Essays on the regulation of multinational banks

Inauguraldissertation
zur Erlangung des akademischen Grades
Doctor oeconomiae publicae (Dr. oec. publ.)
an der Volkswirtschaftlichen Fakultät
der Ludwig-Maximilians-Universität München

vorgelegt von

Miriam Goetz

2021

Referent:	Prof. Dr. Andreas Haufler
Korreferentin:	Prof. Dr. Monika Schnitzer

Promotionsabschlussberatung: 02. Februar 2022

Acknowledgments

This dissertation would not have been possible without the support of many people. First and foremost, I want to thank Andreas Haufler, who has been an excellent advisor. Andreas guided me well through my initial struggles with theory work and was always available to discuss ideas. His well-thought-out and encouraging comments greatly improved the quality of my research; and as the head of the Seminar for Economic Policy he provided a great work atmosphere. Furthermore, I want to thank my second advisor Monika Schnitzer. Prof. Schnitzer took time out of her busy schedule to discuss my first project when it was at a critical stage and was likewise willing to sit on my thesis committee during the most hectic months of the year. I am also grateful to Andreas Peichl for serving as the third member of my thesis committee as well as his many helpful suggestions throughout the years.

I am incredibly grateful to have had the opportunity to work with and learn from the many excellent researchers at the Seminar for Economic Policy and the LMU Public Economics group at large. Thanks especially to our faculty members Ulrich Glogowsky, Andreas Haufler, Jonas Löbbing, Jakob Miethe, Andreas Peichl and Dominik Sachs for inspiring academic excellency as well as an outstanding seminar culture. A big thanks also goes to my colleagues Tobias Hauck, Paul Hufe, Marc Stöckli, Fabian Stürmer-Heiber, Bernhard Kassner and the rest of the group who were always happy to help, comment and share insights.

The team at the Seminar for Economic Policy has made the last years a lot of fun. Thank you Davide, Uli, Franz, Daniel, Flo, Hiro, Tobi and Bernhard for adding levity to our work breaks and for showing me what work in academia is all about. I fondly remember our many insightful and entertaining chats over lunch and coffee.

All three chapters of this dissertation have benefited from the support of student assistants, in particular Josef Aumüller, Susanna Hassinen, Jelena Todorovic and Vincent Weber. I am also grateful to Mandy Häusler and Renate Schwirtz for keeping as many administrative tasks away from us PhD students as possible.

The last chapter of this dissertation uses German administrative data on labor market outcomes. I thank the Research Data Center at the Institute for Employment Research for granting me access and for dealing with my many questions and requests in a timely and professional manner. I am also grateful for generous financial support from the German Research Foundation in the form of the Research Training Group 1928 as well as project funding.

A special thank you goes to my husband, Jan Goetz, for his love and encouragement. Jan listened patiently to my descriptions of proofs that did not work out, too low numbers of observations and missing exogenous variation. In all of this, he always had faith that I would persevere.

Finally, I am grateful to my family for their continuous support and for giving me a place to go to away from work.

Miriam Goetz
Munich, September 2021

Contents

Preface **1**

1 Multinational lending retrenchment after the global financial crisis: The impact of policy interventions **7**

1.1 Introduction 7

1.2 Multinational banking under a binding equity constraint 12

1.2.1 General setup 12

1.2.2 Firms 14

1.2.3 Banks 15

1.3 Banking sector equilibrium 16

1.3.1 Bank monitoring decision 17

1.3.2 Equity allocation decision 18

1.4 Comparative statics 20

1.4.1 Negative equity shock 20

1.4.2 Regulatory requirements 23

1.4.3 Monetary policy 24

1.5 Multinational banking under a non-binding equity constraint 26

1.5.1 Bank monitoring and lending allocation decision 26

1.5.2 Comparative statics 27

1.6 Conclusion 31

2 Supervisory coordination without centralized capital regulation **34**

2.1 Introduction 34

2.2 Banking supervision and capital regulation in a two-country region 38

2.2.1 Multinational banks 38

2.2.2 Firms and consumers 40

2.2.3 Regulators . . . 41
2.3 Optimal capital regulation under different supervisory regimes . . . 44
2.3.1 Second stage: Choice of supervisory standard . . . 44
2.3.2 First stage: Choice of capital regulatory standard . . . 47
2.4 Welfare effects of a global supervisory regime . . . 50
2.5 Conclusion . . . 52

3 The role of early career wage profiles in fertility timing 53
3.1 Introduction . . . 53
3.2 Theoretical framework . . . 57
3.3 Data source and sample . . . 59
3.3.1 Early career characteristics and fertility timing in Germany . 62
3.4 Identification using labor demand shocks . . . 63
3.4.1 Identifying assumption . . . 68
3.5 Results . . . 70
3.5.1 OLS analysis . . . 70
3.5.2 IV analysis . . . 70
3.6 Heterogeneity analyses . . . 74
3.6.1 Interaction - Collective bargaining agreements . . . 74
3.6.2 Interaction - Temporary employment contracts . . . 75
3.6.3 Interaction - Quartiles of the entry wage distribution . . . 77
3.7 Conclusion . . . 80

Conclusion 82

Appendices 84
A Appendix to Chapter 1 . . . 85
A.1 Derivation of equilibrium monitoring efforts and lending volumes (unconstrained case) . . . 85
A.2 Comparative statics of the credit supply (1.28)–(1.30) . . . 86
A.3 Comparative statics of the monitoring and lending decision (1.31)–(1.33) and (1.34)–(1.36) . . . 87
A.4 Cross derivative of the monitoring effort . . . 88
B Appendix to Chapter 2 . . . 89
B.1 Supranational supervisory standard: sufficient condition for an internal solution . . . 89

B.2 Supranational capital standard: sufficient condition for an internal solution 90
B.3 Derivation of condition (2.12) 91

Bibliography **93**

List of Figures

1.1 Share of lending to foreign counterparties by German multinational banks 8
1.2 Lending margins by Euro zone member state 22

3.1 Time structure of the empirical specification 60
3.2 Early career wage growth and fertility timing by region 63
3.3 Correlation of potential and realized wage growth 67

List of Tables

3.1 Summary statistics 61
3.2 OLS and IV analyses 71
3.3 Interactions with industry specific employment conditions 76
3.4 Interactions with quartiles of the entry wage distribution 78

Preface

The financial deregulation of the 1990s has allowed commercial banks to increasingly conduct business across states, countries and regions. The liberalization has given rise to cross-border banking as well as a number of multinational banking groups. Over time, these banking groups have emerged as important players in lending markets outside of their respective domestic market. Indeed, Claessens and Van Horen (2014) document an increase in the global share of foreign owned banks of 70% during the period of $1995 - 2009$. The accompanying integration of lending markets has complicated the task of present-day regulators and policy makers.

The presence of multinational banks has traditionally been associated with better access to credit. In normal times, their larger size and international affiliate network give these banks a better access to financing, either via their own intra-bank or international inter-bank markets. Passing on these more favorable financing conditions, the presence of multinational banks has been found to widen and deepen local lending markets (De Haas and Van Lelyveld, 2010).

In crisis times, however, international intra-bank linkages can pose additional risks. While multinational banks generally support their foreign affiliates during localized crises, they tend to allocate lending capacity away from foreign markets during any crisis affecting the home market (Cetorelli and Goldberg, 2012). This lending "retrenchment" manifests as a disproportionate reduction in foreign credit supply with detrimental consequences to the respective real economies. For the $2007 - 2008$ global financial crisis, Aiyar (2012) finds that each 1% reduction in foreign bank financing caused a contraction in domestic lending in the UK of up to 0.65%. This reduction in credit supply and the associated financial constraints

on firms lead to a significant contraction of firm investment, R&D spending and employment (Campello et al., 2010).

The experiences of the past crises have highlighted the complexity of regulating internationally active banks. In particular, they have shown the difficulty of aligning different policy goals in an international environment. From $2008-2009$, most advanced economy banks lost a significant share of their equity capital buffers above regulatory requirements. Thus constrained but still required to maintain minimum capital ratios, banks drastically reduced their lending volume. This drop was particularly severe for US banks, which reduced their commercial lending by 25%.[1] Linking capital buffers and the retrenchment of multinational lending, De Haas and Van Lelyveld (2014) find a steeper post-crisis reduction in foreign lending for capital constrained banks. In this instance, the policy goal of financial stability interfered with the aim of a stable credit supply.

The losses of the global financial and European sovereign debt crisis were made possible by several loopholes in the then effective Basel II requirements (BIS, 2004). Their design allowed for regulatory arbitrage across asset classes, particularly asset-backed securities (ABS) and sovereign bonds, as well as risk calculation approaches (Efing, 2020; Acharya and Steffen, 2015; Behn et al., 2021). Both instigated risk seeking behavior, for instance in an overexposure to risky sovereign debt. Weakly capitalized banks in particular financed these purchases with central bank liquidity and substituted credit supply for them (Mariathasan and Merrouche, 2014; Carpinelli and Crosignani, 2021). Internationally active banks with large exposures to European sovereign debt withdrew from foreign lending markets (Popov and Van Horen, 2015). This is worrying since a large share of the purchased sovereign debt was domestic, indicating 'moral suasion' by national governments (Altavilla et al., 2017; Ongena et al., 2019). A negative feedback loop between sovereign and bank financing conditions emerged (Farhi and Tirole, 2018). Supervisory forbearance on the part of national regulators allowed this loop to further spiral out of control.

The aftermath of both crises saw major overhauls in financial regulation. Regarding financial stability, the most notable improvement was the switch to the Basel III regulatory framework. Among other measures, the current framework

[1] Drop in aggregate commercial lending to non-financial corporations from 09/2008 to 09/2010. Source: Board of Governors of the Federal Reserve System, St. Louis, MO

mandates a volume based leverage ratio in addition to risk based capital requirements, which is intended to curb banks' risk seeking behavior (BIS, 2010). With regards to banking supervision, the EU introduced the Single Supervisory Mechanism (SSM). In conjunction with the Single Resolution Mechanism (SRM), the SSM assumes the ultimate supervisory authority over all Euro zone banks (EU, 2013b). The centralization of supervisory authority prevents excessive leniency in national supervision. It further enforces cooperation in the resolution of internationally active banks. Thus far, assessments of the SSM have attested a positive impact on bank valuations (Loipersberger, 2018). This is particularly the case for countries with weak national institutions. In contrast, the implementation of the Basel III requirements remains somewhat heterogeneous in the EU. The member states for instance retain discretion in the computation of bank capital ratios, leaving room for national forbearance (Gropp et al., 2021b).

Overall, the past crises have demonstrated the great importance of an effective capital regulation and supervision of internationally active banks. At the same time however, they have highlighted the potential pitfalls and loopholes of existing policies. This thesis considers the prudential regulation of multinational banks in normal and in crisis times. It explores not only the advantages and disadvantages of existing regulation, but also its interaction with bank capitalization and between policy measures. The analysis focuses on commercial banking due to its considerable significance to the real economy. Most of the existing theoretical literature on international banking and regulation does not consider these interactions explicitly. It therefore cannot speak to the responses of capital constrained banks nor to the effects of combined policies. In contrast, this dissertation explains several, at times unintended consequences of internationally coordinated regulatory policy by exploring such interactions.

Given its increasing importance in the last decades, multinational banking and foreign bank entry have become active fields of study, both theoretically (e.g. De Blas and Russ (2013); Niepmann (2015); Faia et al. (2021)) and empirically (e.g. De Haas and Van Lelyveld (2010); Frey and Kerl (2015)). Similarly, a small literature has studied capital regulatory and supervisory coordination between jurisdictions and its impact on multinational bank decision making (e.g. Ongena et al. (2013); Beck et al. (2016); Haufler and Maier (2019); Calzolari et al. (2019)). Substantial empirical and some theoretical work also exists on commercial banking

in crisis times (e.g. Navaretti et al. (2010); Bolton et al. (2016); De Haas and Van Lelyveld (2014); Albertazzi and Bottero (2014); Acharya et al. (2018)).

Yet, while some empirical work exists on multinational banks' response to regulatory or monetary policy shocks during crises (see e.g. Gambacorta and Shin (2018); Gropp et al. (2019); Cappelletti et al. (2019); Carpinelli and Crosignani (2021)), this topic has received little attention from theoretical researchers. Similarly, not much research exists on the interaction between regulatory and supervisory policy measures in an international context; Acharya (2003) and Haufler (2021) are notable exceptions.

The first two chapters of this dissertation contribute to these lines of literature. In these chapters, I show, for instance, that stricter post-crisis capital regulations paired with unfavorable financing conditions can explain the lending retrenchment observed in the past decade (Chapter 1). Concerning regulatory coordination, this dissertation provides insight into welfare and other effects of the centralization of banking supervision under largely national capital regulation. The results suggest, that supervisory unions such as the Single Supervisory Mechanism (SSM) of the EU can be welfare decreasing (Chapter 2). Chapter 3 departs from the topic of banking and considers the relationship of early career wage profiles and women's fertility timing. In contrast to the previous chapters, this analysis is based on quantitative empirical research. I find that women transition to motherhood earlier in stable and employee friendly labor markets that allow for a high average wage growth at the beginning of the career. In the following, I briefly summarize the lines of argument and results of each chapter.[2] Each chapter is based on standalone work and can therefore be read independently.

Chapter 1 considers the increasing home bias in multinational lending following the global financial crisis, a process known as retrenchment. The essay investigates the role of the post-crisis regulatory and monetary policy interventions in this, using an international duopoly model. Two equity constrained multinational banks compete for corporate lending via local affiliates in two separate national lending markets. Due to a binding equity constraint, banks choose the share of their fixed overall lending volume to be allocated to each market. The affiliates subsequently determine the credit risk of their lending operation via a choice of monitoring

[2]Chapter 2 is based on a paper co-authored with Ulf Maier. To clarify that this is joint work, the chapter uses the pronoun "we".

effort, which is more costly to the foreign affiliates. In the model, negative shocks to bank equity, a tightening of regulatory standards and expansionary monetary policy, such as occurred during and after the global financial crisis, consistently decrease the share of banks' foreign lending. The model further predicts a higher equilibrium credit risk of foreign lending. This allows for an interpretation of the (policy induced) retrenchment as a flight to informationally closer or better understood lending. An alternative framework with non-binding equity constraints yields largely identical results.

Chapter 2 analyzes the interaction between the capital regulation and supervision of multinational banks when the latter is centralized. Both, stricter capital regulation and stricter supervision have positive international externalities. The externalities manifest in a reduction of the intra-bank cost of cross-subsidizing failing subsidiaries abroad. As such, stricter, centralized supervision reduces the domestic cost of foreign bank failure. This in turn increases the incentives for each national regulator to set inefficiently lenient capital standards. The essay identifies the cases in which the losses due to too lenient national regulation overcompensate the global welfare gain of stricter, centralized supervision. In these cases, moving towards a supervisory union reduces global welfare.

Departing from the topic of banking regulation, Chapter 3 analyzes the role of early career wage profiles in women's choice of fertility timing for the German context. In the essay, I instrument realized wage growth with a potential, shift-share wage growth rate. This allows me to identify exogenous variation in that component of wage growth which is driven by regional labor market conditions. I find that steeper region specific wage profiles cause an earlier transition to motherhood. This result is in line with the literature, which associates more favorable labor market conditions with increased fertility. The results further suggest that an increase in the individual component of wage growth is associated with a fertility delay.

To summarize, the first two chapters illustrate that an effective regulation of internationally active banks is not straightforward. In particular, they highlight the dilemma of conflicting policy goals, with financial stability on the one hand and a high and stable credit supply on the other. The chapters further demonstrate the necessity of coordination between policy measures and jurisdictions. This emphasizes the conflict between national and supranational policy makers. Departing

from the topic of banking, the last chapter illustrates the role of economic conditions in women's fertility decisions. It shows that fertility timing reacts differently to changes in broader labor market conditions compared to changes in individual career incentives. All essays presented in this dissertation make a contribution to fill the remaining gaps in their respective literature.

Chapter 1

Multinational lending retrenchment after the global financial crisis: The impact of policy interventions

1.1 Introduction

With the increasing liberalization of commercial banking in the past decades, multinational banks have emerged as important players in lending markets outside of their respective domestic market.[1] Given this role, the observation of a persistent reduction of foreign relative to domestic lending activity, which started during the 2007 – 2008 global financial crisis, has caused concern over a new systemic pattern of national lending market segmentation (Buch et al., 2014). Evidence shows a continuous reduction in the share of multinational banks' foreign lending activity starting with the default of Lehman Brothers in September 2008 (see Figure (1.1) for the case of German banks).[2] This gradual segmentation of national lending markets has persisted well throughout the post-crisis regulatory

[1] During the period of 1995–2009, the share of foreign owned banks increased by 70% globally (Claessens and Van Horen, 2014). Lending by foreign owned banks has been found to widen and deepen local lending markets as well as provide additional channels of financing in case of an inter-bank market or local economic shock (see e.g. Allen et al. (2017), Schnabl (2012)).

[2] Works such as De Haas and Van Lelyveld (2014), Cetorelli and Goldberg (2012) or Frey and Kerl (2015) document the post-crisis retrenchment of multinational lending.

Figure 1.1: Share of lending to foreign counterparties by German multinational banks

Data - Deutsche Bundesbank
Note - Own calculations. The figure depicts the share of lending to foreign counterparties (non-financial corporations and households) via local affiliates in total lending of German multinational banks. The vertical red line indicates the default of Lehman Brothers on September 15th, 2008.

and monetary policy interventions implemented 2008 – 2015 as well as the European sovereign debt crisis. Indeed, policy makers have been concerned about the potential role of their interventions in hindering continued financial integration (ECB, 2010).

While banks' reallocative responses to policy measures have received some empirical attention, the literature still lacks a theoretical treatment of this issue. My essay offers a first approach to the topic. To this end, I model multinational banking in an international Cournot duopoly under an equity constraint. Two multinational banks compete for corporate lending via local affiliates in two separate national lending markets. Each local market houses the headquarters of one bank and the foreign affiliate of the other. My model includes a full coverage deposit insurance in both countries. I initially assume the regulatory equity

constraint to be binding. Thus constrained, banks choose the share of their fixed lending volume to be allocated to each market. The affiliates then determine the credit risk of their lending operation via a choice of monitoring effort. Central to my analysis, I assume borrower monitoring to be more costly to the foreign affiliate.

Indeed, empirical studies show that a greater geographical, linguistic, cultural or legal distance between banks and borrowers amplifies the information frictions in the lending process.[3] Such costly frictions arise due to asymmetric information between banks and borrowers in the screening, monitoring, and contract enforcement process. Central to my analysis, Beck et al. (2018) find evidence for greater information frictions for lending by foreign owned banks. The authors show that loans originated by foreign banks are more likely to have repayment issues and a greater loss given default. In turn, the reduction of these frictions is more costly to foreign banks, especially to those headquartered in geographically and culturally distant countries (Brüggemann et al., 2012).[4] This information cost differential between foreign and domestic lending became especially relevant in the financial crisis. For the case of Italy, Albertazzi and Bottero (2014) find a greater post-crisis lending retrenchment of foreign banks headquartered in geographically distant countries.[5]

This essay considers equity constrained multinational banking in particular. From 2007 to 2009, most advanced economy banks lost a significant share of their equity buffers above regulatory requirements, increasingly constraining their lending activity (Ivashina and Scharfstein, 2010). This drop was particularly severe for the largest banks, with US banks of more than 500 billion USD in assets approaching the required minimum of 4.5% common equity under Basel II (Walter, 2019). Equity buffers gradually recovered in all advanced economies from 2009 (Buch and Dages, 2018). Linking equity buffers and the retrenchment of multinational lending, De Haas and Van Lelyveld (2014) find a greater post-crisis reduction in foreign lending of poorly capitalized banks. I investigate this dependency for-

[3] Agarwal and Hauswald (2010) show that a greater geographical distance to a loan applicant increases the likelihood of the loan being rejected. Further, the quality of banks' proprietary information on their existing borrowers decreases with the bank-borrower distance.

[4] As shown by Karceski et al. (2005) and Sapienza (2002), the greater information cost of foreign or geographically distant banks persists even after an acquisition of or merger with a local bank. This can be attributed to a greater "hierarchical distance" between borrower and loan officer within a larger banking organization (Stein, 2002).

[5] Sette and Gobbi (2015) and others show a similar post-crisis retrenchment in lending to informationally distant borrowers within countries.

mally by comparing multinational banks' lending retrenchment for the case of a non-binding and binding equity constraint.

I investigate the reallocative impact of equity, regulatory and monetary policy shocks on multinational lending in each case. I model the impact of the financial crisis on banks' balance sheets as a negative shock to bank equity, either as a decrease in the available volume or an increase in the cost of equity. Under a binding equity constraint, my model predicts banks to increase their lending home bias in response to such a shock. Banks similarly increase their lending home bias following a tightening of regulatory standards or expansionary monetary policy.

Banks' response to a reduction in bank equity or tightening of regulatory standards is robust to relaxing the equity constraint. Following expansionary monetary policy, however, well capitalized banks reduce their lending home bias due to an additional increase in lending volumes and subsequent reduction in the credit interest rate. This result is in direct opposition to the case of a binding equity constraint, where the effect on the credit supply is fully frustrated.[6] These results are consistent with the empirical findings of e.g. Baskaya et al. (2017). For the case of Turkey, the authors show that well capitalized foreign-owned banks increase their local lending supply more than poorly capitalized ones in response to an increased access to external financing.

In both cases, the domestic lending operations bear a smaller credit risk than their foreign counterparts due to their lower cost of monitoring local corporate borrowers. Building on this difference, the model shows two effect channels by which the impact of the policy shocks is intermediated. First, a reduction in bank equity reduces the credit supply to each market and subsequently increases the local credit interest rate. In expectations, this increase is particularly valuable to the less risky domestic lending operation.[7] A second effect channel stems from the government subsidy implicit in the deposit insurance. In expectations, this subsidy is greater for the riskier foreign lending operation giving banks an incentive to go abroad. The value of the subsidy decreases with an increase in the regulatory equity ratio or expansionary monetary policy. The two channels point to the information cost

[6] Gambacorta and Shin (2018) show that well capitalized banks increase their lending supply more strongly in response to expansionary monetary policy.

[7] The existence of such a *credit interest rate channel* is evidenced by the sharp and persistent increase in banks' corporate lending margins following the default of Lehman Brothers, see Figure (1.2).

differential between domestic and foreign lending as being central to the reallocative impact of the shocks. I thus conclude, that the policy interventions following the crisis likely contributed to the observed multinational lending retrenchment. I can interpret this retrenchment as a flight to informationally closer or better understood lending.

My essay connects and contributes to three separate strands of theoretical literature, namely multinational banking, financial regulation, and borrower monitoring. In particular, I connect to recent works on multinational banking which build on frameworks of international trade. Examples of this literature are Niepmann (2015), who studies banks' choice of entry mode into foreign markets as a consequence of national differences in factor endowments and banking sector efficiency, or De Blas and Russ (2013), Bremus (2015) and Corbae and D'Erasmo (2015) who study how the foreign bank entry mode affects local banking market structure and market power. My work is most closely related to those of Faia et al. (2021) and Haufler and Wooton (2021). Faia et al. (2021) set up an oligopolistic regional banking sector with an endogenous number of multinational banks operating under Cournot competition. Similarly to Haufler and Wooton (2021), I simplify this framework to two countries and banks while additionally introducing a binding regulatory equity constraint for the multinational bank as a whole. This modification allows my model to focus on multinational bank decision making under a regulatory constraint.

In explicitly modeling a binding equity constraint, I account for the highly regulated nature of the commercial banking business. In this, I draw from the sizable literature on banking regulation which assesses the impact of equity on bank risk taking and allocative decisions (see Hellmann et al. (2000), Repullo (2004)).[8] For the most part, the regulatory literature solely considers closed economies. One notable exception is the small literature on regulatory competition (see e.g. Acharya (2003) or Haufler and Maier (2019)). Within this literature, I relate most closely to Dell'Ariccia and Marquez (2006) from whom I adopt the application of a binding equity constraint. In this essay, I primarily understand equity requirements as a constraint to banks' lending choice. Indeed, Kopecky and VanHoose (2004) predict that under a binding equity constraint, shocks to regulatory bank equity

[8]Recent contributions to the regulatory literature focus for instance on the cyclicality of the Basel regulations (Chami and Cosimano, 2010; Repullo and Suarez, 2012; Mankart et al., 2019). Their dynamic modeling frameworks allow for positive equity buffers to emerge endogenously.

lead to short-term credit contractions.[9] I build on this result, in that I assess the impact of shocks on the equity constrained allocation of lending between bank affiliates.

I further relate to the literature on borrower monitoring and bank-borrower distance. Banks manage the riskiness of their current investments by monitoring the quality and project progress of existing borrowers at a cost (Freixas and Rochet, 2008). This information cost generally increases with the bank-borrower distance as modeled by Hauswald and Marquez (2006). In this model, I apply their distance dependent cost parameters to the context of lending to national markets of differing informational distance.

The remainder of this chapter is organized as follows. Section 1.2 introduces my theoretical framework of multinational banking under a binding equity constraint while Section 1.3 illustrates the constrained banks' equilibrium lending allocation between national affiliates. Section 1.4 analyzes the reallocative effect of a negative shock to regulatory equity or expansionary monetary policy as after the financial crisis. Section 1.5 compares my baseline model of multinational banking under a binding equity constraint with the case of a slack constraint. Section 1.6 concludes.

1.2 Multinational banking under a binding equity constraint

1.2.1 General setup

I present a model of multinational banking under an equity constraint. Therein, I consider a two-country regional banking sector in which two symmetric multinational banks offer credit via national affiliates. Each country $i \in \{A, B\}$ is headquarters to one multinational bank $i \in \{A, B\}$ and houses the foreign affiliate of the other. The affiliates present in each country engage in Cournot duopolistic competition for local corporate lending. All credit offered in a country is identical. In this choice of market structure, I follow the model of international trade via

[9] Empirical findings corroborate this result in that the lending supply of poorly capitalized banks reacts more severely to negative equity or regulatory shocks (see e.g. Bonaccorsi di Patti and Sette (2012), Fraisse et al. (2020)).

