively. Note that, according to our theoretical considerations, impaired asset relief measures potentially worsen banks' capital positions. In many cases, troubling banks using this measure might have received direct recapitalization measures as well. Therefore, this variable probably also captures effects from direct capital injections. Column (4) of Table 4.10 provides evidence in this direction since the coefficient of asset relief becomes significant, while statistical significance for direct recapitalizations disappears.

As suggested, it is relevant to control for the pure effect of the financial crisis. Consider column (1) and (2) in Table 4.8 and Table 4.10. The interaction between the the financial crisis and external dependence is negative and statistically significant. As Dell'Ariccia, Detragiache, and Rajan (2008) argue, crises impose financial frictions that particularly affect highly dependent industries. Further, in both tables (column (1) and (2)) the effects of the support measures increase if the financial crisis is included as a control variable. This suggests that not controlling for the crisis, as in Laeven and Valencia (2013b), leads to a downward bias of the growth effects of banking sector support. In all regressions, we don't find a significant coefficient of the industry share. This is surprising, since it typically has a negative and statistically significant growth effect. Typically, the explanation for this finding is a catching-up effect of young industries, which are typically relatively small. However, note that the period we investigate is dominated by the crisis and the average annual production growth rate is negative in our sample (see Table 4.6). During the crisis the small industries probably have suffered stronger, but have also recovered faster after the crisis, than big industries, which neutralizes the catching-up effect in average. In addition, we find a relatively strong negative and always highly statistically significant effect of total assets per GDP. Since the significant effect of the crisis partly disappears, it indicates that there is a significant correlation between suffering from the crisis and the size of the banking sector. The negative coefficient of total banking assets potentially reflects a positive correlation of the size of the banking sector and the severity of the crisis.

4.6.2 Short run growth effects

In this section, we investigate short run growth effects of the rescue packages. In contrast to the previous analysis, we investigate the impact of capital injections and liquidity measures on industrial growth on an annual basis. By including country-time, industry-time and country-industry fixed effects, we credibly control for a large share of unobserved

heterogeneity. By including the first lag of all variables, we further reduce endogeneity concerns. Following the same logic as before we apply the aggregated measures of capital injections and liquidity support as well as the disaggregated measures.

Table 4.11 indicates negative coefficients for the interaction between external dependence and capital injections and positive coefficients for the interaction with liquidity support, albeit no coefficient is statistically significant. Here, we don't find significant effects of the financial crisis as well as total bank assets any more. Table 4.12 provides results for disaggregated support measures. The effect of direct recapitalizations is strongly negative and statistically significant in all regressions. Guarantees have a positive effect on industrial growth differentials. Compared to the medium run, the differentials in real growth rates are much smaller in magnitude. For direct recapitalizations it ranges between -0.06 and -0.07 pp per year. Guarantees, however, implied a differential in real growth rates between 0.34 and 0.50 pp per year and hence, had a more pronounced effect.

The result of a switch in the sign for both capital and liquidity support relative to the medium run analysis is remarkable. The policy of the European Commission of approving support measures might have played an important role. Capital measures typically had to be combined with restructuring plans. Liquidity support, however, was typically provided unconditionally. The need to restructure and consolidate business in case of capital support may have set incentives to reduce lending in addition to the pure effect of a capital shortage. In contrast, the unconditional liquidity support seems to stimulate growth-enhancing activities of banks in the short run. However, it should be noted that we cannot fully explain the finding of countervailing effects in particular for the capital-related measures. The insignificant coefficients of asset relief measures illustrate that potential positive effects in the short run are less robust. The significant negative effect of direct recapitalizations, nevertheless, remains. Further investigation on the bank level may provide clearer evidence with respect to this issue.

4.7 Robustness analysis

In this section, we provide additional results to underline our main findings. First, we extend the analysis by measuring banking sector state aid in terms of GDP to obtain alternative measures similar to the ones of Laeven and Valencia (2013b). Second, we adjust the sample period and focus on the measures adopted in 2008 and 2009 only.