Cournot duopolistic incentives of Brander and Krugman (1983).[10] In this framework, international trade arises from the exporters' expectation of higher returns in the foreign market, due to less pre-existing supply. Variants of this framework have previously been applied to the subject of international banking by Faia et al. (2021) and Haufler and Wooton (2021).[11] I analyze the case of symmetric banks and markets.

I depart from Brander and Krugman's framework of goods trade to account for the inherently risky nature of the commercial lending business. This risk is generally not observable by the bank without exerting effort and incuring cost (Berger et al., 2001). In my model, I attribute this information cost to the effort exerted by banks in monitoring corporate projects. By exerting costly monitoring effort s_i, a bank i can affect the success probability of its borrowers' projects.[12] I assume monitoring effort and project success probability to have a linear relationship of slope one, such that a bank monitoring effort s_i yields a success probability of the borrowers' projects of $s_i \in (0, 1)$. Research on lending relationships shows that gathering information about borrowers becomes increasingly costly with the bank-borrower distance (e.g. Agarwal and Hauswald (2010)). Beck et al. (2018) and Brüggemann et al. (2012) show that this concept also applies to lending to foreign borrowers, especially ones located in countries that are geographically and culturally distant to a bank's headquarters. I take up this finding by modeling a greater cost multiplier of monitoring foreign compared to domestic borrowers $b_f > b_d$.

My model further differs from those of Faia et al. (2021) and Haufler and Wooton (2021) in that it assumes bank equity E to be fixed. It thereby describes a situation where banks are limited in their ability to raise equity such as during the global financial crisis. In the short-term, this difficulty in raising additional equity, together with strict equity requirements k, implies a binding equity constraint on banks' lending decisions. Here, a bank i's strategic choice of lending volume in its

[10] Head and Spencer (2017) give an overview of recent applications of oligopolistic models of international trade.

[11] In my model, I abstract from entry costs in foreign markets as in Faia et al. (2021). This describes an integrated regional banking sector where affiliate subsidiaries are already established and entry costs are sunk.

[12] One rationale for this relationship is that increased bank monitoring reduces the entrepreneurs' moral hazard problem, inducing him to exert a greater managerial effort (Holmstrom and Tirole, 1997).

domestic or foreign market reduces to the share γ_i or $1 - \gamma_i$ of its fixed lending capacity $L_i = E/k$ which to allocate to that market. I model the local markets for deposit financing as perfectly competitive.

In my model, the national governments provide a full-coverage deposit insurance for local bank affiliates. This reflects the current practice in most developed and developing countries, which have implemented either an explicit or implicit deposit insurance scheme.[13] In case of default of a bank affiliate, local taxpayers must pay off its depositors. The deposit insurance signifies an implicit subsidy to the bank. The subsidy increases with the affiliate's default probability. Hence, the existence of the deposit insurance gives the affiliates a disincentive to exert monitoring effort.

The timing of my model follows a predefined sequence of events. In the first stage, the banks simultaneously set the share of their fixed lending volume L_i to be allocated to their domestic and foreign affiliates γ_i and $1 - \gamma_i$. The local credit interest rates r_i are then determined from the anticipated credit demand and supply in the national markets i. In stage two, the affiliates decide on their optimal monitoring effort s_{di} or s_{fi}. In stage three, firms decide on whether to apply for a loan at the local credit interest rate r_i. I solve the model by backward induction.

1.2.2 Firms

I consider prospective borrowers in each local lending market $i \in \{A, B\}$ to be individual entrepreneurs or small firms. The population of firms is atomistic in nature and of measure $\bar{R}$. Each firm is risk neutral and has access to a constant-return risky technology ("project") with a random gross return R. Firms draw a realization of R from the continuous, uniform distribution $R \sim \text{unif}(0, \bar{R})$. Each entrepreneur is aware of the gross return of his own project. All projects require a fixed amount of initial external investment which I normalize to $I = 1$. Firms can finance their projects by taking a loan offered by the local affiliate of either the domestic or foreign multinational bank.[14] In addition, firms can only apply for a loan once.

[13] See Barth et al. (2013) for a recent global overview of deposit insurance schemes.

[14] Due to their inherent opacity, small and young businesses have limited access to capital markets and rely largely on local bank credit for external financing (see Berger and Udell (1998) for a summary of the literature). As shown by Beck et al. (2018), even larger and mature firms are twice as likely to receive credit from domestic than foreign banks.

A firm realizes its gross return with a success probability $s \in (0,1)$, determined by the loan monitoring effort of its creditor bank, and receives a return of zero otherwise. In the latter case, the firm defaults on its bank loan. Under this assumption of firm limited liability, a firm's willingness to borrow depends on its valuation of the loan only in the state of project success. Consequently, a firm borrows if its gross return R is larger or equal to the credit interest rate r_i in its local market i, such that $R - r_i \geq 0$. This inequality holds true for all gross returns $R \in [r_i, \bar{R}]$. Assuming a uniform distribution of gross returns across firms, the number of borrowers willing to take out a loan at a given credit interest rate r_i is

$$L_i^D(r_i) = \bar{R} - r_i, \tag{1.1}$$

defining the aggregate credit demand function. With firms confined to borrowing from a local bank affiliate, the national credit markets are separated and local credit demands are independent. Under symmetry of banks, the market clearing credit interest rates are identical $r_i(L_i^D) = r_j(L_j^D)$.

1.2.3 Banks

The two multinational banks $i \in \{A, B\}$ finance their lending in part via equity capital and in part by raising deposits. I summarize a bank i's unit costs from these two forms of financing as

$$C_{di}^C(s_{di}) = (\delta + \rho)k + \delta(1-k)s_{di} \tag{1.2}$$

$$C_{fi}^C(s_{fi}) = (\delta + \rho)k + \delta(1-k)s_{fi}, \tag{1.3}$$

respectively for domestic and foreign lending. Here, s_{di} and s_{fi} denote the credit success probabilities of the domestic and foreign affiliate and thereby the probabilities with which the insured deposits have to be repaid.

Equity holders require a return per unit investment that is equal to a risk premium $\rho > 0$ for the uninsured equity in addition to the risk free interest rate δ. I can interpret the unit cost of equity $\rho + \delta$ as the existing shareholders' opportunity cost of retaining earnings instead of paying them out immediately as dividends.[15] Banks' share of equity financing is determined by minimum regula-

[15]Equivalently, the greater cost of equity can be interpreted as the significant underpricing required in issuing new equity. Both interpretations capture the idea that equity capital is a

tory requirements. A national regulator i imposes a capital adequacy standard k_i, which represents the minimum share of equity financing (henceforth "equity ratio") required for all bank affiliates operating in country i. I assume symmetric regulation $k_i = k_j = k$ across countries, such as within the Euro zone.

The banks' national affiliates have access to an unlimited amount of locally raised deposits. Depositing with a bank is risk free in both countries due to deposit insurance schemes by the national governments. Deposits are consequently priced at the risk free interest rate δ determined by international capital markets. More importantly for the borrowing banks, deposits only have to be repaid if the local bank affiliate does not default. The affiliates' use of this cheaper form of financing is constrained by the regulatory equity ratio k. I assume individual corporate credit risks to be perfectly correlated within each national lending market.[16] This implies, that the credit success probability of its borrowers, s_{di} or s_{fi}, directly reflects an affiliate's default probability and the probability with which it must repay its depositors.

1.3 Banking sector equilibrium

A bank headquartered in country i maximizes the sum of its expected profits from domestic and foreign lending $\Pi_i = \Pi_{di} + \Pi_{fi}$. To this end, the bank optimally chooses the lending volumes and credit risk in the two markets. This decision making is constrained by regulatory equity requirements. At the multinational level, bank i chooses the shares γ_i and $1 - \gamma_i$ of its fixed equity to be allocated to its domestic and foreign affiliate. The amount of equity allocated to the domestic market, $\gamma_i E$, as well as k in turn determine the lending volume $L_{di} \leq \gamma_i E/k$ of bank i in market i. Analogously, bank i's lending volume in the foreign market j is given by $L_{fi} \leq (1 - \gamma_i)E/k$. This sums up to the overall lending volume of bank i, $L_i = L_{di} + L_{fi} \leq E/k$. For the case of a binding equity constraint, as assumed here, these expressions hold with equality. In turn, the bank affiliates take on deposits $D_{di} \leq E\gamma_i(1-k)/k$ and $D_{fi} \leq E(1-\gamma_i)(1-k)/k$, respectively.[17]

particularly costly form of financing (see Dell'Ariccia and Marquez (2006) or Hellmann et al. (2000) for similar assumptions).

[16] Perfect correlation of credit risks is a common assumption in the regulation literature, see e.g. Dell'Ariccia and Marquez (2006) or Boyd and De Nicolo (2005).

[17] For a binding equity constraint, these expressions hold with equality.

The bank affiliates then choose the credit monitoring effort s_{di} and s_{fi} to decrease the credit risk of their respective lending operation. The choice of monitoring and lending allocation determines bank i's overall expected profit

$$\begin{aligned}\Pi_i(\gamma_i, s_{di}, s_{fi}) = & L^S_{di}(\gamma_i)\left(s_{di}r_i - C^M_{di}(s_{di}) - C^C_{di}(s_{di})\right) \\ & + L^S_{fi}(\gamma_i)\left(s_{fi}r_j - C^M_{fi}(s_{fi}) - C^C_{fi}(s_{fi})\right) \\ \text{s.t.} \quad & L^S_{di}(\gamma_i) \geq \frac{E}{k}\gamma_i \\ & L^S_{fi}(\gamma_i) \geq \frac{E}{k}(1-\gamma_i).\end{aligned} \tag{1.4}$$

Here, $C^M_{di}(s_{di})$ and $C^M_{fi}(s_{fi})$ describe the monitoring cost per unit of domestic and foreign lending given bank i's choice of monitoring efforts s_{di} and s_{fi}. Further, the unit capital costs are as given in (1.2) and (1.3). I consider the case of a binding regulatory equity constraint in optimum.

In banking sector equilibrium, the sum of lending supplied to market i, $L^S_i = L_{di}+L_{fj} = E/k[\gamma_i+(1-\gamma_j)]$, equals the local credit demand (1.1). The equilibrium credit interest rate in market i is then given by

$$r_i = \bar{R} - \frac{E}{k}[\gamma_i + (1-\gamma_j)]. \tag{1.5}$$

An analogous expression for r_j applies to market j. Under symmetry of banks and markets, the interest rates take the same value $r_i = r_j = r$ in equilibrium.

1.3.1 Bank monitoring decision

I specify the monitoring cost of bank i per unit of domestic and foreign lending as

$$C^M_{di}(s_{di}) = \frac{1}{2}b_d s^2_{di} \tag{1.6}$$

$$C^M_{fi}(s_{fi}) = \frac{1}{2}b_f s^2_{fi}. \tag{1.7}$$

In line with Hauswald and Marquez (2006), I model monitoring costs as convex. The greater information cost of monitoring borrowers in the foreign market enters my model via a greater cost multiplier $b_f > b_d$ of foreign monitoring. I partially differentiate bank i's expected profit (1.4) with respect to the monitoring efforts

to receive the optimal monitoring

$$s_{di}^* = \frac{r - (1-k)\delta}{b_d} \tag{1.8}$$

$$s_{fi}^* = \frac{r - (1-k)\delta}{b_f}. \tag{1.9}$$

In its choice of monitoring, an affiliate trades off the credit success probability with the monitoring cost and the expected value of the local deposit insurance.[18] Consequently, the first term in the numerator of equations (1.8) and (1.9) denotes the equilibrium credit interest rate or marginal revenue from monitoring in the respective national lending market. The second term describes the opportunity cost of monitoring as the expected value of the national deposit insurance. The cost multiplier in the denominator describes the marginal cost of monitoring of the respective affiliate. The domestic monitoring decision has no bearing on bank i's profit in the foreign market and vice versa.

In banking sector equilibrium $r_i = r_j = r$, the two banks choose symmetric levels of monitoring $s_{di}^* = s_{dj}^*$ and $s_{fi}^* = s_{fj}^*$ (henceforth s_d^* and s_f^*). Due to the greater information cost of the foreign operation, modeled as $b_d < b_f$, domestic monitoring takes a greater value in optimum

$$s_d^* - s_f^* = \frac{(b_f - b_d)(r - (1-k)\delta)}{b_d b_f} > 0. \tag{1.10}$$

This directly translates to a greater credit risk and therefore default risk of the foreign affiliate. I may say qualitatively that the domestic lending operation is "safer" than the foreign one or that the credit risk differential $s_d^* - s_f^*$ between affiliates is positive. The informational advantage of the domestic operation increases with the difference in information cost $b_f - b_d$.

1.3.2 Equity allocation decision

I now formally assess the impact of the lending allocation decision on bank i's overall profits. To do so, I insert the expression for the local credit interest rates

[18] In my model, the local credit interest rates depend on the distribution of firms' gross rather than expected revenue from investment (see eq. (1.1)). In consequence, the banks' choice of local monitoring effort and thus credit risk is independent of the local credit volume and their share therein.

(1.5) into bank i's expected profit function (1.4) and take the first order derivative with regards to the lending share allocated to the domestic affiliate γ_i. This yields the condition for an optimal lending allocation

$$\begin{aligned}\frac{\partial \Pi_i}{\partial \gamma_i} =& \frac{E}{k} s_{di} \left(\bar{R} - \frac{E}{k} \left[2\gamma_i + (1 - \gamma_j) \right] \right) - \frac{E}{k} s_{fi} \left(\bar{R} - \frac{E}{k} \left[2(1 - \gamma_i) + \gamma_j \right] \right) \\ & - \frac{1}{2} \frac{E}{k} \left[b_d s_{di}^2 - b_f s_{fi}^2 \right] - \frac{E}{k} (1 - k) \delta \left[s_{di} - s_{fi} \right] = 0. \end{aligned} \tag{1.11}$$

The bank takes the lending allocation decision of its Cournot competitor in a given market as exogenous. Hence, an increase in the share of bank i's domestic lending γ_i decreases the credit interest rate in the domestic market r_i and increases the credit interest rate in the foreign market r_j, which denote the respective gross revenues from local lending. For an optimal choice of monitoring efforts (1.6) and (1.7), the domestic lending operation bears a lower default risk than its foreign counterpart $s_d^* > s_f^*$. For a given credit interest rate, domestic lending then generates greater expected marginal revenue. On the other hand, monitoring costs are greater for the more intensely monitored domestic lending operation. Further, the deposit insurance takes a smaller expected value for the "safer" domestic affiliate. This implies that deposit financing is more expensive domestically. A bank i's choice of lending allocation γ_i can thus be interpreted as reflecting the trade-off in expected profitability between the domestic and foreign operation.

The banks decide on their lending allocation simultaneously and symmetrically. Inserting the optimal monitoring (1.6) and (1.7) into the first order condition (1.11) and solving for $\gamma_i^* = \gamma_j^* = \gamma^*$ yields the expression

$$\gamma^* = \frac{1}{2} + \frac{1}{2} \frac{(b_f - b_d) \left[\bar{R} - 2\frac{E}{k} - (1 - k)\delta \right]}{\frac{E}{k}(b_f + b_d)} \tag{1.12}$$

for the equilibrium share of domestic lending. I argue that the banks' foreign presence is driven mainly by the expectation of higher expected revenue from foreign lending rather than the greater value of the deposit insurance in the 'riskier' foreign market. Under this assumption, which I can formalize as

$$\left[\bar{R} - 2E/k - (1-k)\delta\right] > 0, \tag{1.13}$$

equation (1.12) represents a lending home bias $\gamma^* > 0.5$ which increases with the informational distance of the foreign to the domestic lending market $b_f - b_d$. The lending home bias decreases with the total amount of credit E/k supplied to each market which drives down the equilibrium credit interest rate $\bar{R} - E/k$ and thus the value of the informational advantage of the domestic operation. Further, γ^* decreases with the opportunity cost of exerting one more unit of monitoring effort $(1-k)\delta$.[19]

I summarize these findings in the following proposition.

Proposition 1.1. *In banking sector equilibrium, the following properties hold.*
(i) The banks' domestic affiliates exert greater monitoring effort than their foreign affiliates $s_d^* > s_f^*$. This implies a smaller credit risk of domestic relative to foreign lending.
(ii) The banks allocate a greater share of lending to the domestic affiliate $\gamma^* > 0.5$ (lending home bias).
(iii) Both, the share of domestic lending γ^* and the difference between domestic and foreign monitoring $s_d^* - s_f^*$, increase with the difference in information costs $b_f - b_d$.

1.4 Comparative statics

1.4.1 Negative equity shock

In the 2007 – 2008 financial crisis, banks experienced a systemic, negative shock to the value of their equity caused by unexpected losses (Demirguc-Kunt et al., 2013; Baron et al., 2021).[20] In this analysis, I abstract from the exact cause of

[19] A binding constraint on banks' overall lending volume can potentially give rise to an additional equilibrium in autarky $\gamma_i = \gamma_j = 1$. I find that my model does not support this. Banks' choice of a greater monitoring effort in the domestic market leads to a greater marginal cost of domestic lending. The cost savings of the first unit of foreign lending subsequently overcompensate a possibly smaller unit revenue, eliminating the possibility of an autarky solution.

[20] In the United States, banks experienced losses as early as 2007, most prominently from direct exposure to mortgage lending. European banks on the other hand experienced losses mostly through the exposure of their securities portfolios to US mortgage backed securities and

this devaluation. Rather, I take bank equity and the negative equity shock to be exogenous to the banks' commercial lending business which is at the center of my analysis.

I first consider the effect of a negative shock to bank equity on the optimal choice of credit risk in the domestic and foreign market. To do so, I differentiate the optimal monitoring efforts (1.8) and (1.9) with respect to bank equity E

$$\frac{\partial s_d^*}{\partial E} = -\frac{1}{kb_d} < 0 \qquad \frac{\partial s_f^*}{\partial E} = -\frac{1}{kb_f} < 0. \tag{1.14}$$

Following a negative equity shock, monitoring increases for both lending operations, causing their credit risk to decrease.[21] This is especially the case for the domestic lending operation, for which increasing the monitoring effort is less costly. Consequently, domestic credit risk decreases by a disproportionate amount. The domestic operation becomes relatively "safer". The increase in monitoring is caused by an increase in the marginal revenue from monitoring, i.e. the equilibrium credit interest rate $r = \bar{R} - E/k$, due to the decrease in the equilibrium supply of credit to each market E/k.

In a second step, I analyze the effect of a negative shock to bank equity on the lending home bias. Differentiating the optimal share of domestic lending γ^* (1.12) with respect to bank equity E yields

$$\frac{\partial \gamma^*}{\partial E} = -\frac{(b_f - b_d)\left[\bar{R} - (1-k)\delta\right]}{E^2/k(b_f + b_d)} < 0. \tag{1.15}$$

A reduction in bank equity E decreases the supply of credit to each market which in turn increases the credit interest rate and thus the gross marginal revenue from domestic and foreign lending. Since the domestic operation bears less default risk $s_d^* > s_f^*$, the increase in the interest rate is in expectations more valuable for the domestic affiliate. Hence, lending in the domestic market becomes relatively more profitable. I call this the *credit interest rate channel*. Empirically, a post-crisis increase in credit interest rates is clearly observed. Figure (1.2) charts the lending

stocks of US financial intermediaries. Investors priced this devaluation of investments into the banks' market valuation starting with the Lehman Brothers default.

[21] This is in line with the empirical finding of Albertazzi and Marchetti (2010) of a general "flight to quality" of banks during the crisis.

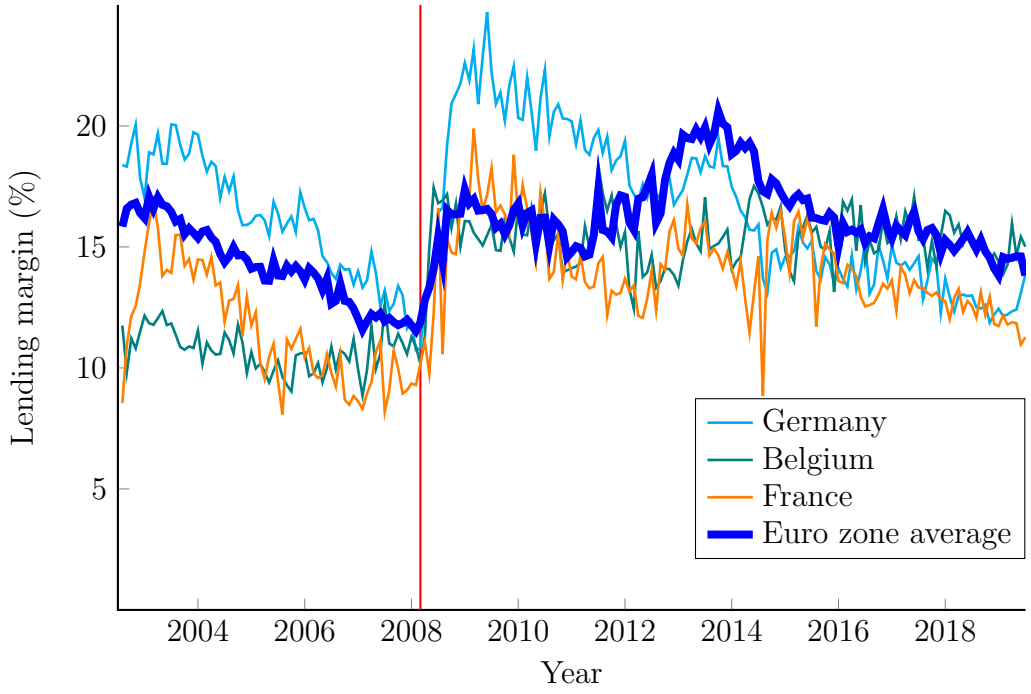

Figure 1.2: Lending margins by Euro zone member state

Data - ECB, Risk Assessment Indicators Data
Note - Own calculations. The figure depicts the lending margins for non-financial corporations in percent by Euro zone member state. The Euro zone average is calculated using an unweighted average of the initial members. The vertical red line indicates the date of the Lehman Brothers default, September 15th, 2008.

margins for non-financial corporate borrowers within the Euro zone. From the early 2000s on, lending margins in the Euro zone were steadily decreasing until September 2008, coinciding with the default of Lehman Brothers. Lending margins increased by an average of 5 % in the following year and have not returned to their level of 2007 since.

I further asses how the informational distance between banks' foreign and domestic markets affects the magnitude of the negative equity shock. I proxy this distance by a larger value of the foreign information cost multiplier b_f. As shown by the derivative of (1.15) with regards to b_f,

$$\frac{\partial \gamma^*}{\partial E \partial b_f} = -\frac{2\left[\bar{R} - (1-k)\delta\right]}{E^2/k(b_f + b_d)^2} < 0, \tag{1.16}$$

I find a larger lending retrenchment effect following a negative equity shock for more distant foreign affiliates. This is in line with the empirical consensus, showing that after the crisis banks withdrew lending especially from markets that were geographically farther away from banks' domestic markets (Emter et al., 2019).

1.4.2 Regulatory requirements

As a consequence of the financial crisis, regulators started to improve on the existing Basel II regulatory framework, leading to the ratification of Basel III in 2010. Central to the revised framework, which was implemented in the Euro zone from 2013 on, is the increase of the required common equity ratio from 2% to 4.5%. Basel III additionally requires a minimum leverage and liquidity ratio (BIS, 2010). I examine the impact of the tightening of regulatory equity requirements as an increase in the regulatory equity ratio k. The impact of an increase in k on the monitoring efforts is given by

$$\frac{\partial s_d^*}{\partial k} = \frac{\frac{E}{k^2} + \delta}{b_d} > 0 \qquad \frac{\partial s_f^*}{\partial k} = \frac{\frac{E}{k^2} + \delta}{b_f} > 0. \tag{1.17}$$

An increase in the required equity ratio decreases the credit risk of both affiliates via an increase in the marginal revenue from monitoring.[22] The greater equity requirement increases the credit interest rate in both local lending markets, making monitoring universally more profitable. Additionally, an increase in the share of equity financing k decreases the value of the national deposit insurance schemes. This decreases the marginal opportunity cost of monitoring $(1-k)\delta$. Due to the smaller unit cost of domestic monitoring, the domestic credit risk decreases disproportionally.

I further analyze the effect of a regulatory tightening on the lending home bias. To do so, I differentiate the optimal share of lending allocated to the domestic affiliate γ^* with respect to the equity ratio k, yielding

$$\frac{\partial \gamma^*}{\partial k} = \frac{(b_f - b_d)(\bar{R} + k\delta)}{E(b_f + b_d)} > 0. \tag{1.18}$$

[22]The negative relationship of equity requirements and credit risk is in opposition to the result of Hakenes and Schnabel (2011). This is due to my modeling of borrower monitoring, which eliminates the entrepreneurs' choice of project risk.

An increase in k increases the lending home bias in that it reduces the credit supply and thus increases the credit interest rate in both national credit markets. As for a negative equity shock, the increase in banks' gross marginal revenue from lending is in expectations more valuable to the less risky domestic lending operation. In addition to this *credit interest rate channel* of lending reallocation, I identify a *liability channel*. The greater required share of internal financing forces the banks to make less use of refinancing via insured deposits. Due to the greater default probability of the foreign affiliate, the limited liability implied in the deposit insurance signifies an additional incentive for lending abroad. An increase in the equity ratio reduces this incentive. This reduction is stronger for more distant and thereby riskier foreign markets.[23]

1.4.3 Monetary policy

From 2008 to 2016, the ECB gradually lowered its bank refinancing rate from 3.75% to 0%. This was accompanied by unconventional measures of expansionary monetary policy such as quantitative easing and targeted asset purchase programmes, some of which remain to the present day (Hartmann and Smets, 2018). I assess the effect of expansionary monetary policy on the decision making of multinational banks as a decrease in the bank refinancing rate.[24] In my model the bank refinancing rate is represented by the riskless deposit rate δ. I find the effect of monetary policy changes on the monitoring efforts to be

$$\frac{\partial s_d^*}{\partial \delta} = -\frac{1-k}{b_d} < 0 \qquad \frac{\partial s_f^*}{\partial \delta} = -\frac{1-k}{b_f} < 0. \tag{1.19}$$

A decrease in the bank refinancing rate increases affiliate monitoring and consequently decreases credit risk. The decrease in δ decreases the value of the subsidy implicit in the deposit insurance, increasing the affiliates' incentive to monitor. Due to the smaller unit cost of domestic monitoring, the domestic credit risk decreases disproportionally.

[23] Similarly, Cappelletti et al. (2019) find that banks respond to increases in equity requirements by shifting their lending to less risky counterparties within the corporate sector.

[24] Unconventional expansionary monetary policy can be modeled as the reduction of a "shadow policy rate" as introduced by Lombardi and Zhu (2014).

Differentiating the share of domestic lending γ^* as in (1.12) with respect to the bank refinancing rate δ yields

$$\frac{\partial \gamma^*}{\partial \delta} = -\frac{1}{2}\frac{(b_f - b_d)(1-k)}{E/k(b_f + b_d)} < 0. \tag{1.20}$$

A decrease in δ disproportionally reduces the capital costs of the less risky domestic operation. Hence, the profitability of domestic lending increases more than that of foreign lending. Accordingly, expansionary monetary policy leads to a greater lending home bias. This effect is more pronounced for informationally distant foreign markets.

I summarize these results for equity constrained multinational banks in the following proposition.

Proposition 1.2. *Under binding equity requirements, a reduction in bank equity E, an increase in equity requirements k, and a decrease in the bank refinancing rate δ, all*
(i) increase the monitoring effort exerted by both bank affiliates. This increase is greater domestically, implying a greater decrease in credit risk for the domestic lending operation.
(ii) increase the lending home bias.

I summarize, that all considered shocks increase the lending home bias and decrease the credit risk of equity constrained banks. A reduction of regulatory bank equity increases the credit interest rate in both markets. In expectations, this increase in the marginal revenue from lending is more valuable for the less risky domestic operation. A regulatory or monetary policy shock reduces the expected value of the deposit insurance. This reduction is greater for the riskier foreign lending operation. The two mechanisms define the *credit interest rate channel* and *liability channel* of lending reallocation, respectively.

1.5 Multinational banking under a non-binding equity constraint

In a situation where equity can be raised without difficulty, the minimum equity requirements of equation (1.4) do not bind. This describes the situation of many advanced economy banks after 2009, which were able to gradually increase their equity buffers in the first post-crisis years (Walter, 2019). In my model, equity unconstrained banks $i \in \{A, B\}$ separately choose their optimal lending volumes in the domestic and foreign market L_{di} and L_{fi}, rather than shares of a fixed total.

This decision is made jointly and simultaneously with the choice of monitoring effort of the respective affiliate. As above, I consider banks and markets to be symmetric.

1.5.1 Bank monitoring and lending allocation decision

I derive the equilibrium monitoring efforts and lending volumes of the equity unconstrained banking sector in appendix A.1. In contrast to the constrained lending decision of Section (1.3.2), the unconstrained equilibrium credit supply $L^S = L_d^\dagger + L_f^\dagger$ and interest rate $r = \bar{R} - L^S$ in each market are endogenously determined rather than fixed by the equity constraint. I find the equilibrium credit supply to each market to be

$$L^S = \frac{3\left[\bar{R} - \delta(1-k)\right] - \sqrt{\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d + b_f)(\delta + \rho)k}}{4}. \tag{1.21}$$

Using this definition, I can simplify the expressions for optimal monitoring and lending (A.1)–(A.4) to

$$s_d^\dagger = \frac{(\bar{R} - L^S) - \delta(1-k)}{b_d} \tag{1.22}$$

$$s_f^\dagger = \frac{(\bar{R} - L^S) - \delta(1-k)}{b_f} \tag{1.23}$$

$$L_d^\dagger = L^S \left(\frac{1}{2} + \frac{1}{2} \frac{(b_f - b_d)\left[\bar{R} - 2L^S - \delta(1-k)\right]}{L^S(b_d + b_f)} \right) \tag{1.24}$$

$$L_f^\dagger = L^S \left(\frac{1}{2} - \frac{1}{2} \frac{(b_f - b_d)\left[\bar{R} - 2L^S - \delta(1-k)\right]}{L^S(b_d + b_f)} \right), \tag{1.25}$$

which match the expressions (1.8)–(1.10) of the constrained case. As above, the monitoring efforts directly reflect the credit risk and default probability $1 - s^\dagger$ of the respective affiliate. In optimum, the credit risk of the domestic affiliate takes a lower value

$$s_d^\dagger - s_f^\dagger = \frac{(b_f - b_d)\left[\bar{R} - L^S - \delta(1-k)\right]}{b_d b_f} > 0. \tag{1.26}$$

For the share of domestic lending $\gamma^\dagger = L_d^\dagger / L^S$ I find

$$\gamma^\dagger = \frac{1}{2} + \frac{1}{2} \frac{(b_f - b_d)\left[\bar{R} - 2L^S - \delta(1-k)\right]}{L^S(b_d + b_f)} \tag{1.27}$$

equivalent to the constrained result (1.12) and implying a lending home bias $\gamma^\dagger > 0.5$.[25] All of the above equilibrium expressions must by definition be non-negative.

1.5.2 Comparative statics

I evaluate the impact of shocks to regulatory bank equity and monetary policy on the monitoring and lending allocation decision of equity unconstrained multinational banks. The comparative static analysis I conduct is comparable to that of the equity constrained case of Section 1.4. One exception is the definition of the negative bank equity shock, which I model here as an increase in the equity

[25] Expression (1.27) reflects a lending home bias under the assumption that banks' foreign lending activity is predominantly driven by the expectation of greater lending revenue rather than that of a reduced liability in the riskier foreign market, or $\left[\bar{R} - 2L^S - \delta(1-k)\right] > 0$.

premium ρ. Such an increase reflects an increase in the cost of equity e.g. via a deterioration of banks' market valuation such as in the financial crisis.[26]

Due to the comparable structure of the constrained and unconstrained optima, I expect similar effect channels to be present in both cases. In the constrained case, shocks to regulatory equity affect banks' decision making by tightening the regulatory constraint on their overall lending capacity. This mechanical effect is absent here. Rather, the shocks affect the unconstrained affiliates' financing costs, impacting optimal lending volumes and thereby the credit supply to both markets. To better assess this additional structure, I first present the comparative statics of the equilibrium local credit supply L^S

$$\frac{\partial L^S}{\partial \rho} < 0 \qquad (1.28) \qquad \frac{\partial L^S}{\partial k} \gtreqless 0 \qquad (1.29) \qquad \frac{\partial L^S}{\partial \delta} < 0. \qquad (1.30)$$

I find that both an increase in the refinancing rate δ and the equity premium ρ universally decrease the credit supply L^S (see full derivatives as well as proofs of the derivative signs in appendix A.2). In general, the effect of an increase in the equity ratio k on the credit supply cannot be signed. Under sufficiently low equity requirements however, L^S decreases with k, $\lim_{k\to 0} \frac{\partial L^S}{\partial k} < 0$. Considering the limit case, the effect signs with regards to ρ and k carry over from my analysis of poorly capitalized banks. My finding of a nonzero effect for a change in monetary policy, is however contradictory to the equity constrained case. The negative effects of ρ and δ on the credit supply are intermediated by an increase in the affiliates' internal and external financing costs, (1.2) and (1.3). An increase in k increases the affiliates' financing costs by increasing the share of costly equity financing.

Drawing on these results, I assess the impact of the shocks to regulatory bank equity and monetary policy on optimal monitoring. The corresponding parameters enter the affiliates' monitoring decision directly in the value of the deposit insurance and indirectly via the credit interest rate $r = \bar{R} - L^S$ i.e. the marginal revenue from monitoring. I present the comparative statics for the affiliates' monitoring effort

[26] Buch and Dages (2018) document an increase in the cost of equity for banks of all advanced economies during the crisis. This increase was most persistent for European banks, whose cost of equity returned to pre-crisis levels only in 2014.

$$\frac{\partial s_d^\dagger}{\partial \rho} = \frac{1}{b_d}\left(-\frac{\partial L^S}{\partial \rho}\right) > 0 \qquad \frac{\partial s_f^\dagger}{\partial \rho} = \frac{1}{b_f}\left(-\frac{\partial L^S}{\partial \rho}\right) > 0 \tag{1.31}$$

$$\frac{\partial s_d^\dagger}{\partial k} = \frac{1}{b_d}\left(-\frac{\partial L^S}{\partial k} + \delta\right) > 0 \qquad \frac{\partial s_f^\dagger}{\partial k} = \frac{1}{b_f}\left(-\frac{\partial L^S}{\partial k} + \delta\right) > 0 \tag{1.32}$$

$$\frac{\partial s_d^\dagger}{\partial \delta} = \frac{1}{b_d}\left(-\frac{\partial L^S}{\partial \delta} - (1-k)\right) \gtreqless 0 \qquad \frac{\partial s_f^\dagger}{\partial \delta} = \frac{1}{b_f}\left(-\frac{\partial L^S}{\partial \delta} - (1-k)\right) \gtreqless 0. \tag{1.33}$$

An increase in the equity premium ρ and ratio k universally increases the monitoring effort. For a decrease in the bank refinancing rate, the effect sign depends on regulatory standards. I show the full derivatives in appendix A.3. An increase in ρ increases the affiliates' monitoring incentives via a decrease in the credit supply L^S. The subsequent increase in the credit interest rate increases the affiliates' marginal revenue from monitoring. The increase in monitoring is greater for the domestic affiliate, leading to a disproportionate decrease of the domestic credit risk.

Expansionary monetary policy and a regulatory tightening additionally affect monitoring incentives directly via changes in the value of the deposit insurance. For an increase in k, both, the increase in the credit interest rate and the reduction in the share of insured deposits, lead to an increase in monitoring effort and thus a decrease in credit risk. Conversely, the effect channels take opposite signs for expansionary monetary policy. A decrease in δ increases monitoring incentives due to a reduction in the value of the deposit insurance while at the same time decreasing monitoring incentives due to a lower credit interest rate. The latter effect channel is not present in the equity constrained case, where the overall effect of expansionary monetary policy can be signed positively without ambiguity. Here, I find that in the limit of only deposit financing, the domestic monitoring effort decreases with the refinancing rate $\lim_{k\to 0} \frac{\partial s_d^\dagger}{\partial \delta} < 0$, in line with the constrained result. Conversely, in the limit of no insured deposit financing, the relationship is positive $\lim_{k\to 1} \frac{\partial s_d^\dagger}{\partial \delta} > 0$. The effect magnitude increases monotonously with the share of equity financing $\frac{\partial^2 s_d^\dagger}{\partial \delta \partial k} > 0$ (see appendix A.4 for the full equation). I argue that the former case of predominantly external financing is the economically relevant one. Equivalent inequalities hold for foreign monitoring.

I asses the effects of shocks to bank regulatory equity and monetary policy on the optimal lending home bias

$$\frac{\partial \gamma^{\dagger}}{\partial \rho} = \frac{(b_f - b_d)}{2(b_d + b_f)(L^S)^2} \left(-\frac{\partial L^S}{\partial \rho} \left[\bar{R} - \delta(1-k) \right] \right) > 0 \tag{1.34}$$

$$\frac{\partial \gamma^{\dagger}}{\partial k} = \frac{(b_f - b_d)}{2(b_d + b_f)(L^S)^2} \left(-\frac{\partial L^S}{\partial k} \left[\bar{R} - \delta(1-k) \right] + \delta L^S \right) > 0 \tag{1.35}$$

$$\frac{\partial \gamma^{\dagger}}{\partial \delta} = \frac{(b_f - b_d)}{2(b_d + b_f)(L^S)^2} \left(-\frac{\partial L^S}{\partial \delta} \left[\bar{R} - \delta(1-k) \right] - (1-k)L^S \right) > 0. \tag{1.36}$$

The lending home bias increases with the equity premium ρ and ratio k and decreases with the bank refinancing rate δ (I present the full derivatives in appendix A.3). An increase in ρ increases the lending home bias in that it increases the credit interest rate and thereby the gross marginal revenue from lending in the banks' domestic and foreign market. Due to the greater success probability of the domestic lending operation, this increases the expected domestic revenues more strongly.[27]

An increase in k similarly increases the credit interest rate. At the same time it reduces banks' ability to make use of insured deposit financing, reducing their incentive for lending in the riskier foreign market. Here, both the *credit interest rate channel* and the *liability channel* lead to an increase in the lending home bias.

For expansionary monetary policy, two equivalent effect channels are present albeit with opposing signs. A decrease in δ decreases the credit interest rate, decreasing the home bias. At the same time, the value of the governmental deposit insurance decreases, decreasing banks' incentive for foreign lending due to a reduced liability. I algebraically find that the *credit interest rate channel* overcompensates the *liability channel* of expansionary monetary policy, leading to an unambiguous decrease in the lending home bias.

[27] While banks reduce their lending volume in both markets in response to an increase in ρ, this reduction is less pronounced in the domestic market, leading to an increase in the lending home bias. Indeed, domestic lending $L_d^{\dagger}$ only decreases only under the assumption of a moderate information cost differential $b_f - b_d < 2b_d$ while the decline of the foreign lending volume $L_f^{\dagger}$ is unambiguous.

I summarize my findings for the equity unconstrained case in the following proposition.

Proposition 1.3. *Under a non-binding equity constraint,*
(i) banks increase (decrease) their monitoring efforts (affiliate credit risk) following an increase in the equity premium ρ or equity ratio k or a decrease in the bank refinancing rate δ.
(ii) banks increase their lending home bias following an increase in the equity premium ρ or equity ratio k.
(iii) banks decrease their lending home bias following a decrease in the bank refinancing rate δ.

My results for equity constrained banks largely carry over to the unconstrained case. The exception is banks' reallocative response to monetary policy changes. Under expansionary monetary policy, the effect of a smaller deposit insurance, which increases the lending home bias, is now overcompensated by a simultaneous negative effect due to an increase in credit supply. This latter effect is not present under a binding constraint, leading to opposing derivative signs in the two cases. Hence, the sign of the overall effect of monetary policy changes on the lending home bias depends on bank capitalization above the regulatory minimum. This is consistent with empirical findings on the lending supply of foreign-owned banks. For the case of Turkey, Baskaya et al. (2017) show that well capitalized foreign-owned banks increase their local lending supply more than poorly capitalized ones in response to a positive funding shock.

1.6 Conclusion

I have proposed a model of multinational banking under an equity constraint which analyzes the role of policy interventions in the persistent lending retrenchment beginning with the 2007 – 2008 global financial crisis. The model predicts negative equity shocks, a tightening of regulatory standards and expansionary monetary policy, as occurred during and after the financial crisis, to increase the lending home bias of multinational banks. The reallocative effect is greater for foreign lending markets that are informationally distant to the banks' respective home market. I additionally find all considered shocks to decrease bank credit risk,

especially that of the domestic lending operations. My results are largely independent of bank capitalization with the exception of banks' reallocative response to monetary policy. Following expansionary monetary policy, well capitalized banks decrease their lending home bias. This is consistent with the result of Baskaya et al. (2017), who show that the increase in foreign lending following a positive funding shock increases with the foreign bank's capitalization.

Central to my analysis is the assumption of a greater cost of monitoring foreign compared to domestic borrowers. This gives rise to a greater equilibrium credit risk of foreign lending. Based on this risk differential, I propose two channels by which the impact of regulatory equity or monetary policy changes is intermediated: the *liability channel* and the *credit interest rate channel*. Increased regulatory standards and expansionary monetary policy decrease the expected value of the deposit insurance. The reduction of the government subsidy implicit in this insurance is greater for the riskier foreign affiliate, leading to a reduced share of foreign lending. Negative shocks to regulatory equity further increase the credit interest rate, disproportionally increasing the expected revenue from lending of the less risky domestic affiliate. Under a non-binding equity constraint, this latter effect is also present for monetary policy shocks, reversing the sign of the equity constrained response.

I conclude, that the policy interventions following the crisis likely contributed to the observed post-crisis retrenchment of multinational lending. This retrenchment can be interpreted as a flight to informationally closer or better understood lending. The result of a reduction in credit risk following all policy interventions additionally points towards their role in the observed "flight to quality" within lending categories.

I have presented a positive study of the effects of policy changes on banks' international lending allocation. This study has not however answered the normative question on how the predicted effects affect the stability of the banking sector and overall welfare. On the one hand, my model predicts an increased segmentation of lending markets to lower the credit risk in each local market. The smaller average bank-borrower distance decreases monitoring costs and thus borrower default probabilities (Agarwal and Hauswald, 2010). At the same time, the literature on multinational banking has shown that foreign-owned banks continue to supply credit in a local market experiencing a negative domestic shock (Allen et al., 2017).

Further, multinational banking provides an alternative to the inter-bank market in channeling capital between countries (Schnabl, 2012).

My model can be extended to answer interesting additional questions. One such question is the lending allocation between banking sectors of differing monitoring efficiency and access to capital. Under a heterogeneity in the monitoring efficiency, the result that a greater lending market segmentation must be accompanied by a lower local credit risk may not hold, allowing for a more differentiated view of the presence of foreign banks. In turn, modeling a heterogeneity in capital endowment would allow studying banks' reaction to local or asymmetric funding shocks. An extension to individual risk-based equity requirements would additionally shed light on the reallocative impact of risk-based regulatory tools.

Chapter 2

Supervisory coordination without centralized capital regulation

2.1 Introduction

The global financial crisis of 2007 – 2009 has highlighted the need for more rigorous, internationally coordinated bank capital regulation and supervision. In particular, the crisis showed the danger of forbearance at the national level and towards internationally active banks. To address this issue, the EU ratified legislation towards a bank supervisory union in 2013: the Single Supervisory Mechanism (SSM). In conjunction with the Single Resolution Mechanism (SRM), the SSM assumes the ultimate supervisory authority over all Euro zone banks (EU, 2013b). Moreover, large, systemically relevant and internationally active banks are under its direct supervision. Early assessments of this centralized mechanism find it to have increased the effectiveness and rigor of supervision, particularly for the case of internationally active banks (Schoenmaker and Véron, 2016). This is supported by event study evidence in Loipersberger (2018), who shows that centralized supervision has positive effects on bank valuation.

In regards to more rigorous capital regulation, the EU legally implemented the Basel III accords in 2013 (EU, 2013a). Unlike the SSM and SRM, the updated capital regulatory framework distinctly allows for national discretion in the implementation of policy standards. For instance, EU member states have room for for-

This chapter is based on joint work with Dr. Ulf Maier.

bearance concerning the computation of bank capital ratios (Gropp et al., 2021b). This is evidenced by the significant cross-country heterogeneity in effective capital ratios calculated by the ECB in their 2014 stress tests of systemically important banks.[1] As such, the EU currently represents a regulatory regime which combines centralized supervision with capital regulation that is at least partly decentralized. The question we address in this essay is whether centralized supervision is efficient in this environment.

We present a model where capital regulatory decisions at the national level interact with decentralized or centralized supervisory decisions. In the model, the national banking sectors are composed of local subsidiaries of multinational banks. The subsidiaries are heterogeneous with respect to their exogenously given investment success probability. The distribution of success probabilities is independent in the two countries, such that one subsidiary of a multinational bank may be successful and its foreign affiliate may fail. In such a case, the successful subsidiary assumes the failure cost of and cross-subsidizes its failing counterpart abroad. As documented by Fiechter et al. (2011), the default of a subsidiary imposes high reputational costs on the multinational bank, such that the bank stands to gain from cross-subsidization. In our model, negative international spillovers of subsidiary failures thus arise through the affiliate network of multinational banks.

The capital regulatory and supervisory decisions are taken sequentially. In the second stage, either the national or central regulators set the supervisory standards in the form of resolution thresholds. These thresholds indicate the minimum success probability required of a bank subsidiary to be allowed to continue and realize its investment outcome. A higher resolution threshold implies a lower share of failing bank subsidiaries. We follow Beck et al. (2013) and Beck et al. (2016) in this modeling approach. Our model includes an additional first stage, in which the national regulators non-cooperatively set capital regulatory standards in the form of minimum capital ratios. A higher capital requirement limits the lending volume and thereby the loss given a subsidiary failure. In this decision, the national regulators anticipate the share of bank failures as determined by the supervisory standards of the second stage.

[1] As discussed by Fratianni and Pattison (2015), national regulators stated average Tier 1 common capital ratios up to 2.9 % higher than those calculated by the ECB.

We compare the regulatory decision making and global welfare under a regime of no policy coordination with a regime of centralized supervision but decentralized capital regulation. Absent policy coordination, national regulators fail to account for the international spillovers of both stricter supervision and stricter capital regulation. Stricter supervision in one country decreases the share of local bank subsidiaries which fail and require cross-subsidization by their successful foreign counterparts. This reduction in the cost of intra-bank subsidization is not considered by the national regulators such that the nationally set supervisory standards are too lenient from a global welfare perspective. Stricter capital requirements similarly reduce the cost of cross-subsidization given an affiliate failure abroad. As such, the capital regulatory standards, too, are too lenient in a non-cooperative setting compared to the supranational optimum.

Moving towards a regime of stricter, centralized supervision while keeping capital regulation decentralized affects the incentives for setting national capital regulation. Stricter supervision reduces the share of failing bank subsidiaries. Consequently, limiting the intra-bank cost of subsidiary failure through strict capital requirements becomes less important. As such, the national governments set even more lenient capital requirements under centralized supervision than in the case of no policy coordination. This has a negative externality on the other country. We show that this negative welfare effect of laxer capital requirements can lead to an overall welfare loss from the supervisory reform. This is the case, when the cost of reimbursing bank creditors through public funds is large compared to the rents from successful investment.

Our analysis connects the existing literature on supervisory and capital regulatory coordination across countries. With regards to supervisory coordination, Beck et al. (2013) and Beck et al. (2016) analyze the effects of various modes of bank activity abroad on centralized and decentralized supervisory decisions. For the case of multinational banking, Calzolari et al. (2019) study the welfare effects of centralizing supervision under an endogenous choice of bank organizational form. Colliard (2020) considers an endogenous choice of bank quality disclosure to the centralized or decentralized regulator. In a related strand of literature, Repullo (2018), Carletti et al. (2020) and others examine the issue of non-optimal information sharing between a central supervisory authority and national regulators.

These papers do not however consider an additional capital regulatory decision as we do.

With regards to capital regulatory coordination, Dell'Ariccia and Marquez (2006) assess the effects of a centralization of capital requirements when bank capital is mobile. Haufler and Wooton (2021) extend this analysis by accounting for a heterogeneous quality of the international banks which is private knowledge. Kara (2016) in contrast, studies the optimal capital regulation of domestic banks in the presence of global, systemic risk. The papers do not consider a supervisory decision.

Our essay is most closely related to the small strand of literature that studies the interaction of the two regulatory policy instruments. Acharya (2003) and Buck and Schliephake (2013) both study the welfare implications of centralized capital regulation in the presence of nationally set supervision. International spillovers of regulation arise through the competition of cross-border banks in national lending markets. In contrast, our essay considers the centralization of supervisory standards in the context of multinational banking. There, international spillovers arise within the subsidiary network of the multinational banks.

Finally, we contribute to the broader literature on the interaction between policy instruments. This has been studied in an international context for capital regulation and deposit insurance (Lóránth and Morrison, 2007), supervision and deposit insurance (Hardy and Nieto, 2011) and supervision and ex-post bailouts (Haufler, 2021).

The remainder of this chapter proceeds as follows. Section 2.2 introduces the theoretical framework of banking supervision and capital regulation in the context of multinational banking. Section 2.3 compares the choice of supervisory and capital regulatory standard under a national and a centralized regime of supervision. Section 2.4 analyzes the welfare effects of moving towards a centralized supervisory regime given this interaction. Section 2.5 concludes.

2.2 Banking supervision and capital regulation in a two-country region

We model the interaction between two national governments in the capital regulation and supervision of multinational bank subsidiaries. In particular, we consider a two-country region $i \in \{A, B\}$, where the national governments (henceforth "regulators") set supervisory and capital regulatory standards for the bank subsidiaries active under their jurisdiction. The regulators set the supervisory standard in the form of a resolution threshold λ_i. The resolution threshold indicates the minimum success probability for bank investments. The investment success probabilities of bank subsidiaries in country i, Λ_i, are heterogeneous and exogenously given. If a subsidiary's success probability is discovered to be below the threshold value $\Lambda_i < \lambda_i$, all of the subsidiary's investments are terminated rather than allowed to continue. We follow Beck et al. (2013) and Beck et al. (2016) in this modeling approach. Our model extends their analysis in that the regulators additionally set a capital regulatory standard. The standard takes the form of a minimum capital ratio k_i. We compare a regime of no coordination with one of supranational supervision, where the choice of the capital regulatory standard remains decentralized. We analyze the case of symmetric countries.

Our model has two stages. In stage one, the national regulators non-cooperatively choose the minimum capital ratio k_i for all bank subsidiaries active under their jurisdiction. The subsidiaries then make risky investments. In the second stage, the regulators discover the heterogeneous success probabilities Λ_i of the subsidiaries' investments. Then, either a central, supranational regulator or the national regulators choose the resolution thresholds λ_i and resolve all bank subsidiaries with a success probability below the threshold $\Lambda_i < \lambda_i$. The continuing subsidiaries move on to have their investments succeed or fail. We solve the model by backward induction.

2.2.1 Multinational banks

The two-country region houses a continuum of perfectly competitive multinational banks. The multinational banks operate via national subsidiaries in countries

$i \in \{A, B\}$ which offer credit to producing firms.[2] The subsidiaries finance their lending in part via equity capital and in part by raising deposits.

In both countries, the bank subsidiaries are owned by domestic capitalists. In this, we assume a multinational bank to be an international merger of formerly domestic units where the national subsidiaries retain their previous, fully domestic ownership structure. International mergers take place for instance as a means of expanding service to domestic customers going abroad (Gulamhussen et al., 2016). The capitalists provide a fixed, aggregate amount of capital E to the domestic bank subsidiaries. They receive all residual profits from their operation.[3]

Each subsidiary has access to an unlimited amount of domestically raised deposits. Depositing with a bank is risk free in both countries due to national, full-coverage deposit insurance schemes. This reflects the current practice in most developed and developing countries, which have implemented either an explicit or implicit deposit insurance scheme (Barth et al., 2013). We therefore assume deposits to be priced at the risk-free interest rate δ as determined by international capital markets. Without loss of generality, we assume $\delta = 0$. Deposits have seniority over equity capital financing. This ensures that the national deposit insurance schemes only have to reimburse local depositors if the banks' overall profits are smaller than the sum of deposits.