Table 4.13 contains the medium run regression results based on rescue measures in terms of GDP. The first two columns reveal a strong growth effect of total capital injec-

Table 4.11: Short run analysis with aggregated state aid measures

	Short run 2009-2013	**Short run 2009-2013**	**Short run 2009-2013**	**Short run 2009-2013**
VARIABLES	An. prod. growth	An. prod. growth	An. prod. growth	An. prod. growth
Industry share	-8.565**	-8.565**	-8.628**	-8.627**
	(4.131)	(4.127)	(4.178)	(4.175)
Capital injections per total assets,	-1.080	-1.188	-1.116	-1.166
depending on external dependence	(0.809)	(0.890)	(0.788)	(0.885)
Liquidity support per total assets,	0.613	0.577	0.388	0.377
depending on external dependence	(0.462)	(0.438)	(0.507)	(0.489)
Financial crisis,		0.0155		0.00738
depending on external dependence		(0.0367)		(0.0381)
Total banking sector assets per GDP,			0.0805	0.0783
depending on external dependence			(0.0582)	(0.0576)
Constant	-0.0220	0.0688	0.0560	0.119**
	(0.0660)	(0.0633)	(0.0626)	(0.0541)
Observations	2,922	2,922	2,922	2,922
R-squared	0.639	0.639	0.640	0.640
Number of industries	683	683	683	683
Country-time fixed effects	yes	yes	yes	yes
Industry-time fixed effects	yes	yes	yes	yes
Country-industry fixed effects	yes	yes	yes	yes

Standard errors clustered on the industry-level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.12: Short run analysis with disaggregated state aid measures

	Short run 2009-2013	**Short run 2009-2013**	**Short run 2009-2013**	**Short run 2009-2013**
VARIABLES	An. prod. growth	An. prod. growth	An. prod. growth	An. prod. growth
Industry share	-8.559**	-8.617**	-8.574**	-8.628**
	(4.124)	(4.170)	(4.121)	(4.166)
Direct recapitalizations per total assets,	-1.977**	-1.850*	-2.169**	-2.041**
depending on external dependence	(0.936)	(0.975)	(0.852)	(0.887)
Assets relief per total assets,			4.022	3.458
depending on external dependence			(5.877)	(5.781)
Guarantees per total assets,	0.917**	0.680	1.001***	0.776*
depending on external dependence	(0.419)	(0.485)	(0.361)	(0.417)
Other liquidity support per total assets,			-2.675	-2.494
depending on external dependence			(2.513)	(2.390)
Financial crisis,	0.0161	0.00811	0.0171	0.00971
depending on external dependence	(0.0358)	(0.0371)	(0.0376)	(0.0379)
Total banking sector assets per GDP,		0.0742		0.0698
depending on external dependence		(0.0574)		(0.0582)
Constant	0.0678	0.120**	0.0680	0.120**
	(0.0632)	(0.0540)	(0.0633)	(0.0541)
Observations	2,922	2,922	2,922	2,922
R-squared	0.639	0.640	0.640	0.640
Number of industries	683	683	683	683
Country-time fixed effects	yes	yes	yes	yes
Industry-time fixed effects	yes	yes	yes	yes
Country-industry fixed effects	yes	yes	yes	yes

Standard errors clustered on the industry-level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.13: Medium run analysis with aggregated and disaggregated state aid measures per GDP

	Medium run 2008-2013	**Medium run 2008-2013**	**Medium run 2008-2013**	**Medium run 2008-2013**	**Medium run 2008-2013**	**Medium run 2008-2013**
VARIABLES	Av. prod. growth	Av. prod. growth	Av. prod. growth	Av. prod. growth	Av. prod. growth	Av. prod. growth
Industry share	-0.0407	-0.118	-0.0326	-0.104	-0.0281	-0.119
	(0.171)	(0.185)	(0.166)	(0.182)	(0.160)	(0.178)
Capital injections per GDP,	0.488**	1.055***				
depending on external dependence	(0.201)	(0.323)				
Liquidity support per GDP,	-0.109*	-0.0727				
depending on external dependence	(0.0634)	(0.0624)				
Direct recapitalizations per GDP,			1.087*	1.340**	1.375	1.100
depending on external dependence			(0.552)	(0.620)	(0.884)	(0.776)
Asset relief per GDP,					-0.624	1.160
depending on external dependence					(1.103)	(0.752)
Guarantees per GDP,			-0.147*	-0.0958	-0.163*	-0.0761
depending on external dependence			(0.0755)	(0.0684)	(0.0849)	(0.0727)
Other liquidity support per GDP,					-0.0939	-0.330
depending on external dependence					(0.157)	(0.236)
Financial crisis,	-0.0113***	-0.00717***	-0.0138***	-0.00767**	-0.0130***	-0.00626*
depending on external dependence	(0.00298)	(0.00241)	(0.00466)	(0.00291)	(0.00424)	(0.00331)
Total banking sector assets per GDP,		-0.0416**		-0.0355**		-0.0412***
depending on external dependence		(0.0158)		(0.0148)		(0.0129)
Constant	0.141	0.148***	0.143	0.135***	0.135	0.144***
	(0.0881)	(0.0474)	(0.0889)	(0.0469)	(0.0887)	(0.0452)
Observations	444	432	444	432	444	432
R-squared	0.386	0.430	0.390	0.427	0.391	0.430
Country fixed effects	yes	yes	yes	yes	yes	yes
Industry fixed effects	yes	yes	yes	yes	yes	yes