By extending credit to the private sector, the bank subsidiaries face a risk of borrower default. The subsidiaries can mitigate this credit risk by exerting effort in monitoring their borrowers. The cost of monitoring differs exogenously across bank subsidiaries. This can for instance depend on the organizational form of their lending operation, where a greater hierachial distance between the loan officer and borrower increases the monitoring cost (Stein, 2002). We assume the (inverse) monitoring cost to be distributed such that the optimal monitoring effort Λ_i of subsidiaries in each country is distributed uniformly $\Lambda_i \sim \mathcal{U}(0, 1)$. By exerting a greater monitoring effort, the subsidiaries increase the success probability

[2] In the EU, approximately 70 % of the multinational lending of the past ten years was intermediated by subsidiaries rather than branches (source: BIS Statistics Warehouse, own calculations).

[3] We assume that the capitalists' outside option yields a return lower than these profits for all units of E.

of their borrowers' production.[4] In particular, we assume the monitoring effort and borrower success probability to have a one-to-one relationship, such that a monitoring effort Λ_i yields a success probability of production of $\Lambda_i \sim \mathcal{U}(0,1)$. If production is not successful, the borrowers default on their bank loan. We assume the investment outcomes of a given bank subsidiary to be perfectly correlated. This implies that all firms receiving financing from a particular subsidiary face the same probability of success, reflecting the degree of oversight and support they receive.[5]

While credit risks are assumed to be perfectly correlated within each national bank subsidiary, risks have a zero correlation between countries. This can be justified by the existence of rigorous national regulation, which helps to ring fence local subsidiaries from foreign credit risk (Anginer et al., 2017). A strong reliance on local deposit financing further minimizes the correlation of credit risks between countries. This is the case for multinational commercial banks in developed economies, which we model. In consequence, each bank faces a non-zero probability of subsidiary i succeeding and j failing and vice versa.

In such a case, the successful subsidiary in i cross-subsidizes its failing foreign counterpart in j. As documented by Fiechter et al. (2011), the default of a subsidiary imposes high reputational costs on the multinational bank as a whole. In consequence, multinational banks stand to gain from cross-subsidizing the creditors of failing subsidiaries. This behavior has been observed during past, localized crises such as the European sovereign debt crisis. For instance, Bofondi et al. (2018) show that multinational banks operating in Italy reduced their local credit supply less during the crisis than domestic Italian banks did.

2.2.2 Firms and consumers

We consider prospective borrowers in each local lending market $i \in \{A, B\}$ to be individual entrepreneurs or small firms without any existing capital. Each firm has access to a production technology which produces one unit of a homogeneous consumption good X_i for each unit of bank credit L_i. The firms face a demand

[4] One rationale for this relationship is that stricter bank monitoring reduces an entrepreneur's moral hazard problem, inducing him to exert a greater managerial effort (Holmstrom and Tirole, 1997).

[5] Perfect correlation of credit risks is a common assumption in the capital regulation literature, see e.g. Dell'Ariccia and Marquez (2006) or Boyd and De Nicolo (2005).

for the consumption good from local consumers. A representative consumer in country i has a quasi-linear utility function $u_i(X_i, Z_i) = \bar{R}X_i - X_i^2/2 + Z_i$, with Z_i being auxiliary consumption, the numeraire good. This gives rise to a demand function for the consumer good of $X_i(p_i) = \bar{R} - p_i$ at a given consumer price p_i. Each unit of lending L_i used in the production of the consumer good bears a cost to the borrowing firm equal to the credit interest rate R_i. Assuming the free entry of firms and zero auxiliary production cost, the zero profit condition holds and the unit cost of credit is passed on fully to the consumers $p_i = R_i$. Then, the demand for the consumption good is reflected in the firms' demand for credit $D_i(R_i) = \bar{R} - R_i$. The aggregate credit supply L_i to each lending market is determined by the fixed amount of bank capital E provided by the domestic capitalists as well as the minimum capital ratio k_i, such that $L_i = E/k_i$. This leads to a market clearing credit interest rate of

$$R_i = \bar{R} - \frac{E}{k_i}. \tag{2.1}$$

Due to perfect competition among the borrowing firms, all rents from the sale of the consumption good are passed on to the consumers. With the inverse demand for the consumption good $p_i(X_i)$ and the equilibrium production volume $X_i = L_i = E/k_i$, the equilibrium consumer surplus in the case of successful production is given by

$$CS_i = \frac{E^2}{2k_i^2}. \tag{2.2}$$

The equilibrium consumer surplus per unit lending is given by $cs_i = E/2k_i$.

2.2.3 Regulators

The regulators sequentially set standards for the capital regulation and supervision of the bank subsidiaries under their jurisdiction. In stage one, the national regulators non-cooperatively set the capital standard in the form of a minimum capital ratio k_i. We argue that a non-cooperative, national regime of capital regulation is plausible. National governments have retained significant discretion in the implementation of the Basel III accords and the Capital Requirements Regulation (CRR) of the EU (Gropp et al., 2021b). This is evidenced by the heterogeneity

in effective capital ratios computed by the ECB in the 2014 stress tests of systemically important banks. There, national regulators stated an average Tier 1 common equity ratio up to 2.9 % higher compared to the calculations of the ECB (Fratianni and Pattison, 2015).

In stage two, either a central, supranational regulator or the national regulators choose the supervisory standard. The standard is based on a signal they receive about the success probabilities Λ_i of the bank subsidiaries' investments. We can for instance interpret this signal as a subsidiary's performance in a stress test. The regulators then set a resolution threshold λ_i and resolve all bank subsidiaries whose investment success probability Λ_i is lower than the threshold value $\Lambda_i \in (0, \lambda_i]$. Since the investment success probabilities are distributed uniformly $\Lambda_i \sim \mathcal{U}(0,1)$, this amounts to a share λ_i of subsidiaries being resolved rather than allowed to continue. We interpret a bank resolution as a government led, early liquidation of its investments. Following Beck et al. (2013) and Beck et al. (2016) and without loss of generality, we assume that the initial investments are recovered in full by the government. This is the case when the market price for liquidated bank assets is sufficiently high (Acharya et al., 2011).

The share $1 - \lambda_i$ of subsidiaries which have a success probability greater than the threshold value $\Lambda_i \in (\lambda_i, 1)$ are allowed to continue on to realize the outcome of their investment. Given the uniform distribution of success probabilities, the continuing $1 - \lambda_i$ subsidiaries have an average success probability of $\frac{1+\lambda_i}{2}$. As such, a share $\frac{1+\lambda_i}{2}$ succeed in their investment and a share $1 - \frac{1+\lambda_i}{2} = \frac{1-\lambda_i}{2}$ fail. Multiplication with the share of continuing subsidiaries $1 - \lambda_i$ yields the ex-ante share of investment success and failure, $\frac{1-\lambda_i^2}{2}$ and $\frac{(1-\lambda_i)^2}{2}$, respectively.

Of the $\frac{1-\lambda_i^2}{2}$ successful subsidiaries in i, a share $\frac{(1-\lambda_j)^2}{2}$ is affiliated with a failing subsidiary in j. In such a case, the successful subsidiary in i cross-subsidizes its failing foreign counterpart due to reputational concerns. The cross-subsidization entails a unit cost per unit lending in j to the successful subsidiary in i. We assume that the profitability of successful investment is large enough to do so, i.e. $(R_i - 1)\frac{E}{k_i} - \frac{E}{k_j} > 0$.

A share $\frac{(1-\lambda_i)^2}{2}$ of subsidiaries in i fail. Of these, a share $\frac{1-\lambda_j^2}{2}$ is affiliated with a successful subsidiary in j and receives an intra-bank cross-subsidy. Conversely, a share $1 - \frac{1-\lambda_j^2}{2} = \frac{1+\lambda_j^2}{2}$ is affiliated with a subsidiary in j that does not succeed and

thereby cannot provide support. These $\frac{(1-\lambda_i)^2}{2}\frac{(1+\lambda_j^2)}{2}$ subsidiaries in i must consequently default on their equity capital and deposits. In such cases, the national deposit insurance scheme is triggered. Government i steps in and reimburses the domestic depositors of the defaulting subsidiaries at the expense of the taxpayer. Each unit of public funds raised to reimburse the depositors incurs a cost of c. We assume the cost of public funds to be larger than one, $c > 1$. This captures the distortions associated with collecting public funds through taxes.

To keep our welfare analysis simple, we assume the consumers as described in Section 2.2.2 to also hold the domestic bank capital in i. Then, all rents in the economy are allocated to the consumer-capitalists, such that domestic welfare can be represented by the utility of a representative consumer-capitalist. The components of utility affected by regulatory policy are the domestic bank profits, the consumer surplus in market X_i and the tax payments into the deposit insurance fund.

We therefore express national welfare in country i, WF_i, as an unweighted sum of domestic bank profits and the consumer surplus CS_i minus the tax payments:

$$\begin{aligned} WF_i = \frac{E}{k_i}\left(\frac{1-\lambda_i^2}{2}\left[R_i - 1 + cs_i\right] - \frac{(1-\lambda_i)^2}{2}\frac{(1+\lambda_j^2)}{2}\left[k_i + c(1-k_i)\right]\right) \\ - \frac{E}{k_j}\frac{(1-\lambda_i^2)}{2}\frac{(1-\lambda_j)^2}{2}. \end{aligned} \tag{2.3}$$

The first term of equation (2.3) describes the profits and consumer surplus from successful investment and production. A share $\frac{1-\lambda_i^2}{2}$ of bank subsidiaries in i succeed, earning a profit per unit lending of $R_i - 1$, with the market clearing credit interest rate $R_i = \bar{R} - E/k_i$. Due to the domestic ownership of the subsidiaries in i, all profits from domestic lending remain in i. The successful production and sale of the consumption good further lead to a consumer surplus of $cs_i = E/2k_i$ per unit of lending. The second term describes the costs from the deposit insurance scheme. A share $\frac{(1-\lambda_i)^2}{2}\frac{1+\lambda_j^2}{2}$ of subsidiaries in i fails and does not receive support through the affiliate network. These subsidiaries default on their domestic equity capital and deposits. The depositors are reimbursed through the national deposit insurance scheme in i at a unit cost of public funds of $c > 1$. The capital holders bear the residual loss. The third term of the domestic welfare function describes

the cost from cross-subsidization of failing affiliates in j. This occurs for a share $\frac{1-\lambda_i^2}{2}\frac{(1-\lambda_j)^2}{2}$ of domestic subsidiaries.

2.3 Optimal capital regulation under different supervisory regimes

2.3.1 Second stage: Choice of supervisory standard

In the second stage, the regulators choose the supervisory standard in the form of an optimal resolution threshold λ_i. The resolution threshold is set either centrally, by a supranational authority or unilaterally by the national regulators. We compare the optimal resolution threshold under a non-cooperative national regime of supervision λ_N and a supranational regime λ_G.

Under a non-cooperative national regime of supervision, each country considers only the domestic costs and benefits in its choice of resolution threshold. Therefore, we derive the first order condition for the nationally optimal resolution threshold as the derivative of the national welfare function (2.3) with respect to λ_i:

$$\frac{\partial WF_i}{\partial \lambda_i} = \frac{E}{k_i}\left(-\lambda_i\left[R_i - 1 + cs_i\right] + (1-\lambda_i)\frac{1+\lambda_j^2}{2}\left[k_i + c(1-k_i)\right]\right) + \frac{E}{k_j}\lambda_i\frac{(1-\lambda_j)^2}{2} = 0. \tag{2.4}$$

The negative first term of equation (2.4) represents the domestic cost from stricter supervision. A higher resolution threshold λ_i reduces the share of successful bank subsidiaries in i. Fewer successful subsidiaries in turn imply lower aggregate profits in the banking sector and a lower consumer surplus from successful production. The domestic benefits from stricter supervision are twofold. The second term represents the reduction in the share of defaulting subsidiaries in i, $\frac{(1-\lambda_i)^2}{2}\frac{1+\lambda_j^2}{2}$, associated with an increase in the domestic resolution threshold. Fewer defaults in turn entail lower losses to domestic capital holders as well as tax payers in the form of a lower cost of reimbursing depositors. The third term reflects the reduction in the cross-subsidization of failing foreign affiliates. A reduced share of successful subsidiaries in i implies that fewer domestic affiliates provide intra-bank support.

The reduction in the cost of the deposit insurance is especially pronounced for a large unit cost of public funds c. In consequence, the nationally optimal resolution threshold λ_N will be high whenever the cost of public funds is high and low if the rents from successful investment are high. Due to the cross-subsidization between bank affiliates, the choice of resolution threshold in country i affects the welfare in country j. We consequently expect the optimal supervisory standard in the supranational regime λ_G to differ from that under national supervision λ_N.

In the supranational regime, the central supervisory authority maximizes the sum of welfare levels of the two countries $WF = WF_i + WF_j$, with $i \neq j$. In order to compare the optimal supervisory standards under the two regimes, we evaluate the effect of marginally stricter supervision in i on WF at the nationally optimal resolution threshold $\lambda_i = \lambda_N$:

$$\begin{aligned} \left.\frac{\partial WF}{\partial \lambda_i}\right|_{\lambda_i=\lambda_N} &= \left.\frac{\partial WF_j}{\partial \lambda_i}\right|_{\lambda_i=\lambda_N} \\ &= \frac{E}{k_i}(1-\lambda_i)\frac{1-\lambda_j^2}{2} - \frac{E}{k_j}\lambda_i\frac{(1-\lambda_j)^2}{2}\left[k_j + c(1-k_j)\right]. \end{aligned} \tag{2.5}$$

A resolution threshold $\lambda_i = \lambda_N$ maximizes the welfare of country i. At this point, the derivative of domestic welfare WF_i is zero. At the same time, a higher resolution threshold has non-zero international externalities on country j. As represented by the first term of equation (2.5), a higher resolution threshold decreases the share of failing bank subsidiaries in i. This decreases the cost of cross-subsidization to their successful affiliates in j which implies a positive effect on country j's welfare. At the same time, a higher resolution threshold λ_i reduces the share of successful bank subsidiaries in i that can support their failing counterparts in j. Consequently, a higher share of failing subsidiaries in j must default on their capital and deposits. The associated losses to capital holders and taxpayers imply a negative effect on the welfare of country j. Each unit of public funds raised to reimburse the $1 - k_j$ depositors incurs a cost of $c > 1$.

The sign of the international externality (2.5) is determined by the tax cost per unit of deposit insurance $c(1-k)$. If the cost is small, the positive spillover of fewer instances of intra-bank cross-subsidization dominates the negative spillover of more frequent defaults abroad. The reimbursement cost is small, either if the

share of deposit financing in j, $1-k_j$, is small or if the unit cost of public funds c is close to its lower bound of $c = 1$. In the symmetric national optimum $\lambda_i = \lambda_j = \lambda_N$ and $k_i = k_j = k_N$, equation (2.5) reduces to the sufficient condition for a positive externality

$$c < 1 + \frac{1}{1 - k_N}. \tag{2.6}$$

Condition (2.6) is more likely to be met when national capital regulation is strict and the required ratio of equity capital k_N is high. We argue that this is the case for all countries implementing the Basel III accords. While cross-country heterogeneity exists in the implementation of the accords, they offer a binding lower bound for prudential capital regulation (BIS, 2010). In such a setting, the international externality of stricter supervision, as given by equation (2.5), is likely to be positive.

We use our analysis of the international spillovers to compare the optimal resolution threshold under the decentralized supervisory regime λ_N with the centralized one λ_G. In appendix B.1, we show that there is indeed an internal solution for the centrally optimal resolution threshold λ_G and that this threshold satisfies the sufficient condition for a welfare maximum. Given the result of a positive externality of stricter supervision, the resolution threshold is higher in the supranational compared to the national optimum $\lambda_G > \lambda_N$. We summarize our findings in the following lemma.

Lemma 2.1. *If the tax cost of deposit insurance is sufficiently small, such that condition (2.6) holds, the international externality of stricter supervision is positive. Consequently, supervision is stricter in the supranational optimum than in the national optimum $\lambda_G > \lambda_N$.*

Lemma 2.1 receives support from assessments of the Single Supervisory Mechanism (SSM) and the Single Resolution Mechanism (SRM) instated in the EU (EU, 2013a). Schoenmaker and Véron (2016) for instance, find the centralized mechanisms to have increased the rigor and timeliness of supervision, particularly for internationally active banks. Further, empirical studies show that local supervisors are more lenient than centralized ones (Agarwal et al., 2014).

2.3.2 First stage: Choice of capital regulatory standard

In the first stage, the national regulators non-cooperatively choose the optimal capital ratio k_i applicable to all bank subsidiaries under their respective jurisdiction. We apply the second stage results for the resolution thresholds in the decentralized optimum $\lambda_i = \lambda_j = \lambda_N$ or centralized optimum $\lambda_i = \lambda_j = \lambda_G$. Maximizing the domestic welfare function of country i as given by equation (2.3), the first order condition for the nationally optimal capital ratio is given by

$$\frac{\partial WF_i}{\partial k_i} = \frac{E}{k_i^2}\left[-\frac{(1-\lambda^2)}{2}(\bar{R} - \frac{E}{k_i} - 1) + \frac{(1-\lambda)^2}{2}\frac{1+\lambda^2}{2}c\right] = 0. \tag{2.7}$$

The negative first term of equation (2.7) represents the cost from stricter capital regulation. A higher capital requirement reduces the aggregate credit supply $L_i = E/k_i$. A lower credit supply in turn reduces bank profits and the consumer surplus from successful investment. The simultaneous increase in the revenue per unit of successful investment $\partial R_i/\partial k_i = \partial(\bar{R} - E/k_i)/\partial k_i > 0$ is not large enough to change the negative sign of this effect. The positive second term represents the benefits from stricter capital regulation. An increase in the required capital ratio decreases the share and volume of deposit financing and thereby the cost to taxpayers of reimbursing depositors of defaulting subsidiaries. This reduction in the cost of depositor reimbursements is especially pronounced for a large unit cost of public funds c. Both, the cost and the benefits from stricter capital regulation decrease in absolute value with an increase in the resolution threshold λ.

Solving the first order condition (2.7) for k_i, we find the nationally optimal capital ratio

$$k_N(\lambda) = \frac{E(1-\lambda^2)}{(1-\lambda^2)(\bar{R}-1) - (1-\lambda)^2(1+\lambda^2)\frac{c}{2}}. \tag{2.8}$$

In its choice of capital ratio, the national regulator trades offer a higher credit interest rate and lower cost of deposit insurance with a lower credit volume. As such, the numerator of equation (2.8) describes the increase in the equilibrium credit interest rate associated with a marginal increase in the capital ratio. The first term of the denominator reflects the reduction in the credit volume while the second one describes the decrease in the cost of deposit insurance payments.

Equation (2.8) describes an internal solution $k \in (0,1)$ if the cost of the deposit insurance scheme is not too large, such that the condition $(1-\lambda^2)(\bar{R}-E-1) > (1-\lambda)^2(1+\lambda^2)\frac{c}{2}$ holds. At a threshold value $\lambda = 0$ for instance, the condition would take the form $\bar{R}-E-1 > \frac{c}{2}$.

Taking the derivative of equation (2.8) by λ, we find the effect of an increase in the resolution threshold on the nationally optimal capital ratio to be

$$\frac{dk_N}{d\lambda} = -\frac{Ec(1-\lambda)^2\left[1-\lambda+\lambda^2+\lambda^3\right]}{\left[(1-\lambda^2)(\bar{R}-1)-(1-\lambda)^2(1+\lambda^2)\frac{c}{2}\right]^2} < 0. \tag{2.9}$$

For all threshold values $\lambda \in (0,1)$, a higher resolution threshold leads to a lower non-cooperatively set capital ratio in the first stage. An increase in the resolution threshold decreases the share of successful investments and thereby the negative effect of stricter capital regulation in reducing the credit volume. In this, a higher resolution threshold reduces the cost of stricter capital regulation as given in (2.7). This effect is partially offset, as a lower share of successful investment also decreases the benefit from a higher credit interest rate $R_i = \bar{R} - E/k_i$. At the same time, a higher resolution threshold decreases the share of subsidiary defaults and thereby the benefits from stricter capital regulation. These benefits take the form of a lower cost of reimbursing depositors. At the nationally optimal capital ratio k_N, the reduction in the benefits dominates the overall effect and the capital ratio declines. For a large cost of public funds c, the capital ratio is particularly sensitive to changes in the resolution threshold.

As summarized in Lemma 2.1, the resolution threshold λ set in the second stage is larger under supranational compared to national supervision $\lambda_G > \lambda_N$. Hence, in stage one, the national regulators optimally set a lower capital ratio under a supranational supervisory regime compared to a national one $k_N(\lambda_G) < k_N(\lambda_N)$. We summarize this finding in the following proposition.

Proposition 2.1. *A supranational supervisory regime with stricter supervision than the national regime $\lambda_G > \lambda_N$ implies a lower non-cooperatively set capital standard, $k_N(\lambda_G) < k_N(\lambda_N)$.*

Proposition 2.1 states that national capital regulation can be more lenient in a supervisory union, as is currently in place in the EU, compared to a setting of no policy coordination. This result shows a potentially harmful side effect of tighter banking supervision in a supervisory union (Enria, 2019). The national regulators anticipate a stricter supervisory standard to be set by a central supervisor in the second stage. In this, they anticipate their domestic benefit from strict capital regulation to decline relative to the domestic cost. Given the national regulators' leeway in implementing and enforcing capital standards, they consequently set more lenient capital requirements so as to account for the reduced relative benefit of strict capital regulation. Proposition 2.1 receives support from empirical studies such as Gropp et al. (2021a). As the evidence suggests, stricter requirements of a centralized regulator lead to laxer capital regulatory standards at the national level. This domestic regulatory leniency can arise due to various national political and economic motives.

Externality of national capital regulation We analyze the international externality of stricter capital regulation at the national optimum k_N. This prepares our study of the welfare effects of a small supervisory reform as discussed in Section 2.4. We do so by evaluating the effect of marginally stricter capital regulation in i on global welfare $WF = WF_i + WF_j$ at the nationally optimal capital ratio $k_i = k_N$:

$$\left.\frac{\partial WF}{\partial k_i}\right|_{k_i=k_N} = \left.\frac{\partial WF_j}{\partial k_i}\right|_{k_i=k_N} = \frac{E}{k_i^2}\frac{(1-\lambda_j)^2}{2}\frac{1-\lambda_i^2}{2}. \tag{2.10}$$

A capital ratio $k_i = k_N$ maximizes welfare of country i such that the derivative of WF_i is zero at this point. The international externality of a higher capital ratio k_i on country j is unambiguously positive. An increase in k_i reduces the lending volume $L_i = E/k_i$ in i. This implies a reduction in the cost to bank subsidiaries in j of cross-subsidizing their failing counterparts in i. We further show in appendix B.2 that an internal solution for the supranationally optimal capital ratio k_G exists if the cost of the deposit insurance is not too large and that k_G satisfies the sufficient condition for a welfare maximum. Given this result, we can infer that the capital ratio is higher in the supranational compared to the national optimum $k_G > k_N$. We summarize this finding in the following lemma.

Lemma 2.2. *The international externality of stricter capital regulation is positive. Consequently, capital regulation is stricter in the supranational optimum than in the national optimum $k_G > k_N$.*

Lemma 2.2 is consistent with previous findings of the capital regulatory literature. A positive externality of capital regulation usually arises whenever a higher domestic capital ratio decreases the cost from bank failure abroad (Kara, 2016). This is the case in our analysis.

2.4 Welfare effects of a global supervisory regime

We assess the welfare implications of moving towards a supervisory union for the example of a small supervisory reform. We represent the reform as a marginal increase in the resolution threshold λ starting in the equilibrium where both the supervisory and the capital regulatory standard are set at the nationally optimal levels $\lambda_i = \lambda_j = \lambda_N$ and $k_i = k_j = k_N$. The overall effect of such a reform on the welfare of country i is given by

$$\left.\frac{dWF_i}{d\lambda}\right|_{\lambda=\lambda_N} = \left.\frac{\partial WF_i}{\partial \lambda_j}\right|_{\lambda_j=\lambda_N} + \left.\frac{\partial WF_i}{\partial k_j}\right|_{k_j=k_N} \cdot \frac{dk_j}{d\lambda}. \tag{2.11}$$

A resolution threshold $\lambda_i = \lambda_N$ and capital ratio $k_i = k_N$ maximize the welfare of country i. Thereby, the first order derivatives of WF_i by λ_i and k_i are zero at this point. The remaining terms describe the international externalities on country i of stricter supervision in country j, working through changes in both λ_j and k_j.

Stricter supervision in j has positive and negative effects on welfare in i. On the one hand, the direct effect of an increased resolution threshold λ_j on WF_i is positive under the condition of lemma 2.1. The increased resolution threshold in j decreases the share of failing bank subsidiaries in j which require cross-subsidization by their successful counterparts in i. At the same time, stricter supervision implies a lower non-cooperatively set capital ratio k_j, $dk_j(\lambda)/d\lambda < 0$. More lenient capital regulation in j in turn has a negative spillover effect on welfare in i. A lower capital requirement in j increases the local lending volume $L_j = E/k_j$ and thereby the cost of cross-subsidization given failure of bank affiliates in i.

In consequence, the overall welfare effect of moving towards a supranational supervisory regime, as given by equation (2.11), can be negative. This is the case, when the positive direct effect of stricter supervision is overcompensated by the negative indirect effect of more lenient, nationally set capital regulation. Appendix B.3 derives the following sufficient condition for a welfare loss:

$$c(1-\lambda_N) > (1+\lambda_N)\left[(1+\lambda_N)(\bar{R}-1) - \lambda_N E\right]. \tag{2.12}$$

Condition (2.12) can be interpreted as follows. The supervisory reform implies a welfare loss if the expected cost of depositor reimbursements is large relative to the expected rents from successful investment. The expected cost of depositor reimbursements is driven by the unit cost of public funds c. A larger cost of public funds affects the reform's welfare impact in two ways. Stricter supervision in one country increases the share of defaulting subsidiaries in the other country which must be reimbursed by the taxpayer at a cost c. Thus, for a large cost parameter, the direct, positive externality of stricter supervision (2.5) is small. At the same time, stricter supervision decreases the share of defaulting domestic subsidiaries and thereby the benefit from setting stricter, national capital regulation. For a large cost of public funds, this domestic benefit is especially sensitive to changes in supervision. Therefore, the reduction in regulatory capital standards caused by tighter supervision is larger the larger c is, see equation (2.9). This in turn implies a large negative international spillover effect of more lenient capital regulation (2.10). Our marginal analysis holds for both countries i and j due to symmetry.

The sufficient condition (2.12) is more likely to be fulfilled for small values of the nationally set resolution threshold λ_N. At a threshold value $\lambda_N = 0$ for instance, the condition would take the form $c > \bar{R} - 1$. A small threshold implies a high share of bank subsidiaries which are allowed to realize their investments. For a small threshold, global welfare reacts strongly to changes in the nationally set capital ratio k_N and thereby the lending volume $L_N = E/k_N$. Additionally, the negative indirect welfare effect of more lenient capital regulation becomes large for small values of λ_N. Accordingly, a small supervisory reform is more likely to be welfare decreasing, if it starts from a lenient nationally set supervisory standard. We summarize this result in the following proposition.

Proposition 2.2. *A reform towards a centralized supervisory regime can be welfare decreasing, if the costs of public funds c are large, relative to the interest rate R_i and if the supervisory standard λ_N is sufficiently low in the initial decentralized equilibrium.*

Proposition 2.2 has an important implication for supervisory unions such as the EU where capital regulation is at least partly decentralized. Moving towards centralized supervision, the welfare loss from more lenient national capital regulation can overcompensate the welfare gain from stricter supervision. As such, the overall welfare effect of centralized supervision depends critically on the degree of national discretion in the setting of capital standards.

2.5 Conclusion

In this essay, we model the interaction between bank capital regulation and supervision in a supervisory union like the one currently in place in the EU. We consider the context of multinational banking. Both, stricter capital regulation and stricter supervision have positive international spillovers in that they reduce the intra-bank cost of cross-subsidizing failing bank subsidiaries abroad. As such, national regulators set too lenient capital regulatory and supervisory standards from a global welfare perspective. We show that stricter, centralized supervision incentivizes even more lenient capital regulation at the national level. Stricter supervision reduces the share of subsidiary defaults and thereby the domestic welfare gain from stricter capital regulation. We further show that the negative spillovers of laxer national capital regulation can overcompensate the global welfare gain of stricter supervision. Then, moving towards a supervisory union without capital regulatory coordination reduces global welfare. This is the case when the cost of public funds is sufficiently large relative to the profitability of successful investments. Our results suggest that the efficiency of a supervisory union critically depends on the consistent definition and implementation of capital standards across member states.

Our model can be extended to analyze additional aspects of supervisory unions. One such question is the role of heterogeneity in the costs of public funds between member states. Modeling heterogeneous costs allows for additional insight into which countries are most likely to benefit or loose from a supervisory union.

Chapter 3

The role of early career wage profiles in fertility timing

3.1 Introduction

Gender inequality in earnings has sharply decreased in the past decades such that most of the gender gap remaining today is explained by the birth of children (Angelov et al., 2016). After the birth of a child, mothers tend to stay at home more than their partners and many of them return to work in part-time or "mommy track" positions with low career prospects. As a results, the transition to motherhood has large and persistent effects on women's earnings. The quantity of this motherhood penalty differs across countries (Kleven et al., 2019). While the average, child related gender wage gap is relatively small in Denmark and Sweden (around 20%), it takes a particularly high value in Germany and Austria ($50 - 60\%$). The long-term impact of the child related wage gap is reflected in gender specific rates of old-age poverty. While 16.4% of German women above the age of 65 were at risk of poverty in 2018, 12.7% of men were in the same position.[1]

The short- and long-term child related gender wage gap varies with the timing of the transition to motherhood (Wilde et al., 2010; Miller, 2011; Herr, 2016). Lundborg et al. (2017) show that delayed childbearing significantly reduces the motherhood penalty and that the delay is particularly profitable for high-potential women. While the effect of delayed childbearing on the motherhood penalty is

[1] Source: Federal Statistical Office

well understood, few studies provide a causal identification of the determinants of optimal fertility timing. Fewer studies still identify the effect of prior wage profiles. This is generally due to a lack of exogenous variation in the relevant explanatory variables. At the individual level, unobserved preferences for children as well as simultaneity in career and family decisions are likely to bias estimates.

The goal of this essay is to identify the effect of early career wage growth on fertility timing for the case of Germany. I focus on wage growth rates as a proxy for the early career wage profile, rather than wage levels. Unlike wage levels, growth rates are able to capture career dynamics while not carrying the direct income effect of wages. I instrument realized, individual wage growth with a region and education specific potential wage growth rate. The potential wage growth rate is constructed by exploiting variation in sector specific employment shares across regions as well as differences in national wage growth rates across sectors. Following the shift-share design of Bartik (1991) and Goldsmith-Pinkham et al. (2020), the potential wage growth rate reflects that part of the realized wage growth that is determined by regional labor market conditions. I show that one can realistically assume the sector specific employment shares to be exogenous to women's choice of fertility timing. Therefore, the shift-share design addresses the potential endogeneity problems of realized wage growth.

In order to gain insight into the role of the different components of wage growth, I conduct additional interaction analyses. The realized wage growth rate is composed of region and sector specific as well as individual components. While the region specific component reflects local labor market conditions, as captured in the potential growth rate, the individual component reflects accumulated human capital (Schönberg, 2007). The accumulation of human capital depends on the employee-job match, occupational choice and effort among other factors. The considered interaction terms moderate the relative significance of this individual component in wage setting. As such, the heterogeneity analyses shed light on the effect of higher individual wage growth on fertility timing. The heterogeneity analyses also give insight into the role of labor protection and collective bargaining agreements.

The results of the instrumental variable estimation show that German women who have steeper wage profiles at the beginning of their career, transition to motherhood earlier. Given the definition of the instrument, this result can be interpreted

broadly as a positive association of labor market conditions and earlier fertility. Conversely, the OLS results indicate that a steeper wage profile is correlated with later fertility. This discrepancy can be explained by unobserved preferences and simultaneity which bias the results towards a fertility delay. Another explanation is that of opposing effect signs for the region specific and individual component of wage growth. Indeed, the results of the heterogeneity analysis can be interpreted in that an increase in the individual component of early career wage growth is correlated with a fertility delay.

This essay contributes to two separate strands of literature regarding fertility, namely that of career characteristics and that of labor market conditions and fertility. With regards to non-monetary career characteristics, the existing literature has focused largely on the impact of educational and occupational choice. Modeling assortative matching in the labor and marriage market, Caucutt et al. (2002) find that in the US, changes in the length of women's education accout for up to 30% of the delay in fertility between 1947-1967. Similarly, Martin (2000) and Amuedo-Dorantes and Kimmel (2005) find that a delay of fertility beyond the age of 30 and 25, respectively, is more likely for university educated women. Tropf and Mandemakers (2017) identify the effect of schooling to be such that one more year of schooling implies a 1.5 month later age at first birth. Adda et al. (2017) set up a structural life-cycle model of occupational choice and fertility. They find a sorting of women with a low preference for children into more abstract occupations with steeper career profiles. Similarly, Begall and Mills (2013) show that women in business and technology related occupations delay their fertility compared to women working in education or healthcare. I contribute to this literature by studying how the relationship between early career wage growth and fertility timing differs for more or less career oriented women.

Another strand of literature has documented the comovement of women's wages and their fertility choices. For the case of Norway, Hart (2015) finds that women's wages are positively correlated with their likelihood of transitioning to motherhood. Andersson et al. (2014) find a similar result for the case of Denmark, while showing that transitions to motherhood decline with the wages of German women. Kingsley (2018) identifies a similar negative relationship for the context of Australia. In a study of female college graduates in Europe, Van Bavel (2010) shows that a steeper wage profile is associated with a higher propensity for fertility de-

lay. These studies, however, do not have access to exogenous variation in realized wages or wage growth. I close this gap by studying early career wage growth and fertility timing in an instrumental variable setting, using region specific, potential wage growth rates as an instrument.

A large literature analyzes the effect of labor market conditions and institutions on the timing of fertility. In this literature, a particular focus lies on the effect of unemployment. Using firm closures in Austria as an instrument for individual unemployment, Del Bono et al. (2015) show that a spell of unemployment is associated with a lower likelihood of a first birth within the next six years. For the context of Germany, Hofmann et al. (2017) show that the extent of this negative effect depends on the business cycle and thereby the prospects of finding a new job quickly. For the US, Da Rocha and Fuster (2006) similarly find improvements in employment rates to be associated with a increase in aggregate fertility. In a cross-country study, Adsera (2004) likewise concludes that greater employment stability and a higher share of public sector employment increase the fertility of women aged 24-29. I confirm these findings by using region specific, potential wage growth rates as a proxy for local labor market conditions. Concerning the impact of institutions, De la Rica and Iza (2005), Auer and Danzer (2016) and others show that women who work under a temporary contract at the beginning of their career tend to postpone their fertility. The authors associate the delay with the higher degree of economic uncertainty inherent in temporary employment. I contribute to this literature by studying how the prevalence of temporary contracts as well as collective bargaining agreements affects the relationship of wage growth and fertility timing.

The remainder of this chapter is structured as follows. Section 3.2 discusses relevant theoretical predictions which can guide the empirical analysis. Sections 3.3 and 3.4 describe the sample, variables and the shift-share design which I use for identification. In Section 3.5, I present the results of the instrumental variable analyses. Section 3.6 describes additional heterogeneity analyses and Section 3.7 concludes.

3.2 Theoretical framework

As a guide for my empirical analysis, I look to the rich literature on female labor supply and fertility. In this, the role of economic "career costs" of having children has received much attention, see e.g. Gustafsson (2001) for a survey. These costs consist of two main parts, an opportunity cost due to foregone wages and a human capital loss affecting future earnings. Foregone wages arise during any periods spent on child rearing rather than employed work. As such, they are dependent on the wage level in the current period. Human capital loss during periods of child rearing can be rationalized as a depreciation or atrophy of general or firm specific human capital when not applied in a job (Mincer and Ofek, 1982; Gupta and Smith, 2002). As shown by Adda et al. (2017), the rate of human capital depreciation varies over the life-cycle and is highest early and mid-career.

In dynamic life-cycle models of fertility such as Cigno and Ermisch (1989) or Walker (1995), the time preferences for children are taken as given.[2] As such, the optimal timing of the transition to motherhood is determined by the different career costs of having children.[3] The different costs interact with the slope of the wage profile in the following ways. Higher wage levels imply a higher opportunity cost due to foregone wages. Having children early therefore minimizes the opportunity cost of child birth. Holding all other factors constant, a steeper wage profile at the beginning of the career implies higher wage levels in later periods. As such, women with a steeper early career wage growth have a greater incentive for early childbearing.

A human capital loss during child rearing periods implies that women return to work on a lower wage trajectory than before. Given that the women cannot return to their initial trajectory, having children later minimizes the life-cycle cost due to loss of human capital. As shown by Blackburn et al. (1993), the human capital depreciation rate is positively correlated with individual wage growth. Accordingly, a steeper wage growth rate implies a more sizable drop in the wage trajectory during periods of child rearing. Then, women with a steeper early career wage

[2]Within the literature of life-cycle models of fertility, one strand particularly considers both the labor supply and fertility timing as choice variables. Moffitt (1984) and Hotz and Miller (1988) are early examples of life cycle models that feature a joint labor supply and fertility decision. Modern examples of such models include Francesconi (2002), Sheran (2007), Keane and Wolpin (2010) and Adda et al. (2017).

[3]The models further assume capital markets to be perfect and the spouse's earnings to be unaffected by the birth timing. They do not explicitly model uncertainty in future earnings.

growth have a greater incentive to delay their childbearing. This is especially the case for wage trajectories that describe a concave function over the life-cycle (see Mincer and Polachek (1974) for the original formulation). For concave wage trajectories, the wage profile becomes flatter with time. Accordingly, the cost of having children due to a loss of human capital is much lower in later compared to earlier periods.

A related strand of literature discusses the impact of earnings uncertainty on fertility (Ejrnæs and Jørgensen, 2020). Life-cyle models such as Sommer (2016) assume children to be costly in that they require at least a minimum amount of expenditures per period. Individuals have limited access to credit and face uninsured, temporary wage shocks. As their objective is to smooth consumption, the individuals respond to such a transitory, negative wage shock by dis-saving, increasing their labor supply and reducing child-related expenditures. Accordingly, women delay childbearing during periods of reduced wages. This also applies to expected wage shocks over the life-cycle (Da Rocha and Fuster, 2006). As such, women have children later in life when the uncertainty about future earnings is high. Earnings uncertainty is largely driven by economic and labor market conditions at the regional, sectoral or national level. For the case of Germany, Kügler et al. (2018) document a persistently positive relationship of economic and wage growth since the 1990s, despite the overall stagnation of wages.[4] In consequence, high and stable wage growth rates can be understood as an indicator for more favorable economic and labor market conditions. Then, high wage growth at the regional, sectoral or national level leads to sooner childbearing.

In sum, the role of early career wage profiles in fertility timing is determined by economic and labor market conditions as well as the different career costs of having children. The direction of the overall effect depends on the relative importance of the different components of wage growth. If economic conditions play a principal role in wage setting, then a steeper wage growth at the beginning of the career implies earlier childbearing. If economic conditions play a secondary role, however, the effect direction is determined by the different career costs. Then,

[4]In most advanced countries, the share of economic output that workers receive has fallen over the last two decades. In Germany, only 60% of productivity growth was passed on to workers as wages during this time. The consequent stagnation of wages is especially pronounced at the bottom of the wage distribution. For Germany, this development has been attributed to the decline in unionization, technological change and increasing outsourcing (Dustmann et al., 2009).

a steeper wage profile is associated with earlier childbearing if the opportunity cost dominates and a later one if the loss of human capital dominates.

3.3 Data source and sample

My study draws on The Sample of Integrated Labour Market Biographies (SIAB) as the main data set. The SIAB is an administrative data set provided by the Institute for Employment Research (IAB) in Nuremberg.[5] It contains the complete employment biographies of a 2% random sample of employees in Germany that contributed to the social security system between $1975-2017$. The SIAB provides detailed and reliable information about wage profiles, transitions in, out of and between work places, occupational choice as well as personal and employer characteristics. The SIAB covers cohorts of approximately $7,000$ women entering the labor market for full-time employment every year. Labor market entry is defined as the first instance of continuous full-time employment for more than 3 months in a woman's employment biography.

The data set contains information on daily wages that are right-censored at the upper threshold for social security contributions. I follow Dustmann et al. (2009) in assuming a log-normal distribution of wages. Using the procedure of Gartner (2005), I then replace the censored values by predicted wages above the truncation threshold. I aggregate the daily wages to the level of months.

I restrict the sample to women who entered the labor market between $1993-2007$. The years after 2007 are excluded in order to preserve a minimum number of observation periods post labor market entry for each individual. I do not consider earlier periods in order to keep the sample somewhat homogeneous with respect to family and career preferences. Following Hofmann et al. (2017), I exclude women from my sample who have ever worked in East Germany. As shown by Boelmann et al. (2021), women who grew up or previously worked in East Germany exhibit different fertility and employment patterns than women who exclusively lived and worked in West Germany.

[5]The data used is the weakly anonymous version of the Sample of Integrated Labour Market Biographies, years $1975-2017$ (Antoni et al., 2019). The data access was provided in the context of research project fdz2134 via on-site use at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB) and subsequent remote data access.

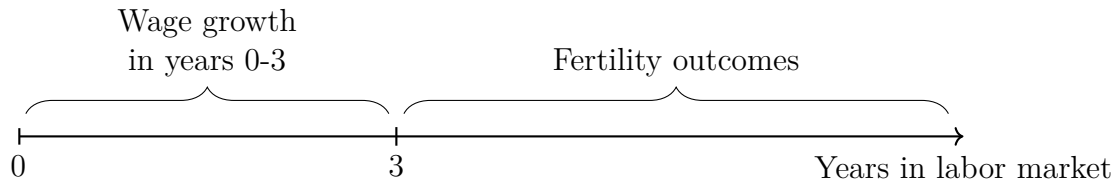

Figure 3.1: Time structure of the empirical specification

I further restrict the sample to individuals who are attached to the labor market at the beginning of their career. I define attachment to the labor market as full time employment for more than 12 months out of the first 36 months after labor market entry. I additionally exclude women who entered the labor market aged 35 and older or are not German nationals. I obtain a data set with cohorts of approximately $3,400$ women entering the labor market for full-time employment in every year $1993 - 2007$.

The SIAB data does not provide direct information on childbirth. Yet, first births in particular can be identified with a high fidelity using the method of Müller and Strauch (2017). This method identifies medical leave spells of young women between the age of $18 - 40$ and of fourteen weeks or more as maternity leave. As demonstrated by Schönberg (2009), approximately 90% of first births in West Germany can be captured in this way. The method of Müller and Strauch has been applied extensively in studies related to childbirth in Germany such as Schönberg and Ludsteck (2014), Adda et al. (2017) and Welteke and Wrohlich (2019).

As depicted in Figure 3.1, I characterize early career wage growth via the increase in monthly wage from labor market entry to three years after. The monthly wage at labor market entry and the monthly wage three years after are constructed as averages of months 0-6 and 36-42 in the labor force, respectively. The three year wage growth $y3incr$ is measured in percent. I capture the timing of first births in two types of variables, namely (1) a continuous variable $mbirth$ for the months between entry into the labor market and first birth and (2) indicator variables $ybirth$ denoting whether a first birth has occurred by the end of a given year after labor market entry. I present summary statistics for these early career characteristics as well as fertility outcomes and covariates in Table 3.1. The middle columns of the table show statistics for the population of German women entering the labor market 1993-2007. The right hand side columns show statistics for my sample. The sample comprises of women who enter the labor market before age

	Population ($N \approx 105,000$)		Sample ($N \approx 51,000$)	
	Mean	SD	Mean	SD
Career characteristics				
Entry wage	1430.90	726.92	1453.39	683.89
Wage (year 3)	1668.99	963.94	1794.15	934.34
Wage (year 6)	1816.97	1165.44	2018.70	1162.43
Wage growth (in %, years 0-3)	31.95	107.41	44.33	120.18
Fertility outcomes				
Months to first birth	88.41	48.52	101.80	42.78
Age at first birth	29.66	4.32	30.29	3.92
Share: first child within 4 years	10.60		4.96	
Share: first child within 6 years	17.76		15.87	
Share: first child within 8 years	24.86		26.35	
Covariates				
Age at entry	27.97	10.29	22.92	4.15
No. employees of employer	498.36	1114.34	567.35	2455.98
Share: secondary education	20.51		18.88	
Share: vocational training	68.37		71.07	
Share: tertiary education	11.13		10.05	

Table 3.1: Summary statistics

Data - Institute for Employment Research (IAB), Sample of Integrated Labour Market Biographies (SIAB), 1993-2007
Note - Own calculations. This figure presents summary statistics of the relevant career characteristics, fertility outcomes and covariates. The different columns are based on the population of German women entering the labor market 1993-2007 and the remaining sample after restrictions are applied.

35 and are attached to it in the definition above. The sample restrictions filter out native and non-native women entering the German labor market at an older age, potentially after a first child birth. This is reflected in the increased months to first birth in the sample. Individuals in the sample also have a steeper early career wage profile. The covariate means do not significantly differ between the population and sample.

3.3.1 Early career characteristics and fertility timing in Germany

As in many European countries, mid- and end-career wage profiles have become flatter in Germany in recent decades (Bönke et al., 2015). In contrast, I find early career wage profiles of women in full-time employment to become steeper over my observation period 1993 − 2007. The average three year wage growth after labor market entry is higher for women entering in 2007 (47.71%) than in 1993 (32.72%). This may partially be due to a change in family norms, implying a lower degree of statistical discrimination in wages and wage growth for childless women of child-bearing age (Manning and Swaffield, 2008; Reshid, 2019). At the same time, the heterogeneity of wage growth rates across regions, sectors and individuals has increased. For example, the three year wage growth for women employed in financial, actuarial, legal and other consulting increased from 34.99% to 56.37% in 1993 − 2007. During this period, early career wage growth in the hospitality industry only grew from 30.13% to 38.11%. One explanation for the increased heterogeneity in wage growth may be the diminishing presence of collective bargaining agreements at the industry or firm level (Dreger and Reimers, 2011). In 2000, 44% of firms in Germany were covered by a collective bargaining agreement while only 27% were covered in 2018. There is also considerable regional heterogeneity in early career wage growth. Panel A of Figure 3.2 depicts the average three year wage growth by region for the entry cohort of 2007. As expected, early career wage growth is high in metropolitan areas as well as rural areas with a high number of midsize and larger companies, averaging at 51.91%. In comparison, some rural areas without much industry exhibit an average early career wage growth of only half of this value.

Over the last decades, Germany has experienced a delay of fertility in that the age at first birth has increased from 27.5 years in 1993 to 30.0 years in 2007.[6] The increased age at first birth can be largely attributed to educational attainment (Ní Bhrolcháin and Beaujouan, 2012). Simultaneously, women decide on their fertility timing relative to labor market entry. The average number of years from labor market entry to first birth has decreased from 8.49 years for the entry cohort of 1993 to 6.94 years for the cohort of 2007. Additionally, there is regional heterogeneity in fertility timing. Panel B of Figure 3.2 shows years to first birth

[6]Source: Federal Statistical Office

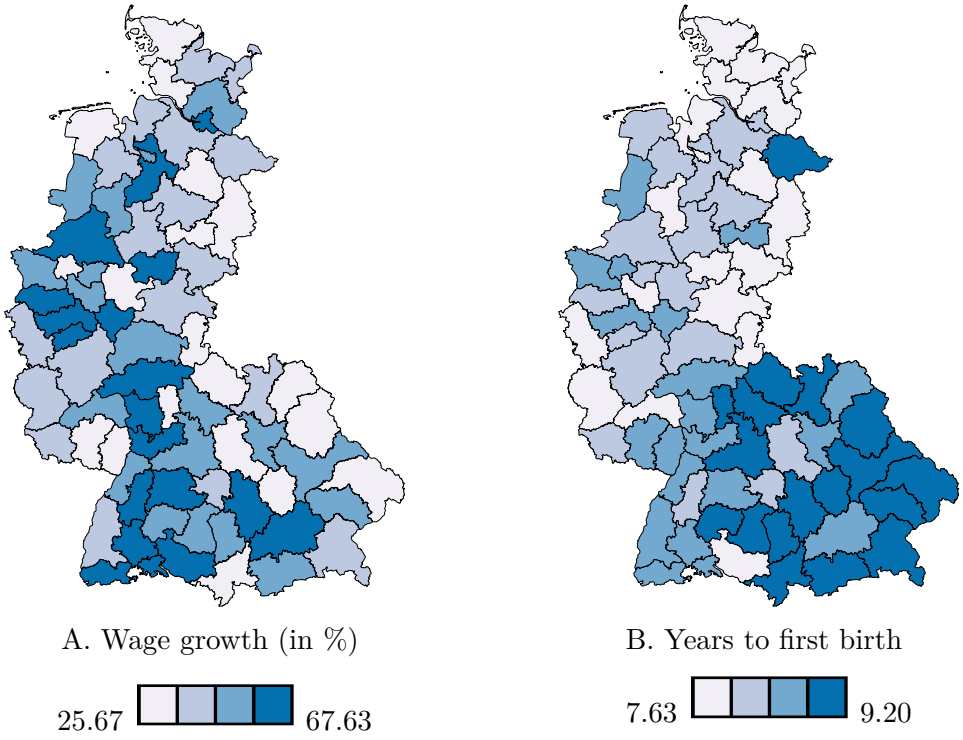

Figure 3.2: Early career wage growth and fertility timing by region

Data - Institute for Employment Research (IAB), Sample of Integrated Labour Market Biographies (SIAB), 2007
Note - Own calculations. Panel A of this figure shows the average three year wage growth in percent of the 2007 entry cohort by commuting zone. Panel B shows the corresponding years to first birth. The 74 commuting zones (Raumordnungsregionen) are taken as defined by the Federal Office for Building and Regional Planning.

by region for the entry cohort of 2007. Somewhat surprisingly, women living in Bavaria have their first child up to 1.5 years later on average compared to women living in North Rhine-Westphalia or Hesse. This may partially be a result of the high share of apprentices in vocational training in Bavaria.

3.4 Identification using labor demand shocks

The main obstacle in identifying the effect of early career wage growth on fertility timing is the endogeneity of women's career profiles. A simple estimation of the equation

$$y_i = \beta_0 + \beta_1 g_i + u_i \tag{3.1}$$

where y_i are fertility outcomes and g_i is the early career wage growth rate may omit relevant variables. Such omitted variables can be risk preferences, the preference for children or the spouse's income which may be correlated with the choice of career and wage growth (Hakim, 2002; Schmidt, 2008). If, for example, unobserved variation in preferences were such that a preference for later childbirth was positively correlated with a greater career orientation, then the coefficient for months to first birth *mbirth* would be biased upward and the coefficients for likelihood of birth *ybirth* would be biased downward (away from zero for the negative coefficients).

In addition, the estimation would suffer from simultaneity bias since it can be assumed that women make decisions about their labor supply and later fertility timing jointly and preemptively (Marks and Houston, 2002). Fertility may also vary exogenously, for instance due to biological factors such as miscarriages or failed fertility treatments (Miller, 2011; Lundborg et al., 2017). If an exogenous postponement of expected fertility at the beginning of the career caused an increase in a woman's labor market attachment, the early career wage growth would increase.[7] In consequence, the coefficient for the outcome of months to first birth would again be biased upward and the coefficients for likelihood of birth would be biased downward (away from zero for the negative coefficients).

Given the relevance of wages, employment and maternity leave spells as provided by the SIAB for the calculation of social security contributions, errors in wage and birth related data are likely to be small. As such, I can assume measurement errors not to pose a serious threat to identification in this setting.

Some information is available about the distribution of the potential omitted variables over a woman's wage growth. Using German data, Adda et al. (2017) find a very low, positive correlation between a woman's ability and the steepness of her wage profile with her desired fertility. In consequence, I can assume the distribution of women's preferences for children to be more or less independent from their wage profile. Eika et al. (2019) find an average correlation of approximately 0.61 for the education levels of US husbands and wives in the time period of 1970

[7] Manning and Swaffield (2008) and Reshid (2019) find evidence of a statistical discrimination of childless women in wages and wage growth in that employers anticipate them having children. It can be easily imagined that this discrimination is worse for women who are perceived as more likely to have children in the near future. As such, expected or perceived future fertility can have an impact on present day wages.