Standard errors clustered on the industry-level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.14: 75th and 25th percentiles as well as median of variables for banking sector state aid and external dependence (2)

Variable	25%	Median (50%)	75%
Capital injection per total assets (2008-2009)	0	0.000377	0.00696
Liquidity support per total assets (2008-2009)	0	0.0132	0.0210
Direct recapitalizations per total assets (2008-2009)	0	0.000377	0.00657
Impaired asset relief per total assets (2008-2009)	0	0	0
Guarantees per total assets (2008-2009)	0	0.00305	0.0173
Other liquidity support per total assets (2008-2009)	0	0	0.000770
Capital injection per GDP (annual)	0	0	0.00647
Liquidity support per GDP (annual)	0	0.00737	0.0540
Direct recapitalizations per GDP (annual)	0	0	0.00258
Impaired asset relief per GDP (annual)	0	0	0
Guarantees per GDP (annual)	0	0.00365	0.0511
Other liquidity support per GDP (annual)	0	0	0.00195
Capital injection per GDP (total)	0	0.0132	0.0638
Liquidity support per GDP (total)	0	0.138	0.326
Direct recapitalizations per GDP (total)	0	0.0126	0.0466
Impaired asset relief per GDP (total)	0	0	0.0157
Guarantees per GDP (total)	0	0.131	0.262
Other liquidity support per GDP (total)	0	0	0.0264
External dependence	0.060	0.140	0.37

Notes: Percentiles for the banking sector support variables are on the country-year-level and for external dependence on the industry level and therefore, are unweighted by the number of industry-country-year observations.

tions. The differential in real growth rates is 0.97 and 2.09 pp per year (see Table 4.14 for corresponding percentiles of the measures in terms of GDP). Thus, the growth effect is similar to the corresponding previous analyses. Using disaggregated support confirms the growth effect of direct recapitalizations from our previous analyses. Including asset relief programs, however, does not change the size of the coefficient of direct recapitalizations significantly, but leads to a loss of statistical significance.

The results for the short run analysis do not reveal robust significant growth effects of both, capital-related measures and liquidity support. While capital injections are never statistically significant, the growth effect of guarantees in column (3) and (5) is positive and significant. The implied differentials in real growth rates are 0.47 pp per year in both cases. This is perfectly in line with the effects in Table 4.12. Hence, in the medium run as well as the short run analysis, results regarding support in terms of GDP do not differ systematically from the baseline results. With respect to the disaggregated measures, results are not particularly robust. In general, measuring support in terms of GDP less

often displays significant growth effects than those based on total assets. It might be understood as evidence that the growth effect of banking sector support in absolute terms depends on the size of the banking sector.

In Table 4.16 we adjust the approach of the main analysis by splitting the whole 6-year sample period into two sub-periods of 2 years, 2010-2011 and 2012-2013 to further investigate medium run growth effects. Moreover, we focus on the 2008-2009 rescue packages only. This allows us to investigate the effect of bank rescue packages on growth without overlapping time periods. Our results support the previous findings. Medium run capital-related measures are beneficial in terms of real growth. In both subperiods, 2010-2011 and 2012-2013, the coefficient of the aggregated capital measure as well as the pure recapitalization measure is statistically significant and positive. Liquidity-related measures do not have a significant impact on growth in this specification. This holds for both, the aggregated measure as well as guarantees only.[28]