– 2010. The correlation of education levels is similar in Germany. Due to this assortative matching in the marriage market, an omitted variable bias due to the unobservable earnings of the spouse cannot be excluded. If higher earnings of the spouse were simultaneously associated with higher career aspirations and a later transition to motherhood, the coefficient for months to first birth would be biased upward and the coefficients for the likelihood of a birth to be biased downward.

In response to the endogeneity of women's career characteristics, this essay exploits potential wage growth rates, $\hat{g}_i$, as an instrument for realized early career wage growth. I construct the potential wage growth rates using a shift-share design. Following Goldsmith-Pinkham et al. (2020), the potential wage growth in a given region can be understood as the average of sector specific, national wage growth rates weighted by the region's exposure to these sectors. Exposure is measured by the historic employment share of a sector in a region in the year 1988. Following Hufe (2021), I define sectors as occupation-industry cells, as given by the German Classification of Occupations 2010 (KldB2010) and the German Classification of Economic Activities 2008 (WZ08).[8] I group employees into 27 x 14 = 378 occupation-industry cells.

Following Autor et al. (2013), I understand regions as commuting zones (CZ) including economic centers and their geographical surroundings. In Germany, commuting zones are best approximated by the spatial planning regions (Raumordnungsregionen) as defined by the Federal Office for Building and Regional Planning. I consider individuals who live in one of the 74 commuting zones or planning regions in West Germany. I further subdivide these regional labor markets into 3 education levels. The low education level includes individuals who attained at most a lower-track secondary degree and did not complete vocational training. The intermediate level includes individuals with either a lower-track secondary degree and vocational training or a higher-track secondary degree. The high education level contains individuals that completed a tertiary education. Combining the regional units and education levels, I identify 74 x 3 = 222 distinct, regional labor markets.

[8]The SIAB provides information on the occupation and industry of individuals according to the KldB2010 and WZ08 on a three-digit level. The aggregation into broader categories is based on the major occupation groups (Berufshauptgruppen) and main economic sections (Wirtschaftsabschnitte), respectively.

Indicating occupations and industries by o and j, I construct the potential wage growth of individuals entering the labor market in year t, with education level e, residing in region r as

$$\hat{g}_{ter} = \sum_i \sum_o \underbrace{\frac{E^{oj}_{88,er}}{E_{88,er}}}_{(1)} \cdot \underbrace{g^{oj}_t}_{(2)}. \tag{3.2}$$

Term (1) of equation (3.2) denotes the region and education specific employment share of each occupation-industry cell in base year 1988. Term (2) describes the national averages of occupation, industry and cohort specific wage growth rates across regions and education levels. Jointly, the two terms define the potential wage growth rate $\hat{g}_{ter}$ as an average of occupation and industry specific, national wage growth rates weighted by the regional labor market's exposure to these occupation-industry cells. As such, each individual in a cohort t has one of 222 potential wage growth rates. I use the SIAB waves of 1988 and 1993-2007 to calculate the occupation-industry shares and occupation-industry specific wage growth rates, respectively. The SIAB does not contain information on hours worked. As such, I understand the monthly wages upon which my measure of wage growth is based as salaries compensating full-time employment.

The potential and realized wage growth rates exhibit a strong correlation. As depicted in Figure 3.3, the bivariate relationship of the potential and realized wage growth rates has a slope of 1.07 and is highly significant. This indicates that potential wage growth is a good instrument for the realized one.

I consequently estimate the following instrumental variable model:

$$\begin{aligned} g_i &= \gamma_0 + \gamma_1 \hat{g}_i + \gamma_2 \delta_r + \gamma_3 \delta_t + \boldsymbol{\gamma}' \mathbf{X_i} + v_i \\ y_i &= \beta_0 + \beta_1 g_i^{pred} + \beta_2 \delta_r + \beta_3 \delta_t + \boldsymbol{\beta}' \mathbf{X_i} + u_i \end{aligned} \tag{3.3}$$

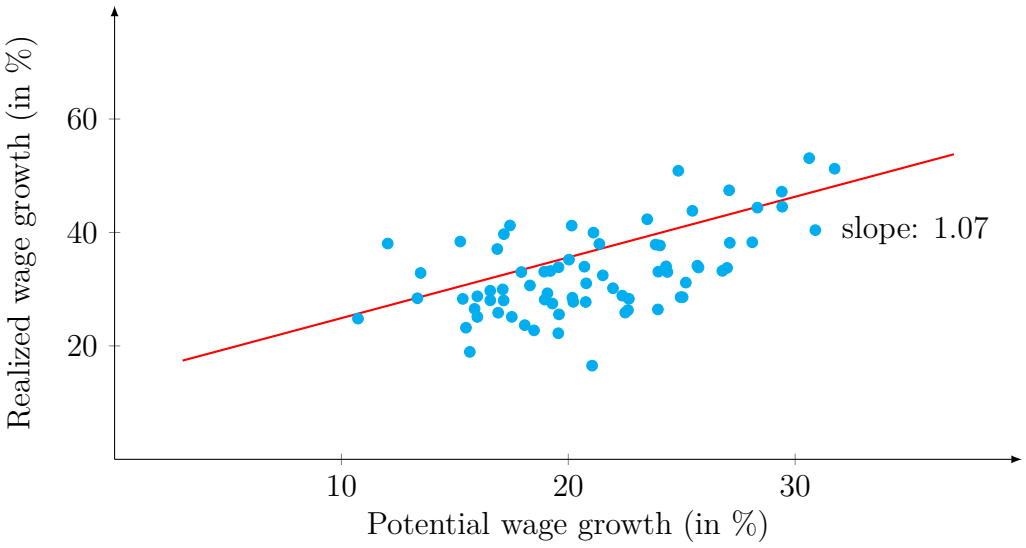

Figure 3.3: Correlation of potential and realized wage growth

Data - Institute for Employment Research (IAB), Sample of Integrated Labour Market Biographies (SIAB), 1993-2007
Note - Own calculations. This figure shows the relationship between potential and realized wage growth rates. Potential wages are calculated according to equation (3.2). The slope coefficient is significant at the 1% level. Data points represent averages by commuting zone as constructed from the sample described in Table 3.1.

In the first stage, the realized wage growth rate g_i is regressed on the shift-share wage growth rate $\hat{g}_i$ as constructed in equation (3.2). Then, in the second stage, the different fertility outcomes y_i are regressed on the predicted rather than the actual wage growth g_i. The shift-share wage growth $\hat{g}_i$ reflects the regional variation in wages due to differences in sectoral composition. Given this definition, the shift-share instrument captures that part of the variation in wage growth rates which is due to local labor market conditions rather than endogeneous career choices.[9] Both regressions include commuting zone dummies δ_r in order to capture fixed variation in fertility timing across regions and cohort dummies δ_t in order to account for variation in fertility timing over time, that is common to all commuting zones. The regressions further include income controls as well as controls for individual and employer characteristics $\mathbf{X_i}$. I cluster standard errors at the level of commuting zones.

[9]Other shift-share designs have been applied to questions of fertility by e.g. Schaller (2016), Furtado (2016) and Mariani and Rosati (2021).

3.4.1 Identifying assumption

I follow the definition of a shift-share instrument as provided in Bartik (1991) and Goldsmith-Pinkham et al. (2020). There, the assumption of exogeneity of the shift-share instrument holds under an exogenous assignment of occupation-industry shares in base year 1988, conditional on a set of controls. In other words, the shares need to be uncorrelated with the residual variation in fertility timing of the IV regression model (3.3). This is the case if no direct links exist between the occupation-industry composition and women's fertility preferences as well as no spatial spillovers between commuting zones. In the following, I argue that these identifying assumptions hold.

As Monte et al. (2018) show for the case of the US, local labor demand shocks can have spatial spillover effects in the form of changing commuting patterns. This mobility between commuting zones can be a source of bias to shift-share estimates if the decision to move is a function of women's fertility preferences. This is the case, for instance, if women with a lower preference for children move more often or select into commuting zones of a specific occupation-industry composition. For Germany in general as well as my particular sample, internal migration does not play a large role. In 2007, 1.29% of all Germans and 3.99% of all 20-29 year-olds moved between states. At the same time, 4.35% of all Germans and 14.85% of the 20-29 year-olds moved between municipalities in and out of state. For all age groups, mobility within the state is more than twice as high than mobility between states.[10] This suggests that labor migration between commuting zones in response to local labor demand shocks is low in Germany.

To support this assumption, I perform the instrumental variable analyses of Section 3.5.2 for different constructions of the shift-share instrument (3.2). Specifically, the occupation-industry specific, national wage growth rates g_t^{oj} can either be calculated as simple averages or as leave-one-out averages. Leave-one-out averages take the average wage growth of all commuting zones except the one where an individual resides. Using this calculation method ensures that the shift-share instrument does not load on wage growth effects specific to the own commuting zone which may directly affect fertility decisions. This particularly includes a selection into commuting zones of a specific occupation-industry composition. I find the regression coefficients to be very similar in size for both methods of instrument

[10] Source: Federal Statistical Office

construction. As such, I surmise that spatial spillovers in the form of migration between commuting zones do not pose a significant threat to my analysis.

In addition, I can make inferences on the threat to identification due to potential endogeneity in the occupation-industry shares. This endogeneity arises if there is a direct link between the employment shares in a given region and women's fertility decisions. Given the definition of the shift-share instrument, the occupation-industry shares themselves can be interpreted as exogenous instruments for realized wage growth (Goldsmith-Pinkham et al., 2020). As such, the regression coefficient of realized wage growth $\hat{\beta}_1$, as instrumented by the shift-share growth rate, can be decomposed into 27 x 14 = 378 occupation-industry specific coefficients $\hat{\beta}_{1,oj}$ and corresponding Rotemberg weights α_{oj}, with $\hat{\beta}_1 = \sum_{oj} \alpha_{oj} \hat{\beta}_{1,oj}$ and $\sum_{oj} \alpha_{oj} = 1$. The occupation-industry specific coefficients instrument realized wage growth by the respective occupation-industry share. I find that the coefficients neither differ much among themselves nor from the aggregate shift-share coefficient, indicating that many occupation-industry shares identify similar parts of the variation in realized wage growth. This speaks to the interpretation of the instrumented wage growth as a potential growth rate, determined by characteristics of the local labor market. The Rotemberg weights indicate the relative importance of individual occupation-industry coefficients in the aggregate estimation. As such, they represent the degree of the threat to identification to the shift-share design, should the specific occupation-industry share not be entirely exogenous to the outcome variable.

In my setting, the 378 Rotemberg weights are highly dispersed. The five highest weights are 7.70% for women working in sales occupations in commerce, 7.41% for management positions in the manufacturing industry, 7.39% for management positions in financial, actuarial, legal and other consulting, and 5.45% for management positions in commerce followed by 5.14% for nursing occupations in healthcare. The high degree of dispersion of the Rotemberg weights indicates a low sensitivity of my analysis to violations to the exogeneity assumption of individual occupation-industry shares.

3.5 Results

3.5.1 OLS analysis

Panel A of Table 3.2 presents regression results for the ordinary least squares (OLS) specification (3.1). All regressions include income controls in the form of the entry wage level *wentry*. They also include individual and firm characteristics such as the education level and number of employees. The regressions further include commuting zone and cohort dummies. Standard errors are clustered at the commuting zone level. The coefficient of the early career wage growth *y3incr* is positive for the outcome variable months to first birth *mbirth*. It is negative for the outcomes likelihood of first birth by year four, six and eight in the labor market (*y4birth*, *y6birth* and *y8birth*). The coefficients are small but significant at the one percent level for all outcome variables except the likelihood of first birth by year eight. The results imply that a one percentage point higher wage growth rate at the beginning of the career is associated with a delay of the first birth by 0.031 months. Similarly, a one percentage point higher wage growth rate is associated with a 0.010 pp and 0.008 pp lower likelihood of having a first child by the end of year four and six, respectively. The results of Panel A also give insight into the effect of a higher entry wage on fertility timing. While the coefficients of *wentry* are significant for some of the outcome variables, their size is at least two orders of magnitude smaller than the coefficients of wage growth.

The results are consistent across outcome variables. They indicate that women with a higher endogeneous wage growth rate are more likely to delay their transition to motherhood. The estimated effects become smaller with years in the labor market. For instance, a 100% increase in average wage growth would decrease the share of first births by year four by 8.87% while decreasing the share of births by year six only by 2.23%. The smaller relative size of the entry wage coefficient is in line with the existing literature (Van Bavel, 2010). This indicates that the slope of the early career wage profile is the more relevant variable in the fertility timing decision.

3.5.2 IV analysis

Panel B of Table 3.2 presents the regression results for the two stage least squares (2SLS) specification (3.3) in which potential wage growth rates are used as an

B. OLS estimates

	mbirth	*y4birth*	*y6birth*	*y8birth*
y3incr	0.03133^{***}	-0.00010^{***}	-0.00008^{***}	-0.00003
wentry	0.00004^{***}	-0.00000	0.00000^{**}	0.00000^{***}
Covariates	X	X	X	X
CZ dummies	X	X	X	X
Cohort dummies	X	X	X	X
Clustered SE	X	X	X	X
Individuals	13,232	24,935	24,935	24,935

B. IV estimates

	mbirth	*y4birth*	*y6birth*	*y8birth*
y3incr	-0.04351^{**}	0.00021^{***}	0.00062^{***}	0.00081^{***}
wentry	-0.00004^{**}	0.00000^{***}	0.00000^{***}	0.00001^{***}
Covariates	X	X	X	X
CZ dummies	X	X	X	X
Cohort dummies	X	X	X	X
Clustered SE	X	X	X	X
Observations	13,232	24,935	24,935	24,935
1. stage coeff.	1.425	1.332	1.332	1.332
1. stage F-stat.	68.56	103.23	103.23	103.23

Table 3.2: OLS and IV analyses

Data - Institute for Employment Research (IAB), Sample of Integrated Labour Market Biographies (SIAB), 1993-2007
Note - Own calculations. This table displays the response in fertility timing to changes in the endogenous early career wage growth rate (Panel A) and the instrumented early career wage growth rate (Panel B). The shift-share instrument is calculated as in equation (3.2) using simple averages of the national wage growth rates. The lower number of individuals stems from the inclusion of the covariate employer size as well as childless women. All regressions control for commuting zone and cohort fixed effects. Standard errors are clustered at the commuting zone level.

instrument for realized ones. The regressions include the same income controls, covariates and dummy variables as above. The shift-share instrument is constructed as in equation (3.2) using simple averages of the national wage growth rates. In the 2SLS specification, the coefficient of the early career wage growth $y3incr$ has a negative sign for the outcome variable months to first birth $mbirth$ and a positive sign for the likelihood of first birth until the end of years four, six and eight in the labor market ($y4birth$, $y6birth$ and $y8birth$). The coefficients are highly significant. As column one shows, an exogenous increase in the early career wage growth rate by one percentage point causes a 0.044 months earlier first birth. Similarly, a one percentage point higher wage growth rate causes a 0.021 pp and 0.062 pp higher likelihood of having a first child by the end of year four and six, respectively. An increase in the entry wage level $wentry$ has a much smaller impact on fertility timing. As the second row of Table 3.2, Panel B shows, an increase in $wentry$ by 1 Euro decreases the months to first birth only by 0.00004 months. While pointing in the same direction as the effect of increased wage growth, the coefficients are more than two magnitudes smaller. The results of the first stage are presented in the last rows of Table 3.2, Panel B. The predicted, realized wage growth is highly correlated with the potential wage growth. The F-statistics satisfy the criteria for a strong instrument as defined by Stock et al. (2002) and Lee et al. (2021). Both findings indicate a strong instrument.

The results of the instrumental variable analysis are consistent across outcome variables. They indicate that women in labor markets with a high potential wage growth rate have children earlier. The estimated effects increase with years in the labor market. In relative terms, a 100% increase in average wage growth would increase the share of first births by year four by 18.78% and by year six by 17.32%. This indicates, that a change in the potential wage growth rate mainly shifts births around the mean of the fertility timing distribution. The much smaller size of the entry wage coefficient suggests that direct income effects play a secondary role in women's choice of fertility timing.

Notably, the effect of early career wage growth on fertility timing takes opposing signs for the OLS and IV regressions. While a higher, endogenous wage growth is associated with a fertility delay, a higher instrumented wage growth causes an earlier transition to motherhood. By instrumenting realized wage growth with a region and education specific shift-share wage growth, I isolate variation in that

component of realized wage growth, which is driven by local labor market conditions. As such, the instrumented wage growth reflects potential wage growth rates exogenous to individual career choices. Therefore, the results of the IV analysis can be interpreted as a positive exogenous shock to potential wage growth leading to earlier fertility.

The fact that the IV coefficient takes a negative value in the regression of months to first birth *mbirth* while the OLS coefficient takes a positive one, conforms with the expected upward direction of the different biases. Direct reverse causality, in the sense of a positive effect of exogenous fertility delay on wage growth, would cause the OLS coefficient to be upward biased in this regression and downward biased for the likelihood of first birth regressions (*y4birth*, *y6birth* and *y8birth*). Unobserved preferences that positively correlate late fertility with career orientation would bias the OLS estimates in the same direction.

Another interpretation of the discrepancy between the OLS and IV coefficients is that of different components of wage growth. The realized wage growth rate is composed of region specific, industry specific, employer specific and individual components. The first two components reflect local and sectoral labor market conditions (Porter, 2003; Dreger and Reimers, 2011). Sectoral labor market conditions can be driven by institutions such as unions and collective bargaining agreements. The third component reflects firm idiosyncracies as well as the firm-employee match (Pavan, 2011). I partially control for these effects by including employer characteristics in both the OLS and IV specification. The last component reflects individual human capital accumulation over time. The rate of accumulation is determined by the employee-job match as well as effort among other factors. Schönberg (2007) finds that human capital accumulation is the most important source of wage growth for German employees $1975 - 1994$.

The results of the IV analysis can be interpreted in that a positive exogenous shock to the region specific component of wage growth causes earlier fertility. A comparison with the OLS coefficients suggests that the correlation of the individual components of wage growth with fertility timing points towards a fertility delay. The effect of the individual component cannot however be disentangled from simultaneity and the omitted variable bias.

The results do not change materially under alternative instrumental variable specifications. For instance, the regressions yield similar results when constructing the

occupation-industry specific, national wage growth rates used in the shift-share instrument as leave-one-out averages.[11] Further, the results are qualitatively unchanged when using 1983 or 1993 as alternative base years. Finally, the regression coefficients remain largely the same when estimating an IV Probit regression model instead of a 2SLS model.

3.6 Heterogeneity analyses

The analyses of Section 3.5 cannot reliably identify the effect of the individual component of wage growth. To better understand the role of this component, I consequently perform heterogeneity analyses. In these, I interact the realized wage growth rate $y3incr$ with several indicator variables. The first two indicators reflect the degree of collective bargaining and labor protection in a given industry. The last two indicators moderate the relative significance of the individual component in wage setting. As such, the following heterogeneity analyses shed light on the direction of the effect of higher individual wage growth on fertility timing as well as the role of institutions. All heterogeneity analyses are based on OLS estimations and include the same income controls, covariates and dummy variables as the analyses presented above.

3.6.1 Interaction - Collective bargaining agreements

The first indicator variables identifies labor markets heavily regulated by collective bargaining agreements. Such agreements reduce the economic uncertainty of employees but also the scope for individual negotiations in lower pay grades (Marginson et al., 2014). The variable $tarif$ takes the value one if an individual works in an industry where a high share of contracts is covered by either industry or firm-wide collective bargaining agreements.[12] I set the threshold share at 40% of contracts under collective bargaining agreements. The threshold roughly represents the median share of contracts covered in a given industry. The variable

[11] This method implies averaging wage growth over all commuting zones but the one of interest. Using leave-one-out averages ensures that the shift-share wage growth rate does not load on wage growth effects specific to the own commuting zone which may directly affect fertility decisions (Goldsmith-Pinkham et al., 2020).

[12] Source: Federal Statistical Office, own calculations. The variable reflects shares of collective bargaining agreements as of 2010 based on WZ08 sectors. See Lübker and Schulten (2020) for a discussion.

tarif takes the value zero if an individual works in an industry where the share is lower.

The regression results for an OLS specification including this interaction are presented in Table 3.3, Panel A. As shown in the first column, working in an industry heavily regulated by collective bargaining agreements is associated with a 2.19 months earlier transition to motherhood on average. The probabilities of a first birth by the end of years four, six and eight are increased accordingly. This finding is in line with the literature arguing that more stable, employee friendly labor market conditions lead to an earlier timing of fertility (Da Rocha and Fuster, 2006). At the same time, the coefficients for the interaction term *tarif* x *y3incr* are considerably smaller and insignificant. This implies that working in an industry with a high agreement coverage does not affect the relationship of realized wage growth and fertility timing. The results suggest that the source of individual wage growth, be it moving up the pay grades of a collective bargaining agreement or individual negotiations, does not have a bearing on its effect on fertility timing.

In sum, the results of the heterogeneity analysis show that more stable, employee friendly working conditions in the form of collective bargaining agreements are associated with earlier child bearing. At the same time, these agreements have no impact on the relationship between realized wage growth and fertility timing.

3.6.2 Interaction - Temporary employment contracts

Another indicator variable that characterizes the degree of labor protection in a given industry is the share of temporary employment contracts among new hires. In 2007, temporary contracts made up 42 % of all contracts for this group of German employees. As discussed by Auer and Danzer (2016), working under a temporary contract significantly increases the perceived economic uncertainty of employees. Further, Gebel (2010) finds temporary employment at labor market entry to be associated with a wage and wage growth penalty in the first five years of the career. I construct the indicator variable *temp* as follows: The variable takes the value one if an individual works in an industry where more than 30 % of new hires are employed temporarily.[13] The threshold value approximates the median share of temporary contracts among new hires in a given industry. The

[13]Source: Bossler et al. (2021), own calculations.

A. Indicator - Prevalence of collective bargaining agreements

	mbirth	*y4birth*	*y6birth*	*y8birth*
y3incr	0.02905^{***}	-0.00009^{***}	-0.00007^{***}	-0.00002
tarif	-2.18488^{***}	0.00462^{*}	0.018941^{***}	0.02377^{***}
tarif x *y3incr*	0.00301	-0.00001	-0.00003	-0.00001
Covariates	X	X	X	X
CZ dummies	X	X	X	X
Cohort dummies	X	X	X	X
Clustered SE	X	X	X	X
Observations	13,232	24,935	24,935	24,935

B. Indicator - Prevalence of temporary employment contracts

	mbirth	*y4birth*	*y6birth*	*y8birth*
y3incr	0.03039^{***}	-0.00010^{***}	-0.00008^{***}	-0.00003
temp	1.98194^{**}	-0.00461	-0.01169^{**}	-0.02294^{***}
temp x *y3incr*	0.00131	-0.00001	-0.00002	-0.00001
Covariates	X	X	X	X
CZ dummies	X	X	X	X
Cohort dummies	X	X	X	X
Clustered SE	X	X	X	X
Observations	13,232	24,935	24,935	24,935

Table 3.3: Interactions with industry specific employment conditions

Data - Institute for Employment Research (IAB), Sample of Integrated Labour Market Biographies (SIAB), 1993-2007
Note - Own calculations. The table displays heterogeneous effects of wage growth across two indicators for labor market conditions. All coefficients are estimated using the OLS regression model of equation (3.1) including an additional interaction term. The lower number of individuals stems from the inclusion of the covariate employer size as well as childless women. All regressions control for commuting zone and cohort fixed effects. Standard errors are clustered at the commuting zone level.

variable *temp* takes the value zero if the industry specific share of new hires who are employed temporarily is lower than that.

The regression results for an OLS specification including the indicator and its interaction are presented in Table 3.3, Panel B. Row two shows the coefficients for the variable *temp*. Working in an industry with a high share of temporary employment among new hires delays the first birth by an average of 1.98 months. Correspondingly, the probabilities of a first birth by the end of years four, six and eight are reduced. These findings are in line with the results of De la Rica and Iza (2005) for the context of Spain. The coefficients for the interaction term *temp* x $y3incr$, as depicted in row three, are insignificant. This implies, that the effect of realized wage growth on fertility timing does not on average depend on the prevalent mode of employment contract.

Overall, the heterogeneity analysis confirms the above findings in that greater, industry specific job uncertainty is associated with a delay of fertility. Meanwhile, the prevalence of temporary employment does not have an impact on the relationship of realized wage growth and fertility timing.

3.6.3 Interaction - Quartiles of the entry wage distribution

I further analyze the interaction of the wage growth rate with indicators for the top and bottom quartiles of the industry, occupation and education specific entry wage distribution ($WQ4$, $WQ1$). A high position in the distribution can be indicative of a selection into a larger firm or a job that is more complicated or implies more responsibility (Wang, 2016). I consequently interpret individuals with a high industry, occupation and education specific entry wage as highly career oriented. I conversely interpret individuals at the lower end of the distribution as little career oriented. The variable $WG4$ takes the value one for individuals that earn more than the 75th percentile of the entry wage within their industry, occupation and education level. Contrarily, the variable $WQ1$ takes the value one for individuals that earn an entry wage of less than the 25th percentile. The variables take the value zero for all other individuals.

The regression results for an OLS specification including these interactions are presented in Table 3.4, Panel A and B. As the second row of Panel A shows, being in the top quartile for the entry wage does not affect fertility timing in itself.

A. Indicator - Top quartile of the entry wage distribution (WQ4)

	mbirth	y4birth	y6birth	y8birth
y3incr	0.02927***	−0.00009***	−0.00007***	−0.00002
WQ4	−0.65807	0.00472	0.00460	0.00953
WQ4 x y3incr	0.07701***	−0.00042***	−0.00043***	−0.00017
Covariates	X	X	X	X
CZ dummies	X	X	X	X
Cohort dummies	X	X	X	X
Clustered SE	X	X	X	X
Individuals	13,279	25,046	25,046	25,046

B. Indicator - Bottom quartile of the entry wage distribution (WQ1)

	mbirth	y4birth	y6birth	y8birth
y3incr	0.05936***	−0.00036***	−0.00017**	−0.00005
WQ1	0.88521	−0.00492	−0.020041**	−0.02497**
WQ1 x y3incr	−0.03131***	0.00029***	0.00011	−0.00006
Covariates	X	X	X	X
CZ dummies	X	X	X	X
Cohort dummies	X	X	X	X
Clustered SE	X	X	X	X
Individuals	13,279	25,046	25,046	25,046

Table 3.4: Interactions with quartiles of the entry wage distribution

Data - Institute for Employment Research (IAB), Sample of Integrated Labour Market Biographies (SIAB), 1993-2007
Note - Own calculations. The table displays heterogeneous effects of wage growth across two indicators for individual career orientation. All coefficients are estimated using the OLS regression model of equation (3.1) including an additional interaction term. The lower number of individuals stems from the inclusion of the covariate employer size as well as childless women. All regressions control for commuting zone and cohort fixed effects. Standard errors are clustered at the commuting zone level.

This speaks against the relevance of a direct income effect on fertility timing. At the same time, the coefficients of the interaction term $WQ4$ x $y3incr$ are largely significant and point towards a fertility delay. As column one shows, an increase in the wage growth rate by one percentage point delays the first birth by 0.077 months more for individuals in the top quartile of the entry wage distribution compared to others. Given my above interpretation of quartile assignment, this implies that highly career oriented individuals delay their fertility more than three times as much as less career oriented individuals if faced with a higher wage growth. In relative terms, a 100% increase in the average wage growth of highly career oriented women would decrease the share of first births by year four among them by 45.58% and by year six by 13.97% compared to 8.04% and 6.26% for less career oriented women.

The results for an interaction with the indicator $WQ1$ for the bottom quartile of the industry, occupation and education specific entry wage distribution paint a similar picture. As shown in row three of Panel B, the coefficients of the interaction term $WQ1$ x $y3incr$ are largely significant and indicate an earlier first birth. An increase in the wage growth by one percentage point reduces the months to first birth by 0.031 for individuals in the bottom quartile of the entry wage distribution compared to others. The overall effect remains positive for both groups, in that a higher wage growth implies a fertility delay. The results imply that for more career oriented individuals, the relationship between early career wage growth and fertility timing is more positive, in that a higher wage growth implies a larger fertility delay. Conversely, the relationship is significantly less positive for little career oriented individuals, such that a higher wage growth implies a smaller fertility delay. For them, a 100% increase in the average wage growth would decrease the share of first births by year four by 6.26% compared to 32.18% for the other quartiles.

On average, the realized wage growth rate is strongly correlated with the constructed, potential wage growth rate. As shown in Figure 3.3, the bivariate relationship of the two variables has a slope of 1.07. This positive correlation is less pronounced for the highly career oriented women in the top quartile of the entry wage distribution. For their subsample, the relationship has a slope of 0.20. In contrast, the little career oriented in the bottom quartile of the entry wage distribution exhibit a stronger correlation. For them, the slope takes a value of 2.64.

Hence, the part of the variation in realized wage growth that is explained by local labor market conditions appears to be lower for highly career oriented individuals compared to others. Conversely, the part of the variation that is explained by endogenous, individual factors such as the employee-job match and effort must be higher. Given this relationship, I can reasonably assume that the OLS coefficients as shown in Table 3.2 in part reflect the individual component of wage growth. I can further surmise that the causal effect of a higher individual component of wage growth points towards a fertility delay. At the same time, the results of the heterogeneity analyses of Sections 3.6.1 and 3.6.2 show that safer, more employee friendly labor market conditions lead to earlier fertility. Together, these findings explain the sign flip from the OLS to the IV analysis.

3.7 Conclusion

This essay studies the role of early career wage profiles in women's choice of fertility timing for the case of Germany. To this end, I instrument realized, individual wage growth with a region and education specific potential wage growth rate. Given the design of the shift-share instrument, the potential wage growth rate reflects that component of realized wage growth which is determined by region specific labor market conditions. In order to also gain insight into the role of the individual component of wage growth, I conduct additional interaction analyses. The interaction terms moderate the relative significance of the individual component in wage setting. As such, the presented analyses shed light on the effect of higher individual wage growth on fertility timing. They additionally give insight into the role of labor protection and collective bargaining agreements.

In this setting, I find that a higher wage growth rate causes an earlier timing of fertility. Given the definition of the shift-share instrument, this implies that higher region specific wage growth rates and more favorable labor market conditions are associated with an earlier transition to motherhood. This result is in line with the literature, which associates lower economic uncertainty, for instance due to a lower unemployment risk, with increased birth rates (Da Rocha and Fuster, 2006). On the other hand, I find tentative evidence that an increase in the individual component of early career wage growth is associated with a fertility delay. This is in line with the result from the literature, that women who accumulate especially

much human capital at the beginning of their career tend to delay childbearing (Blackburn et al., 1993).

The geographical focus of this study opens up interesting avenues of further research. Internationally, Germany presents a somewhat special case given its strict labor protection laws and generous parental leave policies on the one hand and its imperfect availability of childcare and traditional family norms on the other. As such, similar investigations in other institutional and cultural environments may lead to different conclusions (Müller and Wrohlich, 2020).

Conclusion

This dissertation has considered the regulation of multinational banks as well as fertility decisions of women. Two of the three essays examine the role of interactions in regulatory policy making, either of regulation and bank capital constraints or between policy measures. The third essay evaluates the role of early career characteristics in women's fertility timing.

The first two essays reveal somewhat surprising consequences of more rigorous, internationally coordinated regulatory policy. Chapter 1 shows that stricter capital requirements, as introduced after the global financial crisis, can lead to an increase in the home bias of multinational lending. In line with empirical findings of a post-crisis "flight to quality", this retrenchment can be understood as a reallocation of lending capacity to informationally closer or better understood markets. The results suggest a more severe lending retrenchment for weakly capitalized banks. Concerning the international coordination of regulatory standards, one would generally expect coordinated policies to be efficient. As the second chapter points out, however, this is not necessarily the case in the presence of other, decentralized policies. Chapter 2 demonstrates the existence of a second best outcome for a centralized regime of banking supervision in the presence of nationally set capital standards. This analysis is of particular policy relevance given the recent formation of a supervisory union in the EU. There, capital standards remain at least partly decentralized. My results suggest that such a supervisory union can be welfare decreasing.

Departing from the topic of banking, Chapter 3 demonstrates that the relationship of early career wage growth and female fertility timing is heterogeneous across components of wage growth. An increase in the region specific component of wage growth leads to an earlier transition to motherhood. In contrast, an increase in the

individual component of wage growth is associated with a fertility delay. These results suggest that the fertility decisions of women react to changes in local labor market conditions differently than to changes in individual career incentives.

All of the results have in common that they describe unintended effects of policy or market environments. Some of the effects (e.g. those described in Chapter 2) are in direct opposition to policymakers' intentions. Others are unintended side effects to stricter regulation (Chapter 1) or labor market conditions (Chapter 3). This highlights the continued relevance of public economics research in informing political and regulatory decision-making.

Appendices

A Appendix to Chapter 1

A.1 Derivation of equilibrium monitoring efforts and lending volumes (unconstrained case)

We partially differentiate bank i's expected profit (1.4) with respect to the monitoring efforts and lending volumes, yielding the first order conditions

$$\frac{\partial \Pi_i}{\partial s_{di}} = L_{di}\left(\left[\bar{R} - (L_{di} + L_{fj})\right] - \delta(1-k) - b_d s_{di}\right) = 0 \tag{A.1}$$

$$\frac{\partial \Pi_i}{\partial s_{fi}} = L_{fi}\left(\left[\bar{R} - (L_{fi} + L_{dj})\right] - \delta(1-k) - b_d s_{fi}\right) = 0 \tag{A.2}$$

$$\frac{\partial \Pi_i}{\partial L_{di}} = s_{di}\left(\left[\bar{R} - (L_{fj} + 2L_{di})\right] - (\delta+\rho)k - \delta(1-k) - 0.5 b_d s_{di}^2\right) = 0 \tag{A.3}$$

$$\frac{\partial \Pi_i}{\partial L_{fi}} = s_{fi}\left(\left[\bar{R} - (L_{dj} + 2L_{fi})\right] - (\delta+\rho)k - \delta(1-k) - 0.5 b_d s_{fi}^2\right) = 0. \tag{A.4}$$

Solving the system of equations (A.1)–(A.4) under bank symmetry, we find the equilibrium monitoring efforts and lending volumes

$$s_d^\dagger = \frac{\bar{R} - \delta(1-k) + \sqrt{\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d + b_f)(\delta+\rho)k}}{4b_d} \tag{A.5}$$

$$s_f^\dagger = \frac{\bar{R} - \delta(1-k) + \sqrt{\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d + b_f)(\delta+\rho)k}}{4b_f} \tag{A.6}$$

$$L_d^\dagger = \frac{(5b_d + b_f)\left[\bar{R} - \delta(1-k)\right] - (3b_d - b_f)\sqrt{\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d + b_f)(\delta+\rho)k}}{8(b_d + b_f)} \tag{A.7}$$

$$L_f^\dagger = \frac{(5b_f + b_d)\left[\bar{R} - \delta(1-k)\right] - (3b_f - b_d)\sqrt{\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d + b_f)(\delta+\rho)k}}{8(b_d + b_f)}. \tag{A.8}$$

These results include the assumption that the monitoring efforts must take non-negative values in optimum.

A.2 Comparative statics of the credit supply (1.28)–(1.30)

The full equations of the comparative statics (1.28)–(1.30) of the local credit supply L^S with regards to ρ, δ and k are given by

$$\frac{\partial L^S}{\partial \rho} = -\frac{k(b_d + b_f)}{\sqrt{\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d + b_f)(\delta + \rho)k}} < 0 \tag{A.9}$$

$$\frac{\partial L^S}{\partial k} = \frac{\delta\left(3\sqrt{\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d + b_f)(\delta + \rho)k} - \left[\bar{R} - \delta(1-k)\right]\right) - 4(b_d + b_f)(\delta + \rho)}{4\sqrt{\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d + b_f)(\delta + \rho)k}} \gtreqless 0 \tag{A.10}$$

$$\frac{\partial L^S}{\partial \delta} = \frac{(1-k)\left(\left[\bar{R} - \delta(1-k)\right] - 3\sqrt{\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d + b_f)(\delta + \rho)k}\right) - 4k(b_d + b_f)}{4\sqrt{\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d + b_f)(\delta + \rho)k}} < 0. \tag{A.11}$$

While the derivative with regards to ρ is unambiguously negative we must prove that the derivative by δ indeed takes a negative value.[1] The derivative by k cannot by signed in general. To prove the negative sign of (A.11), we replace the square root in the numerator with square roots of the individual summands yielding the following expression

$$\frac{-(1-k)\left(2\left[\bar{R} - \delta(1-k)\right] + 3\sqrt{8(b_d + b_f)(\delta + \rho)k}\right) - 4k(b_d + b_f)}{4\sqrt{\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d + b_f)(\delta + \rho)k}} < 0. \tag{A.12}$$

Inequality (A.12) is unambiguously negative. Thereby, also the derivative (A.11) must be negative as the sum of square roots is greater than the square root of the summands. □

[1] In the following, we make use of the inequality $\sqrt{a+b} < \sqrt{a} + \sqrt{b}$.

A.3 Comparative statics of the monitoring and lending decision (1.31)–(1.33) and (1.34)–(1.36)

We present the full equations of the comparative statics (1.31)–(1.33) of the domestic affiliates' monitoring effort $s_d^\dagger$

$$\begin{aligned}
\frac{\partial s_d^\dagger}{\partial \rho} &= \frac{1}{b_d}\left(-\frac{\partial L^S}{\partial \rho}\right) \\
&= \frac{(b_d+b_f)k}{b_d\sqrt{\left[\bar{R}-\delta(1-k)\right]^2+8(b_d+b_f)(\delta+\rho)k}} > 0 \qquad \text{(A.13)} \\
\frac{\partial s_d^\dagger}{\partial k} &= \frac{1}{b_d}\left(-\frac{\partial L^S}{\partial k}+\delta\right) \\
&= \frac{1}{4b_d}\left(\frac{\left[\bar{R}-\delta(1-k)\right]\delta+4(b_d+b_f)(\delta+\rho)}{\sqrt{\left[\bar{R}-\delta(1-k)\right]^2+8(b_d+b_f)(\delta+\rho)k}}+\delta\right) > 0 \qquad \text{(A.14)} \\
\frac{\partial s_d^\dagger}{\partial \delta} &= \frac{1}{b_d}\left(-\frac{\partial L^S}{\partial \delta}-(1-k)\right) \\
&= \frac{1}{4b_d}\left(\frac{4(b_d+b_f)k-(1-k)\left[\bar{R}-\delta(1-k)\right]}{\sqrt{\left[\bar{R}-\delta(1-k)\right]^2+8(b_d+b_f)(\delta+\rho)k}}-(1-k)\right) \gtreqless 0. \qquad \text{(A.15)}
\end{aligned}$$

The derivatives of the foreign affiliates' monitoring effort $s_f^\dagger$ are defined equivalently. The full equations of the comparative statics (1.34)–(1.36) of the share of domestic lending are given by

$$\begin{aligned}
\frac{\partial \gamma^\dagger}{\partial \rho} &= \frac{(b_f-b_d)\left[\bar{R}-\delta(1-k)\right]}{2(b_d+b_f)(L^S)^2}\left(-\frac{\partial L^S}{\partial \rho}\right) \\
&= \frac{(b_f-b_d)\left[\bar{R}-\delta(1-k)\right]k^2\left(\left[\bar{R}-\delta(1-k)\right]^2+8(b_d+b_f)(\delta+\rho)k\right)^{-\frac{1}{2}}}{\left(3\left[\bar{R}-\delta(1-k)\right]-\sqrt{\left[\bar{R}-\delta(1-k)\right]^2+8(b_d+b_f)(\delta+\rho)k}\right)^2} > 0
\end{aligned} \qquad \text{(A.16)}$$

$$\begin{aligned}\frac{\partial \gamma^{\dagger}}{\partial k} &= \frac{(b_f - b_d)}{2(b_d + b_f)(L^S)^2}\left(-\frac{\partial L^S}{\partial k}\left[\bar{R} - \delta(1-k)\right] + \delta L^S\right) \\ &= \frac{8(b_f - b_d)(\delta+\rho)\left[\bar{R} - \delta(1+k)\right]\left(\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d+b_f)(\delta+\rho)k\right)^{-\frac{1}{2}}}{\left(3\left[\bar{R} - \delta(1-k)\right] - \sqrt{\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d+b_f)(\delta+\rho)k}\right)^2} \\ &> 0 \end{aligned} \tag{A.17}$$

$$\begin{aligned}\frac{\partial \gamma^{\dagger}}{\partial \delta} &= \frac{(b_f - b_d)}{2(b_d + b_f)(L^S)^2}\left(-\frac{\partial L^S}{\partial \delta}\left[\bar{R} - \delta(1-k)\right] - (1-k)L^S\right) \\ &= \frac{8(b_f - b_d)k\left[\bar{R} + (1-k)(\delta+2\rho)\right]\left(\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d+b_f)(\delta+\rho)k\right)^{-\frac{1}{2}}}{\left(3\left[\bar{R} - \delta(1-k)\right] - \sqrt{\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d+b_f)(\delta+\rho)k}\right)^2} \\ &> 0. \end{aligned} \tag{A.18}$$

with the latter result holding under the condition $\bar{R} > \delta(1+k)$.

A.4 Cross derivative of the monitoring effort

We present the cross derivative of the monitoring effort with regards to δ and k for the example of domestic monitoring

$$\begin{aligned}&\frac{\partial^2 s_d^{\dagger}}{\partial \delta \partial k} \\ &= \frac{1}{4b_d}\left(1 + \frac{\left[\bar{R} - \delta(1-k)\right]^3 + 4(b_d+b_f)\left(\left[\bar{R} - \delta(1-k)\right]^2 + 4(b_d+b_f)(\delta+\rho)k\right)}{\sqrt[3]{\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d+b_f)(\delta+\rho)k}}\right. \\ &\quad \left. + \frac{4(b_d+b_f)\left(\left[\bar{R} - \delta(1-k)\right]\left[\delta(1-k)+\rho\right] + \left[\bar{R} - 3\delta(1-k)\right]k(\delta+\rho)\right)}{\sqrt[3]{\left[\bar{R} - \delta(1-k)\right]^2 + 8(b_d+b_f)(\delta+\rho)k}}\right) \\ &> 0. \end{aligned} \tag{A.19}$$

The cross derivative of foreign monitoring is defined equivalently .

B Appendix to Chapter 2

B.1 Supranational supervisory standard: sufficient condition for an internal solution

We show that there is indeed an internal solution for the resolution threshold λ_G which maximizes global welfare. To this end, we show that the second order derivative of the global welfare function WF by λ_i is negative, indicating a maximum

$$\begin{aligned}\left.\frac{\partial^2 WF}{\partial \lambda_i^2}\right|_{\lambda_i=\lambda_G} = &-\frac{E}{k_i}\left[\bar{R}-\frac{E}{2k_i}-1+k_i+c(1-k_i)+\frac{1-\lambda_j^2}{2}(1-c)(1-k_i)\right] \\ &+\frac{E}{k_j}\left[\frac{(1-\lambda_j)^2}{2}(1-c)(1-k_j)\right].\end{aligned}$$

With $\lambda_i = \lambda_j = \lambda$ and $k_i = k_j = k$ this reduces to

$$\left.\frac{\partial^2 WF}{\partial \lambda_i^2}\right|_{\lambda_i=\lambda_G} = -\frac{E}{k}\left[\bar{R}-\frac{E}{2k}-1+k+c(1-k)+\lambda(1-\lambda)(1-c)(1-k)\right]. \tag{B.1}$$

Under the assumption that profits from a successful investment are positive and large enough to cross-subsidize a failing foreign subsidiary $\bar{R}-\frac{E}{k}-1>1$, equation (B.1) is negative for all $\lambda \in (0,1)$.

We now show that the limit cases $\lambda_i \to 0$ and $\lambda_i \to 1$ do not satisfy the first order condition for maximal global welfare and can thereby not be optimal:

$$\left.\frac{\partial WF(\lambda_i)}{\partial \lambda_i}\right|_{\lambda_i=0} = \frac{E}{k_i}\left[k_i + c(1-k_i)\underbrace{\left(1-\frac{1-\lambda_j^2}{2}\right)}_{>0} + \frac{1-\lambda_j^2}{2}(1-k_i)\right] > 0 \tag{B.2}$$

$$\left.\frac{\partial WF(\lambda_i)}{\partial \lambda_i}\right|_{\lambda_i=1} = -\frac{E}{k_i}\left[\bar{R} - \frac{E}{2k_i} - 1\right] + \frac{E}{k_j}\underbrace{\left[\frac{(1-\lambda_j)^2}{2}(1-c)(1-k_i)\right]}_{<0}. \quad \text{(B.3)}$$

With $k_i = k_j = k$ and $c > 1$, expression (B.3) reduces to the sufficient condition

$$\left.\frac{\partial WF(\lambda_i)}{\partial \lambda_i}\right|_{\lambda_i=1} < -\frac{E}{k}\underbrace{\left[\bar{R} - \frac{E}{2k} - 1\right]}_{>0}, \quad \text{(B.4)}$$

which is smaller than zero for all $\lambda \in (0,1)$ due to the assumption of sufficiently large profits from lending. Hence, $0 < \lambda_G < 1$. □

B.2 Supranational capital standard: sufficient condition for an internal solution

We show that any internal solution for the capital ratio in supranational optimum k_G represents a maximum of global welfare. To this end, we show that for any solution $k_G \in (0,1)$, the second order derivative of the global welfare function $WF = WF_i + WF_j$ by k_i is negative, indicating a maximum.

Maximizing the global welfare function, the first order condition for the supranationally optimal capital ratio k_G is given by

$$k_G(\lambda) = \frac{E(1-\lambda^2)}{(1-\lambda^2)(\bar{R}-1) - \frac{(1-\lambda)^2}{2}\left[(1+\lambda^2)c + 1 - \lambda^2\right]}, \quad \text{(B.5)}$$

with $\lambda = \lambda_i = \lambda_j$. Equation (B.5) describes an internal solution $k_G \in (0,1)$ if the cost of the deposit insurance scheme and intra-bank cross-subsidization is not too large compared to the rents from successful investment, such that the condition $(1-\lambda^2)(\bar{R} - E - 1) > \frac{(1-\lambda)^2}{2}\left[(1+\lambda^2)c + 1 - \lambda^2\right]$ holds.

The second order derivative of WF with respect to k_i is given by

$$\left.\frac{\partial^2 WF}{\partial k_i^2}\right|_{k_i=k_G} = \frac{2E}{k_i^3}\left(\frac{1-\lambda^2}{2}\left[\bar{R} - \frac{3E}{2k_i} - 1\right] - \frac{1-\lambda^2}{4}\left[(1+\lambda^2)c + 1 - \lambda^2\right]\right).$$

It takes a negative value, if the expression in the round brackets is negative. We insert the first order condition $k_G(\lambda)$ given by equation (B.5). The expression in the brackets takes a negative value if the following condition holds:

$$(1-\lambda^2)(\bar{R}-1) - \frac{(1-\lambda)^2}{2}\left[(1+\lambda^2)c + 1 - \lambda^2\right] > 0. \tag{B.6}$$

Given the restriction to internal solutions, this reduces to the sufficient condition

$$(1-\lambda^2)E > 0 \tag{B.7}$$

which holds for all $\lambda \in (0,1)$. Hence, any internal solution $k_G \in (0,1)$ for the supranational capital standard must represent a maximum. □

B.3 Derivation of condition (2.12)

We prove that if sufficient condition (2.12) holds, moving towards a global supervisory regime decreases the welfare of country i. To this end, we analyze the welfare impact of a small supervisory reform, as given by equation (2.11). In a first step, we insert the expressions for the international externalities of stricter supervision and capital regulation on country i, (2.5) and (2.10), into the welfare analysis. Starting at the national optimum $\lambda_i = \lambda_j = \lambda_N$ and $k_i = k_j = k_N$, this leads to a condition for a welfare loss $\frac{dWF_i}{d\lambda} < 0$

$$\begin{aligned} 0 \; > & (1-\lambda_N)\frac{1-\lambda_N^2}{2} - \lambda_N \frac{(1-\lambda_N)^2}{2}\left[k_N + c(1-k_N)\right] \\ & + \frac{1}{k_N}\frac{(1-\lambda_N)^2}{2}\frac{1-\lambda_N^2}{2}\frac{dk_N}{d\lambda}. \end{aligned} \tag{B.8}$$

Into this inequality, we insert expressions (2.8) and (2.9) for the national regulators' choice of capital ratio $k_N(\lambda)$ and its dependence on λ, $dk_N/d\lambda$:

$$
\begin{aligned}
0 \;>\; & c\lambda(1-\lambda)\left[\frac{c}{2}(1-\lambda)^2(1+\lambda^2)-(1-\lambda^2)(\bar{R}-E-1)\right] \\
& +\; (1-\lambda^2)\left[(1-\lambda^2)(\bar{R}-1)-\lambda(1-\lambda)E\right] \\
& -\; c(1-\lambda)\left[(1-\lambda)(1-\lambda^4)-\lambda(1-\lambda)^2\right].
\end{aligned}
\tag{B.9}
$$

Under the condition for an interior solution $k_N \in (0,1)$ of the nationally set capital requirement, $(1-\lambda^2)(\bar{R}-E-1) > (1-\lambda)^2(1+\lambda^2)\frac{c}{2}$, the first line of inequality (B.9) must be negative for all values of $\lambda \in (0,1)$. Replacing the first line by zero leads to the sufficient condition

$$
\begin{aligned}
0 \;>\; & (1-\lambda^2)\left[(1-\lambda^2)(\bar{R}-1)-\lambda(1-\lambda)E\right] && \text{(B.10)} \\
& -\; c(1-\lambda)^2\left[(1-\lambda^4)-\lambda(1-\lambda)\right] \\
\Leftarrow \quad 0 \;>\; & (1+\lambda)\left[(1+\lambda)(\bar{R}-1)-\lambda E\right]-c(1-\lambda). && \text{(B.11)}
\end{aligned}
$$

The sufficient condition (B.11) is more likely to be fulfilled for small values of λ. At $\lambda = 0$ it takes the form $c > \bar{R} - 1$.

Bibliography

Acharya, V. V. (2003). Is the international convergence of capital adequacy regulation desirable?, The Journal of Finance **58**(6): 2745–2782.

Acharya, V. V., Eisert, T., Eufinger, C. and Hirsch, C. (2018). Real effects of the sovereign debt crisis in Europe: Evidence from syndicated loans, The Review of Financial Studies **31**(8): 2855–2896.

Acharya, V. V., Shin, H. S. and Yorulmazer, T. (2011). Crisis resolution and bank liquidity, The Review of Financial Studies **24**(6): 2166–2205.

Acharya, V. V. and Steffen, S. (2015). The "greatest" carry trade ever? Understanding eurozone bank risks, Journal of Financial Economics **115**(2): 215–236.

Adda, J., Dustmann, C. and Stevens, K. (2017). The career costs of children, Journal of Political Economy **125**(2): 293–337.

Adsera, A. (2004). Changing fertility rates in developed countries. The impact of labor market institutions, Journal of Population Economics **17**(1): 17–43.

Agarwal, S. and Hauswald, R. (2010). Distance and private information in lending, The Review of Financial Studies **23**(7): 2757–2788.

Agarwal, S., Lucca, D., Seru, A. and Trebbi, F. (2014). Inconsistent regulators: Evidence from banking, The Quarterly Journal of Economics **129**(2): 889–938.

Aiyar, S. (2012). From financial crisis to great recession: The role of globalized banks, American Economic Review **102**(3): 225–30.

Albertazzi, U. and Bottero, M. (2014). Foreign bank lending: Evidence from the global financial crisis, Journal of International Economics **92**: S22–S35.

Albertazzi, U. and Marchetti, D. (2010). Credit supply, flight to quality and evergreening: An analysis of bank-firm relationships after Lehman. Bank of Italy Temi di Discussione No. 756.

Allen, F., Jackowicz, K., Kowalewski, O. and Kozłowski, Ł. (2017). Bank lending, crises, and changing ownership structure in Central and Eastern European countries, Journal of Corporate Finance **42**: 494–515.