To combine our analyses on short run and medium run effects, we further modify the approach of Table 4.16. We use the medium run methodology based on average industrial growth rates, but define a first subperiod of 2 years (2008-2009) and a second subperiod of 4 years (2010-2013). Again, we focus on the 2008-2009 rescue packages only. Hence, we investigate the effect of bank rescue packages on growth close to the date of implementation as well as on later time periods. Our results support our general interpretation. Capital support generates its growth effects in the medium run and may have negative effects in the short run. Suppose total capital injections in the period 2008-2009 compared to 2010-2013. While in 2008-2009 the coefficient is negative and statistically insignificant, for 2010-2013 the coefficient is significant and strongly positive. Liquidity support, in contrast, has a strong positive growth effect in the period of implementation. In the subsequent subperiod, the coefficient is negative, but never statistically significant. Again, the results are very similar if applying the more precise measures of direct recapitalizations and guarantees.

These results confirm our findings that capital injections are particular relevant for restoring long-term viability, whereas liquidity support is particularly beneficial in the short run and might have no or even negative effects in the medium run.

[28]In this analysis we do not consider asset relief programs and other liquidity support due to the restriction on implementation in 2008 and 2009 only.

Table 4.15: Short run analysis with aggregated and disaggregated state aid measures per GDP

	Short run 2009-2013	**Short run 2009-2013**	**Short run 2009-2013**	**Short run 2009-2013**	**Short run 2009-2013**	**Short run 2009-2013**
VARIABLES	An. prod. growth	An. prod. growth	An. prod. growth	An. prod. growth	An. prod. growth	An. prod. growth
Industry share	-8.243**	-8.629**	-8.230**	-8.614**	-8.233**	-8.612**
	(3.809)	(4.179)	(3.805)	(4.172)	(3.805)	(4.168)
Capital injections per GDP,	-0.278	-0.279				
depending on external dependence	(0.343)	(0.340)				
Liquidity support per GDP,	0.229	0.125				
depending on external dependence	(0.159)	(0.182)				
Direct recapitalizations per GDP,			-0.555	-0.522	-0.633	-0.607
depending on external dependence			(0.363)	(0.375)	(0.378)	(0.393)
Asset relief per GDP,					1.696	1.546
depending on external dependence					(2.096)	(2.152)
Guarantees per GDP,			0.296*	0.193	0.297*	0.212
depending on external dependence			(0.158)	(0.184)	(0.158)	(0.178)
Other liquidity support per GDP,					-1.114	-1.087
depending on external dependence					(0.988)	(0.984)
Financial crisis,	0.0118	0.00651	0.0147	0.00927	0.0169	0.0122
depending on external dependence	(0.0365)	(0.0386)	(0.0348)	(0.0370)	(0.0358)	(0.0368)
Total banking sector assets per GDP,		0.0684		0.0623		0.0513
depending on external dependence		(0.0596)		(0.0596)		(0.0601)
Constant	0.0755	0.122**	0.0748	0.123**	0.0747	0.126**
	(0.0600)	(0.0546)	(0.0599)	(0.0545)	(0.0599)	(0.0546)
Observations	2,986	2,922	2,986	2,922	2,986	2,922
R-squared	0.640	0.640	0.640	0.640	0.641	0.640
Number of industries	686	683	686	683	686	683
Country-time fixed effects	yes	yes	yes	yes	yes	yes
Industry-time fixed effects	yes	yes	yes	yes	yes	yes
Country-industry fixed effects	yes	yes	yes	yes	yes	yes

Standard errors clustered on the industry-level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.16: Medium run analysis for various time periods with state aid measures per total assets for 2008/2009

	Medium run 2010-2011	**Medium run 2010-2011**	**Medium run 2012-2013**	**Medium run 2012-2013**
VARIABLES	Av. prod. growth	Av. prod. growth	Av. prod. growth	Av. prod. growth
Industry share	0.248	0.258	0.283	0.277
	(0.317)	(0.317)	(0.200)	(0.202)
Capital injections in 08/09 per total assets,	9.488*		5.970**	
depending on external dependence	(4.931)		(2.515)	
Liquidity support in 08/09 per total assets,	-0.0615		-1.514	
depending on external dependence	(0.874)		(0.980)	
Direct recap. in 08/09 per total assets,		15.50**		7.799*
depending on external dependence		(6.766)		(4.008)
Guarantees in 08/09 per total assets,		-0.163		-1.534
depending on external dependence		(0.876)		(0.964)
Financial crisis,	0.0198	0.0198	0.0248***	0.0213**
depending on external dependence	(0.0162)	(0.0149)	(0.00895)	(0.00926)
Total banking sector assets per GDP,	-0.0422**	-0.0442***	-0.00467	-0.00432
depending on external dependence	(0.0157)	(0.0158)	(0.0164)	(0.0143)
Constant	0.284***	0.283***	0.156	0.156
	(0.0391)	(0.0393)	(0.118)	(0.121)
Observations	567	567	580	580
R-squared	0.553	0.556	0.268	0.267
Country fixed effects	yes	yes	yes	yes
Industry fixed effects	yes	yes	yes	yes