Altavilla, C., Pagano, M. and Simonelli, S. (2017). Bank exposures and sovereign stress transmission, Review of Finance **21**(6): 2103–2139.

Amuedo-Dorantes, C. and Kimmel, J. (2005). The motherhood wage gap for women in the United States: The importance of college and fertility delay, Review of Economics of the Household **3**(1): 17–48.

Andersson, G., Kreyenfeld, M. and Mika, T. (2014). Welfare state context, female labour-market attachment and childbearing in Germany and Denmark, Journal of Population Research **31**(4): 287–316.

Angelov, N., Johansson, P. and Lindahl, E. (2016). Parenthood and the gender gap in pay, Journal of Labor Economics **34**(3): 545–579.

Anginer, D., Cerutti, E. and Pería, M. S. M. (2017). Foreign bank subsidiaries' default risk during the global crisis: What factors help insulate affiliates from their parents?, Journal of Financial Intermediation **29**: 19–31.

Antoni, M., vom Berge, P., Graf, T., Grießemer, S., Kaimer, S., Köhler, M., Lehnert, C., Oertel, M., Schmucker, A., Seth, S. and Seysen, C. (2019). Weakly anonymous Version of the Sample of Integrated Labour Market Biographies (SIAB) – Version 7517 v1. Research Data Centre of the Federal Employment Agency (BA) at the Institute for Employment Research (IAB).

Auer, W. and Danzer, N. (2016). Fixed-term employment and fertility: Evidence from German micro data, CESifo Economic Studies **62**(4): 595–623.

Autor, D. H., Dorn, D. and Hanson, G. H. (2013). The China syndrome: Local labor market effects of import competition in the United States, American Economic Review **103**(6): 2121–68.

Bank for International Settlements (2004). Basel II: International convergence of capital measurement and capital standards - a revised framework. BCBS Communication.

Bank for International Settlements (2010). Basel III: A global regulatory framework for more resilient banks and banking systems. BCBS Communication No.189.

Baron, M., Verner, E. and Xiong, W. (2021). Banking crises without panics, The Quarterly Journal of Economics **136**(1): 51–113.

Barth, J. R., Phumiwasana, T. and Lee, C. (2013). Deposit insurance schemes, in C.-F. Lee and A. C. Lee (eds), Encyclopedia of Finance, Springer, pp. 207–212.

Bartik, T. J. (1991). Who Benefits from State and Local Economic Development Policies?, W.E. Upjohn Institute, Kalamazoo, MI.

Baskaya, Y. S., Di Giovanni, J., Kalemli-Özcan, Ş., Peydró, J.-L. and Ulu, M. F. (2017). Capital flows and the international credit channel, Journal of International Economics **108**: 15–22.

Beck, T., Ioannidou, V. and Schäfer, L. (2018). Foreigners vs. natives: Bank lending technologies and loan pricing, Management Science **64**(8): 3792–3820.

Beck, T., Todorov, R. and Wagner, W. (2013). Supervising cross-border banks: Theory, evidence and policy, Economic Policy **28**(73): 5–44.

Beck, T., Wagner, W. et al. (2016). Supranational supervision: How much and for whom?, International Journal of Central Banking **12**(2): 221–268.

Begall, K. and Mills, M. C. (2013). The influence of educational field, occupation, and occupational sex segregation on fertility in the Netherlands, European Sociological Review **29**(4): 720–742.

Behn, M., Haselmann, R. F. and Vig, V. (2021). The limits of model-based regulation, Journal of Finance (forthcoming).

Berger, A. N., Klapper, L. F. and Udell, G. F. (2001). The ability of banks to lend to informationally opaque small businesses, Journal of Banking & Finance

25(12): 2127–2167.

Berger, A. N. and Udell, G. F. (1998). The economics of small business finance: The roles of private equity and debt markets in the financial growth cycle, Journal of Banking & Finance **22**(6-8): 613–673.

Blackburn, M. L., Bloom, D. E. and Neumark, D. (1993). Fertility timing, wages, and human capital, Journal of Population Economics **6**(1): 1–30.

Boelmann, B., Raute, A. and Schönberg, U. (2021). Wind of change? Cultural determinants of maternal labor supply. CEPR Discussion Paper No. 16149.

Bofondi, M., Carpinelli, L. and Sette, E. (2018). Credit supply during a sovereign debt crisis, Journal of the European Economic Association **16**(3): 696–729.

Bolton, P., Freixas, X., Gambacorta, L. and Mistrulli, P. E. (2016). Relationship and transaction lending in a crisis, The Review of Financial Studies **29**(10): 2643–2676.

Bonaccorsi di Patti, E. and Sette, E. (2012). Bank balance sheets and the transmission of financial shocks to borrowers: Evidence from the 2007-2008 crisis. Bank of Italy Temi di Discussione No. 848. Rome.

Bönke, T., Corneo, G. and Lüthen, H. (2015). Lifetime earnings inequality in Germany, Journal of Labor Economics **33**(1): 171–208.

Bossler, M., Gürtzgen, N., Kubis, A., Küfner, B. and Popp, M. (2021). Befristungen bei Neueinstellungen 2020. IAB Aktuelle Daten und Indikatoren.

Boyd, J. H. and De Nicolo, G. (2005). The theory of bank risk taking and competition revisited, The Journal of Finance **60**(3): 1329–1343.

Brander, J. and Krugman, P. (1983). A 'reciprocal dumping' model of international trade, Journal of International Economics **15**(3-4): 313–321.

Bremus, F. M. (2015). Cross-border banking, bank market structures and market power: Theory and cross-country evidence, Journal of Banking & Finance **50**: 242–259.

Brüggemann, B., Kleinert, J. and Prieto, E. (2012). The ideal loan and the patterns of cross-border bank lending. Graz Economic Papers No.2012-03.

Buch, C. and Dages, B. (2018). Structural changes in banking after the crisis. BIS CGFS Paper No. 60.

Buch, C. M., Neugebauer, K. and Schröder, C. (2014). Changing forces of gravity: How the crisis affected international banking. ZEW Discussion Papers No.14(6).

Buck, F. and Schliephake, E. (2013). The regulator's trade-off: Bank supervision vs. minimum capital, Journal of Banking & Finance **37**(11): 4584–4598.

Calzolari, G., Colliard, J.-E. and Lóránth, G. (2019). Multinational banks and supranational supervision, The Review of Financial Studies **32**(8): 2997–3035.

Campello, M., Graham, J. R. and Harvey, C. R. (2010). The real effects of financial constraints: Evidence from a financial crisis, Journal of Financial Economics **97**(3): 470–487.

Cappelletti, G., Ponte Marques, A., Varraso, P., Budrys, Ž. and Peeters, J. (2019). Impact of higher capital buffers on banks' lending and risk-taking: Evidence from the euro area experiments. ECB Working Paper Series No. 2292.

Carletti, E., Dell'Ariccia, G. and Marquez, R. (2020). Supervisory incentives in a banking union, Management Science .

Carpinelli, L. and Crosignani, M. (2021). The design and transmission of central bank liquidity provisions, Journal of Financial Economics **141**(1): 27–47.

Caucutt, E. M., Guner, N. and Knowles, J. (2002). Why do women wait? Matching, wage inequality, and the incentives for fertility delay, Review of Economic Dynamics **5**(4): 815–855.

Cetorelli, N. and Goldberg, L. S. (2012). Liquidity management of US global banks: Internal capital markets in the great recession, Journal of International Economics **88**(2): 299–311.

Chami, R. and Cosimano, T. F. (2010). Monetary policy with a touch of Basel, Journal of Economics and Business **62**(3): 161–175.

Cigno, A. and Ermisch, J. (1989). A microeconomic analysis of the timing of births, European Economic Review **33**(4): 737–760.

Claessens, S. and Van Horen, N. (2014). Foreign banks: Trends and impact, Journal of Money, Credit and Banking **46**(1): 295–326.

Colliard, J.-E. (2020). Optimal supervisory architecture and financial integration in a banking union, Review of Finance **24**(1): 129–161.

Corbae, D. and D'Erasmo, P. (2015). Foreign competition and banking industry dynamics: An application to Mexico, IMF Economic Review **63**(4): 830–867.

Da Rocha, J. M. and Fuster, L. (2006). Why are fertility rates and female employment ratios positively correlated across OECD countries?, International Economic Review **47**(4): 1187–1222.

De Blas, B. and Russ, K. N. (2013). All banks great, small, and global: Loan pricing and foreign competition, International Review of Economics and Finance **26**: 4–24.

De Haas, R. and Van Lelyveld, I. (2010). Internal capital markets and lending by multinational bank subsidiaries, Journal of Financial Intermediation **19**(1): 1–25.

De Haas, R. and Van Lelyveld, I. (2014). Multinational banks and the global financial crisis: Weathering the perfect storm?, Journal of Money, Credit and Banking **46**(1): 333–364.

De la Rica, S. and Iza, A. (2005). Career planning in spain: Do fixed-term contracts delay marriage and parenthood?, Review of Economics of the Household **3**(1): 49–73.

Del Bono, E., Weber, A. and Winter-Ebmer, R. (2015). Fertility and economic instability: The role of unemployment and job displacement, Journal of Population Economics **28**(2): 463–478.

Dell'Ariccia, G. and Marquez, R. (2006). Competition among regulators and credit market integration, Journal of Financial Economics **79**(2): 401–430.

Demirguc-Kunt, A., Detragiache, E. and Merrouche, O. (2013). Bank capital: Lessons from the financial crisis, Journal of Money, Credit and Banking **45**(6): 1147–1164.

Dreger, C. and Reimers, H.-E. (2011). On the role of sectoral and national wage components in the wage bargaining process, Regional and Sectoral Economic Studies **11**(1).

Dustmann, C., Ludsteck, J. and Schönberg, U. (2009). Revisiting the German wage structure, The Quarterly Journal of Economics **124**(2): 843–881.

Efing, M. (2020). Reaching for yield in the ABS market: Evidence from German bank investments, Review of Finance **24**(4): 929–959.

Eika, L., Mogstad, M. and Zafar, B. (2019). Educational assortative mating and household income inequality, Journal of Political Economy **127**(6): 2795–2835.

Ejrnæs, M. and Jørgensen, T. H. (2020). Family planning in a life-cycle model with income risk, Journal of Applied Econometrics **35**(5): 567–586.

Emter, L., Schmitz, M. and Tirpák, M. (2019). Cross-border banking in the EU since the crisis: What is driving the great retrenchment?, Review of World Economics **155**(2): 287–326.

Enria, A. (2019). The banking union - a personal view on its past, present and future. Centre for European Reforms [Accessed: 2021 05 05].
URL: *https://www.bankingsupervision.europa.eu/press/speeches/html/index.en.html*

European Central Bank (2010). Financial stability review: June 2010.

European Parliament and Council (2013a). Capital Requirements Regulation (CRR). Regulation No. 575/2013.

European Parliament and Council (2013b). Single Supervisory Mechanism (SSM). Regulation No. 1024/2013.

Faia, E., Laffitte, S., Mayer, M. and Ottaviano, G. (2021). Global banking: Endogenous competition and risk taking, European Economic Review **133**: 103661.

Farhi, E. and Tirole, J. (2018). Deadly embrace: Sovereign and financial balance sheets doom loops, The Review of Economic Studies **85**(3): 1781–1823.

Fiechter, J., Ötker-Robe, İ., Ilyina, A., Hsu, M., Santos, A. and Surti, J. (2011). Subsidiaries or branches: Does one size fit all? IMF Staff Discussion Note No. 11/04.

Fraisse, H., Lé, M. and Thesmar, D. (2020). The real effects of bank capital requirements, Management Science **66**(1): 5–23.

Francesconi, M. (2002). A joint dynamic model of fertility and work of married women, Journal of labor Economics **20**(2): 336–380.

Fratianni, M. and Pattison, J. C. (2015). Basel III in reality, Journal of Economic Integration **30**(1): 1–28.

Freixas, X. and Rochet, J.-C. (2008). Microeconomics of banking, 2 edn, MIT Press. Cambridge, MA.

Frey, R. and Kerl, C. (2015). Multinational banks in the crisis: Foreign affiliate lending as a mirror of funding pressure and competition on the internal capital market, Journal of Banking & Finance **50**: 52–68.

Furtado, D. (2016). Fertility responses of high-skilled native women to immigrant inflows, Demography **53**(1): 27–53.

Gambacorta, L. and Shin, H. S. (2018). Why bank capital matters for monetary policy, Journal of Financial Intermediation **35**: 17–29.

Gartner, H. (2005). The imputation of wages above the contribution limit with the German IAB employment sample. FDZ Methodenreport No. 2/2005.

Gebel, M. (2010). Early career consequences of temporary employment in Germany and the UK, Work, Employment and Society **24**(4): 641–660.

Goldsmith-Pinkham, P., Sorkin, I. and Swift, H. (2020). Bartik instruments: What, when, why, and how, American Economic Review **110**(8): 2586–2624.

Gropp, R., Mosk, T. C., Ongena, S., Simac, I. and Wix, C. (2021a). Supranational rules, national discretion: Increasing versus inflating regulatory bank capital? SAFE Working Paper No. 296.

Gropp, R., Mosk, T., Ongena, S., Simac, I. and Wix, C. (2021b). Supranational rules, national discretion: Increasing versus inflating regulatory bank capital. VoxEU [Accessed: 2021 02 15].
URL: *https://voxeu.org/article/supranational-rules-national-discretion-and-regulatory-bank-capital*

Gropp, R., Mosk, T., Ongena, S. and Wix, C. (2019). Banks response to higher capital requirements: Evidence from a quasi-natural experiment, The Review of Financial Studies **32**(1): 266–299.

Gulamhussen, M. A., Hennart, J.-F. and Pinheiro, C. M. (2016). What drives cross-border M&As in commercial banking?, Journal of Banking & Finance **72**: S6–S18.

Gupta, N. D. and Smith, N. (2002). Children and career interruptions: The family gap in Denmark, Economica **69**(276): 609–629.

Gustafsson, S. (2001). Optimal age at motherhood. Theoretical and empirical considerations on postponement of maternity in Europe, Journal of Population Economics **14**(2): 225–247.

Hakenes, H. and Schnabel, I. (2011). Capital regulation, bank competition, and financial stability, Economics Letters **113**(3): 256–258.

Hakim, C. (2002). Lifestyle preferences as determinants of women's differentiated labor market careers, Work and occupations **29**(4): 428–459.

Hardy, D. C. and Nieto, M. J. (2011). Cross-border coordination of prudential supervision and deposit guarantees, Journal of Financial Stability **7**(3): 155–164.

Hart, R. K. (2015). Earnings and first birth probability among Norwegian men and women 1995–2010, Demographic Research **33**: 1067–1104.

Hartmann, P. and Smets, F. (2018). The first twenty years of the European Central Bank: Monetary policy. ECB Working Paper Series No. 2219.

Haufler, A. (2021). Bailout and regulatory decisions in a banking union. CESifo Working Paper No. 8964.

Haufler, A. and Maier, U. (2019). Regulatory competition in capital standards: A 'race to the top' result, Journal of Banking & Finance **106**: 180–194.

Haufler, A. and Wooton, I. (2021). Multinational banks in regulated markets: Is financial integration desirable?, Canadian Journal of Economics .

Hauswald, R. and Marquez, R. (2006). Competition and strategic information acquisition in credit markets, The Review of Financial Studies **19**(3).

Head, K. and Spencer, B. J. (2017). Oligopoly in international trade: Rise, fall and resurgence, Canadian Journal of Economics **50**(5): 1414–1444.

Hellmann, T. F., Murdock, K. C. and Stiglitz, J. E. (2000). Liberalization, moral hazard in banking, and prudential regulation: Are capital requirements enough?, American Economic Review **90**(1): 147–165.

Herr, J. L. (2016). Measuring the effect of the timing of first birth on wages, Journal of Population Economics **29**(1): 39–72.

Hofmann, B., Kreyenfeld, M. and Uhlendorff, A. (2017). Job displacement and first birth over the business cycle, Demography **54**(3): 933–959.

Holmstrom, B. and Tirole, J. (1997). Financial intermediation, loanable funds, and the real sector, The Quarterly Journal of Economics **112**(3): 663–691.

Hotz, V. J. and Miller, R. A. (1988). An empirical analysis of life cycle fertility and female labor supply, Econometrica: Journal of the Econometric Society pp. 91–118.

Hufe, P. (2021). Essays on Equality of Opportunity. ifo Beiträge zur Wirtschaftsforschung No. 93.

Ivashina, V. and Scharfstein, D. (2010). Bank lending during the financial crisis of 2008, Journal of Financial Economics **97**(3): 319–338.

Kara, G. I. (2016). Systemic risk, international regulation, and the limits of coordination, Journal of International Economics **99**: 192–222.

Karceski, J., Ongena, S. and Smith, D. C. (2005). The impact of bank consolidation on commercial borrower welfare, The Journal of Finance **60**(4): 2043–2082.

Keane, M. P. and Wolpin, K. I. (2010). The role of labor and marriage markets, preference heterogeneity, and the welfare system in the life cycle decisions of black, hispanic, and white women, International Economic Review **51**(3): 851–892.

Kingsley, M. (2018). The influence of income and work hours on first birth for Australian women, Journal of Population Research **35**(2): 107–129.

Kleven, H., Landais, C., Posch, J., Steinhauer, A. and Zweimüller, J. (2019). Child penalties across countries: Evidence and explanations, AEA Papers and Proceedings **109**: 122–26.

Kopecky, K. J. and VanHoose, D. (2004). A model of the monetary sector with and without binding capital requirements, Journal of Banking & Finance **28**(3): 633–646.

Kügler, A., Schönberg, U. and Schreiner, R. (2018). Productivity growth, wage growth and unions, Price and wage-setting in advanced economies, Vol. 2018, ECB, pp. 215–247.

Lee, D. L., McCrary, J., Moreira, M. J. and Porter, J. (2021). Valid t-ratio inference for IV. NBER Working Paper No. 29124.

Loipersberger, F. (2018). The effect of supranational banking supervision on the financial sector: Event study evidence from Europe, Journal of Banking & Finance **91**: 34–48.

Lombardi, M. J. and Zhu, F. (2014). A shadow policy rate to calibrate us monetary policy at the zero lower bound. BIS Working Paper Series No. 452.

Lóránth, G. and Morrison, A. D. (2007). Deposit insurance, capital regulations, and financial contagion in multinational banks, Journal of Business Finance & Accounting **34**(5-6): 917–949.

Lübker, M. and Schulten, T. (2020). Tarifbindung in den Bundesländern: Entwicklungslinien und Auswirkungen auf die Beschäftigten. Elemente Qualitativer Tarifpolitik No. 87.

Lundborg, P., Plug, E. and Rasmussen, A. W. (2017). Can women have children and a career? IV evidence from IVF treatments, American Economic Review **107**(6): 1611–37.

Mankart, J., Michaelides, A. and Pagratis, S. (2019). Bank capital buffers in a dynamic model, Financial Management pp. 1–30.

Manning, A. and Swaffield, J. (2008). The gender gap in early-career wage growth, The Economic Journal **118**(530): 983–1024.

Marginson, P., Keune, M. and Bohle, D. (2014). Negotiating the effects of uncertainty? The governance capacity of collective bargaining under pressure, European Review of Labour and Research **20**(1): 37–51.

Mariani, R. and Rosati, F. (2021). Immigrant supply of marketable child care and native fertility in Italy, Technical report, GLO Discussion Paper No. 745.

Mariathasan, M. and Merrouche, O. (2014). The manipulation of Basel risk-weights, Journal of Financial Intermediation **23**(3): 300–321.

Marks, G. and Houston, D. M. (2002). The determinants of young women's intentions about education, career development and family life, Journal of Education and Work **15**(3): 321–336.

Martin, S. P. (2000). Diverging fertility among US women who delay childbearing past age 30, Demography **37**(4): 523–533.

Miller, A. R. (2011). The effects of motherhood timing on career path, Journal of Population Economics **24**(3): 1071–1100.

Mincer, J. and Ofek, H. (1982). Interrupted work careers: Depreciation and restoration of human capital, Journal of Human Resources pp. 3–24.

Mincer, J. and Polachek, S. (1974). Family investments in human capital: Earnings of women, Journal of Political Economy **82**(2, Part 2): S76–S108.

Moffitt, R. (1984). Profiles of fertility, labour supply and wages of married women: A complete life-cycle model, The Review of Economic Studies **51**(2): 263–278.

Monte, F., Redding, S. J. and Rossi-Hansberg, E. (2018). Commuting, migration, and local employment elasticities, American Economic Review **108**(12): 3855–90.

Müller, D. and Strauch, K. (2017). Identifying mothers in administrative data. FDZ-Methodenreport No. 13/2017.

Müller, K.-U. and Wrohlich, K. (2020). Does subsidized care for toddlers increase maternal labor supply? Evidence from a large-scale expansion of early childcare, Labour Economics **62**: 101776.

Navaretti, G. B., Calzolari, G., Pozzolo, A. F. and Levi, M. (2010). Multinational banking in Europe–financial stability and regulatory implications: Lessons from the financial crisis, Economic Policy **25**(64): 703–753.

Ní Bhrolcháin, M. and Beaujouan, É. (2012). Fertility postponement is largely due to rising educational enrolment, Population Studies **66**(3): 311–327.

Niepmann, F. (2015). Banking across borders, Journal of International Economics **96**: 244–265.

Ongena, S., Popov, A. and Udell, G. F. (2013). "When the cat's away the mice will play": Does regulation at home affect bank risk-taking abroad?, Journal of Financial Economics **108**(3): 727–750.

Ongena, S., Popov, A. and Van Horen, N. (2019). The invisible hand of the government: Moral suasion during the European sovereign debt crisis, American Economic Journal: Macroeconomics **11**(4): 346–79.

Pavan, R. (2011). Career choice and wage growth, Journal of Labor Economics **29**(3): 549–587.

Popov, A. and Van Horen, N. (2015). Exporting sovereign stress: Evidence from syndicated bank lending during the euro area sovereign debt crisis, Review of Finance **19**(5): 1825–1866.

Porter, M. (2003). The economic performance of regions, Regional Studies **37**(6-7): 549–578.

Repullo, R. (2004). Capital requirements, market power, and risk-taking in banking, Journal of Financial Intermediation **13**(2): 156–182.

Repullo, R. (2018). Hierarchical bank supervision, SERIEs **9**(1): 1–26.

Repullo, R. and Suarez, J. (2012). The procyclical effects of bank capital regulation, The Review of Financial Studies **26**(2): 452–490.

Reshid, A. A. (2019). The gender gap in early career wage growth: The role of children, job mobility, and occupational mobility, Labour **33**(3): 278–305.

Sapienza, P. (2002). The effects of banking mergers on loan contracts, The Journal of Finance **57**(1): 329–367.

Schaller, J. (2016). Booms, busts, and fertility testing the Becker model using gender-specific labor demand, Journal of Human Resources **51**(1): 1–29.

Schmidt, L. (2008). Risk preferences and the timing of marriage and childbearing, Demography **45**(2): 439–460.

Schnabl, P. (2012). The international transmission of bank liquidity shocks: Evidence from an emerging market, The Journal of Finance **67**(3): 897–932.

Schoenmaker, D. and Véron, N. (2016). European banking supervision: Compelling start, lingering challenges. VoxEU [Accessed: 2020 11 27].
URL: *https://voxeu.org/article/early-assessment-single-supervisory-mechanism*

Schönberg, U. (2007). Wage growth due to human capital accumulation and job search: A comparison between the United States and Germany, ILR Review **60**(4): 562–586.

Schönberg, U. (2009). Does the IAB employment sample reliably identify maternity leave taking? A data report, Zeitschrift für Arbeitsmarkt Forschung **42**(1): 49–70.

Schönberg, U. and Ludsteck, J. (2014). Expansions in maternity leave coverage and mothers' labor market outcomes after childbirth, Journal of Labor Economics **32**(3): 469–505.

Sette, E. and Gobbi, G. (2015). Relationship lending during a financial crisis, Journal of the European Economic Association **13**(3): 453–481.

Sheran, M. (2007). The career and family choices of women: A dynamic analysis of labor force participation, schooling, marriage, and fertility decisions, Review of Economic Dynamics **10**(3): 367–399.

Sommer, K. (2016). Fertility choice in a life cycle model with idiosyncratic uninsurable earnings risk, Journal of Monetary Economics **83**: 27–38.

Stein, J. C. (2002). Information production and capital allocation: Decentralized versus hierarchical firms, The Journal of Finance **57**(5): 1891–1921.

Stock, J. H., Yogo, M. et al. (2002). Testing for weak instruments in linear IV regression. NBER Technical Working Paper No. 0284.

Tropf, F. C. and Mandemakers, J. J. (2017). Is the association between education and fertility postponement causal? The role of family background factors, Demography **54**(1): 71–91.

Van Bavel, J. (2010). Choice of study discipline and the postponement of motherhood in Europe: The impact of expected earnings, gender composition, and family attitudes, Demography **47**(2): 439–458.

Walker, J. R. (1995). The effect of public policies on recent Swedish fertility behavior, Journal of Population Economics **8**(3): 223–251.

Walter, J. R. (2019). US bank capital regulation: History and changes since the financial crisis, Economic Quarterly (1Q): 1–40.

Wang, Z. (2016). Wage growth, ability sorting, and location choice at labor-force entry: New evidence from US Census data, Journal of Urban Economics **96**: 112–120.

Welteke, C. and Wrohlich, K. (2019). Peer effects in parental leave decisions, Labour Economics **57**: 146–163.

Wilde, E., Batchelder, L. L. and Ellwood, D. T. (2010). The mommy track divides: The impact of childbearing on wages of women of differing skill levels. NBER Working Paper No.16582.

Eidesstattliche Erklärung

Ich versichere hiermit eidesstattlich, dass ich die vorliegende Arbeit selbständig und ohne fremde Hilfe verfasst habe. Die aus fremden Quellen direkt oder indirekt übernommenen Gedanken sowie mir gegebene Anregungen sind als solche kentlich gemacht. Die Arbeit wurde bisher keiner anderen Prüfungsbehörde vorgelegt und auch noch nicht veröffentlicht. Sofern ein Teil der Arbeit aus bereits veröffentlichten Papers besteht, habe ich dies ausdrücklich angegeben.

München, 14.09.2021

Miriam Goetz