Standard errors clustered on the industry-level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.17: Medium run analysis for 2008-2009 and 2010-2013 with state aid measures per total assets for 2008/2009

	Medium run 2008-2009	**Medium run 2008-2009**	**Medium run 2010-2013**	**Medium run 2010-2013**
VARIABLES	Av. prod. growth	Av. prod. growth	Av. prod. growth	Av. prod. growth
Industry share	-0.190	-0.159	-0.0192	-0.0192
	(0.215)	(0.203)	(0.241)	(0.246)
Capital injections in 08/09 per total assets,	-1.467		8.524*	
depending on external dependence	(2.845)		(4.649)	
Liquidity support in 08/09 per total assets,	2.755***		-0.366	
depending on external dependence	(0.928)		(0.795)	
Direct recap. in 08/09 per total assets,		-6.007		12.987*
depending on external dependence		(4.872)		(6.442
Guarantees in 08/09 per total assets,		3.058***		-0.424
depending on external dependence		(1.065)		(0.893)
Financial crisis,	0.0154	0.0298	0.00814	0.00743
depending on external dependence	(0.0186)	(0.0213)	(0.00776)	(0.00700)
Total banking sector assets per GDP,	-0.0759**	-0.0805**	-0.0281*	-0.0288*
depending on external dependence	(0.0331)	(0.0354)	(0.0163)	(0.0165)
Constant	-0.0708	-0.0710	0.0205	0.0193
	(0.0607)	(0.0608)	(0.0247)	(0.0258)
Observations	432	432	567	567
R-squared	0.479	0.480	0.427	0.429
Country fixed effects	yes	yes	yes	yes
Industry fixed effects	yes	yes	yes	yes

Standard errors clustered on the industry-level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.8 Conclusion

This chapter adds to the literature on the real effects of banking sector support during times of crises. Particularly in Europe and the US, banks had to be rescued by enormous amounts of taxpayers' money. To mitigate direct and prohibit second-round effects from troubling banks, the rescue measures were provided as a significant backstop for real economic activity. Our study investigates potential growth effects of banking sector state aid during the financial and sovereign debt crisis. We use industrial production data for the EU from 2008 to 2013 and apply the methodology of Rajan and Zingales (1998) by investigating differentials in real growth rates dependent on industries' inherent need for external financing. Our analyses use two different approaches. First, we investigate medium run growth effects by averaging growth rates over the sample period and apply total volumes of the banking sector support measures provided by the European Commission. Identifying short run effects is achieved by using annual data and investigating deviations from medium run averages. We differentiate between capital-related and liquidity-related support, which we further split into direct recapitalizations and impaired asset relief programs and in guarantees and other liquidity support, respectively.

In the medium run, we find that capital injections had a positive impact on the differentials between average industrial production growth over the whole sample period. The implied medium run differentials in real growth rates of capital injections are about 1.5 pp per year. Liquidity support, in contrast, tends to have a negative effect on economic growth. Our short run analysis on an annual basis reveals a negative and statistically significant growth effect of direct recapitalization measures. The differentials in real growth rates, however, are rather small compared to the long-run effects. Guarantees, however, have a strong positive effect in the short run. Differentials for guarantees range between 0.34 and 0.5 pp per year. This is smaller than medium run effects for direct recapitalizations, but nevertheless provides an important contribution to economic growth during financial crises. In general, our empirical results are not overwhelmingly robust. This is in line with previous literature, which does not provide clear-cut evidence for a positive effect of banking sector interventions. However, irrespective of measuring amounts in terms of total bank assets or GDP and splitting the sample period into different subsamples, the general interpretation of our results is unaffected. Methodologically, by controlling for the financial crisis itself, we considerably strengthen the identification strategy relative to previous literature. Our results suggest a downward bias of the effect of state aid if the crisis is not taken into account. Further, throughout all medium run regressions, we find a strong negative and statistically significant growth effect of total bank assets. This points

towards the discussion about too much finance (see Arcand, Berkes, and Panizza (2012)) and an overbanking problem in Europe (see European Systemic Risk Board (2014b) and Langfield and Pagano (2016)).

This chapter provides insights into the question how to provide banking sector support in the European Union should it become necessary again. For restoring long-term viability and to generate long-term growth effects, capital injections should be applied. Liquidity measures, in particular guarantees, generate positive short-term effects and can buffer negative effects of the crisis itself and negative short run effects of capital injections. This is in line with our theoretical considerations. Assuming that in crises periods risk-weighted assets temporarily increase, capital injections are necessary to maintain solvency. Furthermore, after a normalization, they have the potential to increase the balance sheet in the medium run (e. g., by increasing the loan volume). Equivalently, they can buffer regulatory pressure to increase capital ratios. In contrast, guarantees are particularly beneficial in the short run since they reduce funding costs to obtain a positive margin for new corporate lending. As soon as funding spreads normalize, guarantees do no longer provide additional benefits. Our results suggest that if capital injections become necessary, they should be backed by guarantees. This keeps banks solvent by supporting them to maintain corporate financing at an appropriate level in times of distress.

The need to provide huge amounts of bank capital worsened governments fiscal position considerably and additionally fueled the sovereign debt crisis. As Honohan and Klingebiel (2003) show in a general examination of the fiscal costs of banking sector intervention, these massive outlays have to be taken into consideration. Our results suggest that on the one hand, the Commission's policy to require banks to contribute appropriately in the burden sharing much stricter than US authorities did, is likely to have depressed the rescue packages' positive impact on the economy. On the other hand, from the perspective of the different relationship between banks and their home countries in Europe and the US, banks are much larger in the EU relative to the sovereigns and in some countries total banking sectors are huge relative to GDP, the reaction of depressing state aid to the minimum necessary amount in Europe and requiring an significant burden-sharing seems understandable. To get an impression of the trade-off, consider the differential in real growth rates implied by capital injections of 1.5 pp per year. This differential is derived by the difference between the 25th and 75th percentile of the distribution of capital injections. In the case of Germany, the required amount of capital injections would have been about 160 billion Euro to obtain a difference in real growth rates that is by about 8-9 pp higher relative to a country without capital injections over the entire sample pe-

riod of 6 years. One might conclude that this effect is economically significant. Associated fiscal costs, however, would have been huge. As Schoenmaker and Siegmann (2014) show in a simulation for the largest European banks, national bank bailout mechanisms are relatively inefficient relative to a supranational bailout. Further, Acharya, Drechsler, and Schnabl (2014) show that indeed the increase of European sovereign credit default swaps (CDS) was caused by their bank bailout programs. However, they also document a feedback loop since bank CDS increased in response to lower sovereign creditworthiness, too. From this perspective effort to increase integration in this political field will have benefits for both, European sovereigns as well as banks, if bank bailout programs become necessary again. In this regard, there is some need to conduct banking sector support on the supranational level and put it into effect in a more harmonized way in future emergency cases.

Appendix

4.A Industry production data

The European Commission provides industry production data on the 2-, 3-, and 4-digit levels of the European industry classification NACE, before 2008 by the classification Rev. 1.1 (corresponding to the international classification ISIC Rev. 3.1) and since 2008 by the classification Rev. 2 (corresponding to ISIC Rev. 4). By using official correspondence tables from UNIDO, we match the data to the 3- and 4-digit industry sectors originally studied in the work of Rajan and Zingales (1998), which is based on the classification ISIC Rev. 2. We obtain 93 3-digit NACE Rev. 2 sectors, which we aggregate to 35 sectors. Note that the sector *Synthetic resins* (ISIC Rev. 2 code 3513) of the Rajan-Zingales study could not be matched to any single 3-digit NACE Rev. 2 sector and is therefore dropped from the analysis. We drop all industries with a production value of less than 0.01% of GDP. These industries are so small that they contain too few firms. For the medium run analysis, we compute the simple average over industry production growth rates for the period from 2008-2013.

4.B Dataset

Table 4.18: Country-specific summary statistics on financial crisis

Country	Total assets of banking sector per GDP	Number of years in crisis
Austria	2.955	2
Belgium	3.140	3
Bulgaria	0.965	0
Croatia	1.322	0
Czech Republic	1.024	0
Denmark	3.762	4
Estonia	1.262	0
Finland	1.883	0
France	2.334	3
Germany	2.973	2
Greece	1.839	6
Hungary	1.102	3
Ireland	6.808	6
Italy	2.000	6
Latvia	1.422	3
Lithuania	0.755	0
Netherlands	3.276	3
Poland	0.791	0
Portugal	2.625	6
Romania	0.596	0
Slovakia	0.918	0
Slovenia	1.260	6
Spain	2.599	6
Sweden	2.384	3
United Kingdom	4.311	5

Notes: Values denote mean figures from 2000 to 2013 (sample period may differ due to data availability).

Chapter 5

Conclusion

This thesis provides arguments for a balanced approach of reshaping banking sectors via public interventions and regulatory reforms. While they can be helpful in improving financial stability, negative real economic effects have to be considered. In this regard, this dissertation provides three different analyses. First, we show theoretically that the introduction of a leverage ratio may have countervailing effects. Second, we empirically analyze growth effects of banking sector integration in the European Union and find particular strong growth effects during financial crises and times of deleveraging. Finally, we demonstrate that banking sector support effectively buffered negative growth effects during the financial crisis.

The banking sector is still in the process of a deep restructuring. Partly driven by an inherent motivation of banks themselves, but mainly fostered by political interventions, banks will be much more constrained in their behavior than before the financial crisis. The existing regulatory framework of risk-weighting capital requirements is under investigation and will probably be adjusted with respect to specific issues, such as the zero-risk-weight of sovereign exposure. In addition, from 2018 onwards, capital requirements will be complemented by a leverage ratio requirement (see Fender and Lewrick (2015)). Our results on allocation effects induced by the introduction of such a risk-insensitive capital requirement suggest that, on the one hand, a strict regulation mitigates a favorable selection among banks and reduces specialization and its welfare improving gains. On the other hand, banks may choose a more precautionary business model by reducing asset risk. An appropriate leverage ratio balances these two effects and potentially achieves a welfare optimizing structure of the banking sector. However, this trade-off only appears if governments avoid implicit bailout guarantees, which may eliminate the risk-mitigating effect of higher capital requirements. Hett and Schmidt (2015) show that the bailout of one institution may be sufficient to reduce market discipline significantly. In addition to

the effects on the macro level, the leverage ratio is suggested to have also practical effects. Positions with short maturity typically have relatively low capital requirements. Under the leverage ratio, they have the same weight as long-term assets. Hence, incentives are strong to reduce this business area. In addition, requirements with respect to asset composition and liability structure are designed to further complement the existing tools. They affect banks in their choice of the business model and services they provide. Under the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR), banks will be required to adjust their assets composition and their liability structure to reduce liquidity- as well as maturity mismatch. It is suggested that these regulations are likely to reduce bank profitability. With respect to the LCR, banks will have to invest large amounts into highly liquid assets like best-rated sovereign bonds. Revenues from these assets, however, are typically very low (see also Allen, Chan, Milne, and Thomas (2012) and King (2013)). A further aspect are the revised minimum capital requirements for market risk of the Basel Committee (see Basel Committee on Banking Supervision (2016)). Due to the fact that large losses of banks during the financial crisis resulted from market movements, model choice of measuring market risk will become more restricted and more conservative. By a more granular application of own methodologies as well as a benchmarking against a standard approach, the overall level of capital charges on market risk will increase. In summary, regulatory reforms are extensive. Our results, however, suggest that particular attention on negative consequences is advisable. While all these measures can increase financial stability, a worse allocation of funds may also have negative effects on real growth.

There is also strong supervisory effort to obtain a more general framework of banking supervision in Europe. In this regard, the ECB is undertaking annually a comprehensive evaluation of European banks' overall situation and business model in its new supervisory review and evaluation process (SREP). In addition, regular stress tests further improve transparency with respect to asset and liquidity risk. From a political point of view, the introduction of the banking union by the Single Supervisory Mechanism (SSM) and the Single Resolution Mechanism (SRM) raised European economic integration to a new level. In this regard, by concentrating banking supervision for the largest European banks to the ECB, a methodologically and practically more coherent supervision is achieved. In contrast, de facto financial integration is now lacking behind its political counterpart. With beginning of the crisis, banks are concentrating more on domestic markets after a phase of strong globalization before the crisis. In addition to political pressure, also new regulation, which makes international banking activities more costly, fostered this process. However, financial integration is a significant driver of economic growth in the European Union.

Our results suggest a general growth effect of financial integration, which is particularly pronounced in times of crisis and bank deleveraging. In particular the presence of foreign banks, rather than cross-border lending, seem to stimulate growth significantly. Hence, fostering financial integration by incentivizing banks to engage in foreign countries via branches and subsidiaries is an important tool for a robust monetary policy transmission mechanism and an improved growth performance. In this light, the policy of the European Commission to condition rescue packages on business restructuring, which in many cases involved a significant reduction of foreign business, seems to be harmful.

Our study on real effects of banking sector state aid during the crisis provides implications for the design of potential future bank rescue packages. During the crisis, banking sector support by national governments was put into effect relatively heterogeneously. Our results suggest that a favorable bailout program complements capital-related measures, such as direct recapitalizations, by liquidity provision in the form of guarantees. While capital injections have significant positive medium run effects, growth might be mitigated in the short run. However, these adverse effects can potentially be buffered by guaranteeing debt instruments, which spurs growth in the short run, but with a neutral or slightly negative effect in the medium run. In order to avoid a situation in which bank bailout become necessary again, additional regulation is imposed. Minimum requirements for own funds and eligible liabilities (MREL) formulated by the European Banking Authority (EBA) and total loss absorbing capacity (TLAC) by the Financial Stability Board (see European Banking Authority (2015) and Financial Stability Board (2015)). Furthermore, regulation on recovery and resolution planning are implemented to improve restructuring and resolution as well as to increase the bail-in potential of liabilities. In this regard, also the concept of contingent convertible bonds (CoCo-bonds) plays an important role and commentators suggest further requirements based on these instruments (see Calomiris (2012) and Koziol and Lawrenz (2012)). Their structure as debt instruments that convert into equity capital with respect to certain trigger levels improves the share of loss-absorbing liabilities. Although these measures are important requirements to improve supervisors' ability to resolve failing banks, it remains likely that bailout policies will still be necessary to reduce negative consequences for real economic activity during a systemic banking crisis. Our results, therefore, provide useful guidance for banking sector state aid in future emergency cases.

This thesis illustrates real growth effects stemming from public interventions and regulatory reforms in the banking sector. Our analyses show that real effects were present and have to be considered carefully. Nevertheless, further research is necessary to ob-

tain a more comprehensive picture about potential effects. In Chapter 2, we provide a general equilibrium model of banking regulation, which reveals effects that may not be considered in partial equilibrium only. Nevertheless, further research has to deeper investigate specific aspects. E. g., our model gives hints that regulation affects the allocation of funds between traditional and shadow banks. An evaluation to which extent shadow banks can substitute traditional banks as well as of the associated costs can help better understand these aspects. In Chapter 3, we demonstrate that financial integration was particularly beneficial in terms of real growth during the financial crisis, when integration sharply reversed, as well as in times of deleveraging. The determinants and conditions under which these situations occur, however, need further investigations. The strong growth effects of integration call for an evaluation of appropriate measures to restore integration in times of distress. In Chapter 4, we evaluate bank bailout policies with respect to real economic growth in the medium and short run. Nevertheless, the effects on the banking sector itself lack detailed understanding. In particular, the policy of the European Union to require a restructuring of rescued banks likely affects both, troubling banks as well as the whole banking sector. E. g., banks winding down complete business segments may significantly influence the degree of competition in the market with corresponding effects on risk-taking. The bank itself may increase risk, since decreasing revenues from a reduction of business are not set off completely by decreasing costs. Additionally, changes in the ownership structure due to bailouts may set incentives for moral hazard.

Overall, the financial crisis appeared to have affected politics and societies significantly over the last years. It influenced many individuals around the world by the associated economic crash, and, more than seven years after its beginning, certain countries still suffer from high levels of sovereign debt and unemployment. This thesis is motivated by these developments. It illustrates the importance to carefully disentangle the effects of public interventions and regulatory reforms to appropriately respond to potential crises in the future.

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